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A Theory of Syllabification and Segmental Alternation

With studies on the phonology of French, German, Tonkawa and Yawelmani

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Roland Noske, A Theory of Syllabification and Segmental Alternation (LA 296).

CORRIGENDA

- Introduction, page 1. First sentence should read:

The topic of this thesis is the syllable, considered from the point of view of syllable-changing processes.

- Chapter 5, page 155. Figure (29) should be:

(29) *Archangeli's Yawelmani Epenthesis*

$$\emptyset \rightarrow \overset{\sigma}{\underset{|}{X}} \; / \_\_ \; X'$$

- Chapter 6, page 199. French Syllabification (43) should read:

(43) *French Syllabification*

a. syllable imposition triggered by as yet unsyllabified full vowels (including nonalternating schwas), followed by mapping;
b. *optional* syllable structure imposition, triggered by as yet unsyllabified empty V's (alternating schwas), followed by mapping;
c. dumping;
d. syllable imposition triggered by consonants.

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Introduction

This topic of this book the syllable, considered from the point of view of syllable changing processes.

The syllable is a concept much referred to in various phonological frameworks. In generative phonology, which more than other theories (including classical American structuralist phonology) focussed its attention on processes, the syllable was at first not recognised as a phonological category. This is notably the case in Chomsky & Halle (1968). Rather soon in the further development of generative phonology, however, it was noted that many rules seemed to be related to syllable structure. In a discussion on "natural rules", Schane (1972: 207) mentions a type of rule which he terms "the preferred syllable structure rule". The well-known truncation (or, from a different point of view, liaison) phenomena in French involve for example a rule which deletes the *t* in *petit* in *petit garçon* [pəti gaʀsɔ̃] 'little boy', but which does not affect it in *petit ami*, [pətit ami] 'little friend'. According to Schane, the sort of rule which deletes a consonant before another consonant is a natural rule because it creates a CV syllable structure, which is claimed to be the preferred structure. The opposite type of rule – a rule deleting a consonant before a vowel – would be highly unnatural from the point of view of syllable structure. Schane then continues by saying that (1972: 208)

> ... in French the whole complex interplay of elision and liaison is intended to guarantee the CVCV pattern.

At the stage of development of the theory at which Schane wrote these words, no formal link could be established between syllable structure and syllable-changing processes.

Earlier, Kisseberth (1969a, 1970b) had noted that in Yawelmani, two rules "conspire" to avoid trilitteral clusters. These rules are (Kisseberth 1969a: 136, 1970: 293):

(1) $\emptyset \rightarrow V / C\_\_CC$ (2) $C \rightarrow \emptyset / CC+\_\_$

Although Kisseberth did not mention syllable structure, it is obvious that syllable structure is the real conditioning factor here. Yawelmani does not have syllables more complex than CVC, hence it has no triliteral clusters. In the framework Kisseberth was working in, this conspiracy remained a complete accident – there was no formal reason why the rules in Yawelmani should be organised precisely in such a way as to avoid this type of cluster. Kisseberth himself was not satisfied with the fact that he was not able to express formally the principle he felt condition the "conspiring" rules he had designed. He writes about the state of phonology in 1970 (1970: 293):

> ... the theory of phonology has hitherto been blind to phenomena of this sort, (partially because formal, structural sameness has been emphasized at the expense of functional sameness.)

Kisseberth then asks linguists to look at the relationship he feels exists between the conspiring rules.

We have taken this exhortation as our point of departure. In the course of this work we will develop a theory in which the relationship between syllable structure and the processes alluded to by Schane and Kisseberth has been formalised. Therefore, it will no longer be an accident that rules like the ones discussed by Kisseberth conspire. It will be shown that the phenomena under discussion are in fact conditioned by the syllable structure of the language in question.

In order to be able to formalise this theory, we will take a close look at the representation of the syllable structure, as well as at the way in which syllable structure is created.

Other theories relating to syllable structure and syllabification have hitherto not been successful in providing a satisfactory and genuine explanation for the relationship between the segmental alternation processes and syllable structure.

Regarding the structure of the syllable, these theories include the metrical models proposed by Kiparsky (1979) and Giegerich (1985), the CV-model of the syllable proposed by Clements & Keyser (1983) (and adopted by Wiese (1988)), the autosegmental model without subsyllabic nodes used by Kahn (1976), the $\bar{X}$-model proposed by Levin (1985), the government based phonology by Kaye, Lowenstamm & Vergnaud (1990) and the moraic approach offered by Hayes (1989) and Itô (1986, 1989). With respect to the moraic approach, which has become very popular of late, we demonstrate that this model runs into problems concerning the principles on which it is based. Instead, we adopt the *true constituent model*, in which subsyllabic nodes like onset and nucleus play a role similar to that of autosegments.

With respect to the assignment of syllable structure, basically two approaches have been taken in the literature: the *rule approach*, which represents a bottom-up creation of syllable structure, and the template matching approach, which, if anything, represents a top-down creation of syllable structure. To each theory objections can be raised because the data contain both bottom-up and top-down effects. We propose a theory which we have called the *syllable assignment theory.* Under this theory, syllable structure imposition is combined with the working of the general association conventions of autosegmental phonology. The conflict between a bottom-up and a top-down approach is thus avoided.

This study takes the *principles and parameters approach*, which has been dominant in generative grammar in the last ten years. Following this approach, there is a set of principles provided by Universal Grammar (UG) which explain the behaviour of language. Systematic differences in behaviour between languages are explained by the fact that certain 'switches' or *parameters* are set differently for different languages. In this thesis it will be shown that at least two such parameters play an important role in

the assignment of syllabic structure: the direction of syllable structure assignment, as well as the question of how many subsyllabic nodes are assigned by the process of basic syllable structure assignment.

We will make use here of the principles and parameters approach in a modified fashion. The modification is the following: Universal Grammar is supposed to consist of several simple modules whose interaction accounts for the complex behaviour of language. The extension we will propose pertains to the way in which the modules interact. Hence the organisation of the grammar, i.e. the way in which the modules are configured with respect to each other, and not only the parametrically determined form of the modules, is claimed to be different for different languages. This will be illustrated in our treatment of the syllabification in French. This version of the principles and parameters approach was suggested by Huang (1982), Muysken (1989: 134-135) and Lefebvre & Muysken (1988).

The thesis is organised in a deductive fashion: the general theory we have developed is presented first, in chapter 1. In that chapter, an extensive look will be taken at the internal structure of the syllable, the process of assignment of syllable structure, as well as the way this is triggered. In this way the link between the syllable changing processes and the syllable is established. In the same chapter, syllabically conditioned processes in German, French, Dutch, Navaho and Wiyot will be touched upon, for the purpose of outlining the theory.

In the next chapter, chapter 2, we will treat the moraic theory of syllable structure as devised by Hayes (1989). We will show that this theory is untenable.

The theory will receive its full motivation in the following chapters, where syllable-changing processes of Tonkawa (chapter 3), Yawelmani (with a short interlude on Tigrinya, chapter 4), German (including a comparison to Dutch, chapter 5) and French (chapter 6) will be treated. The analyses presented in this thesis constitute an integration of, and therefore supercede, the analyses of Tonkawa in Noske (1987), of Yawelmani in Noske (1985), of Tigrinya in Noske (1988b) and of German in Hamans & Noske (1988). The analysis of French given in this work significantly differs from the one presented in Noske (1981, 1982, 1988a), which it supplants.

A word must still be said about the transcription method used. Wherever possible, we have used the IPA standard (where *y* stand for a high rounded front vowel and *j* for an unrounded front glide). Only for the cases of Mokilese, Navaho, Tonkawa and Yawelmani have we opted to maintain the 'American' style of transcription (where *y* stands for an unrounded front glide and *j* for a voiced homorganic alveolar affricate (= *dz* in IPA)) originally used in the sources on these languages. As readers should be familiar with both systems, we expect that no misunderstandings will arise.

1 Syllable assignment and the true constituent model

1.1 Introduction: autosegmental theory and syllabification

In our undertaking to develop a theory of syllabically conditioned alternations, which adopts the principles and parameters approach, it is incumbent on us to exploit as many principles as possible which have already received their motivation. Following this approach, principles which govern the linking of tones to segments, as worked out in autosegmental theory starting with Goldsmith (1976) can be expected to be operative in other parts of phonology where there is also a process of linking between different layers. Devising completely different principles for linking phenomena between layers other than the tonal tier and those containing the tone bearing elements would result in severely curtailing the general validity of autosegmental principles.

Apart from these metatheoretical considerations, it should be realised that there is a very close parallel between the process of syllabification, i.e., the assignment of syllabic structure to a string of segments, and certain types of tone assignment. To see this, one has to realise what happens in those cases where a tonal melody is not part of the underlying form, but can be predicted. This is the case in languages where tone is non-distinctive at the word level, i.e. in intonational languages, like Dutch and English, where tone only has a role to play at the phrasal or sentential level, as well as in languages where tonal melodies are assigned to certain word categories. In these types of languages, tonal phenomena involve both the creation of an element or a sequence of elements (a tone melody), as well as the application of a linking process between the tier on which this element is located and the segments (or, skeletal elements). The creation of syllable structure takes place in a completely parallel way. Here too, an element is created (a syllable), which is then linked to a group of segments (or skeletal elements).

Therefore, we will make use of the basic principles of autosegmental phonology. These principles, which deal basically with the erection of links between elements on different layers, have had a long-standing usage in phonology, but have nevertheless hithertofore not been applied in a systematic way in theories of syllable structure assignment. This is primarily due to the fact that at the start of the process of syllable structure assignment, syllable structure is presumably absent, and hence there are no elements to which the segments (or skeletal elements) can be linked. This is assumed to be so because syllable structure is generally predictable.[1] Autosegmental theory, however, originates from the study of tone languages, i.e. languages in which the tones are generally not predictable, and hence should be assumed to be present in the un-

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1 Barra Gaelic (see Borgstrøm 1937, 1940, Clements 1986a) is quoted by some as an exception. In this language, a difference in syllabification is reported to be distinctive.

derlying representation. The application of autosegmental principles to tonal phenomena in languages where tone is not distinctive at the word level is a later development. It was later assumed that in non-tone languages a sentence melody is assigned, and that the principles of autosegmental theory are also operative in these languages.

We will thus advocate an approach in which syllable nodes and subsyllabic nodes – just like sentence melodies – are assigned, and in which the linking between the tiers on which these nodes are located and the segmental (or skeletal) tier takes place by way of application of general conventions, in the same way in which sentence melodies are linked to words and segments.

This approach contrasts with other theories, in that one has to assume that *only* the syllabic nodes and subnodes are assigned at the appropriate level. The establishment of the actual links between segments (or alternatively, skeletal elements) and the syllabic (sub)nodes is done by the same principles that link tones and skeletal elements. Assuming a more specific algorithm of syllabification in fact boils down to duplicating mechanisms of linking elements on different tiers. These mechanisms are universal, so they need not and should not be stated as part of separate rules or processes.

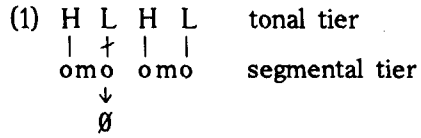
In a common sense view, it may seem strange that relationships between tones and tone bearing units are of the same nature as those between syllables and segments. This may be so because syllables are thought of as *containing* the segments, whereas tones do not contain tone bearing units (if anything, tone bearing units contain tones). This objection, however, stems from a pretheoretical point of view. The type of relationship expressed by loose expressions like "contain" here simply points to a mapping relationship between elements of two different types of set. In mapping, there is no intrinsic relationship as to which tier "contains" another. This is fundamentally different when an instantiation of one category (for example the metrical category phonological word) is projected from a group of elements belonging to another category. In that case, there is clearly a *bottom-up process* in constructing the "containing" category. This contrasts with the assignment of syllable structure, which as we will see, is not merely a bottom-up process. But even in the case of a full bottom-up projection of a higher category, the term "contain" can only be defined in terms of the *process* of hierarchical structure creation (or, bluntly, extrinsic (and therefore in this connection: circular) statements of which category is higher in the hierarchy), *not merely* in terms of a mathematical *relationship* between elements on different tiers. Note that also that the idea of ambisyllabicity (where one segment belongs to two syllables) is incompatible with the pretheoretical notion "contain" (whatever its exact meaning). Therefore, the type of objection outlined here is based on a misunderstanding of the theoretical status of association lines in the framework of hierarchical phonology.

After having developed our theory of syllabification, which we have called *Syllable Assignment Theory*, we will compare it with other theories of syllabification.

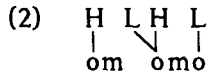
1.2 Some basic concepts of autosegmental phonology

As mentioned, our concept of syllabification exploits all the basic principles of autosegmental phonology, as developed by Williams (1976 (1971)) and Goldsmith (1976). Therefore it is useful to give a short outline of these principles. (For a more extensive overview than the one presented below we refer the reader to Van der Hulst & Smith (1982, 1985) and Goldsmith (1990)).

Crucial to autosegmental phonology (and to nonlinear phonology in general) is the idea of a *multilayered* representation. In their general overview, Van der Hulst & Smith (1985: 14) mention three arguments for separating a tonal and a segmental tier. The first is that it is observed that if an element bearing a tone (a so-called *tone bearing unit* (TBU)) is deleted, the tone may remain and be connected to another TBU. Consider the scematic example in (1) (taken from Van der Hulst & Smith (1985: 14)).

(1)


Initially, the hypothetical form *omo omo* contains an alternating high-low tone pattern, starting with a high tone. However, as shown in (1), the second vowel is deleted, but not the low tone which is linked to it. As a result, this tone is now "floating". In this type of situation it is frequently noted that the floating tone is then linked to another tone bearing unit, even if this unit already bears another tone. In this case the result would be:

(2)


Here a low tone followed by a high tone is linked to what is now the second syllable of the form. The resulting sequence of a low tone followed by a high tone linked to the same TBU is realised as a *rising* tone. The process of linking unlinked tones to tone bearing units that are already linked to other tones is called *dumping* (cf. below for a summary enumeration of the basic principles of autosegmental phonology).

The second argument involves the fact that in many tone languages there are certain morphemes that consist exclusively of a tone or of morphemes that, although they have a tone bearing unit, do not have a tone themselves.

The third argument concerns the fact that words consisting of different numbers of syllables may display behaviour that strongly suggests that they have the same tonal melody. Cf. the following data of Etung taken from Edmundson & Samuel (1966). They give the following melodies on mono-, bi- and trisyllabic words (taken from Van der Hulst & Smith (1985: 14)):

(3)

	1 syllable	*2 syllables*	*3 syllables*
a.	L	L L	L L L
b.	H	H H	H H H
c.	L͡H	L H	L H H
d.	H͡L	H L	H L L
e.	-	L H͡L	L H L
f.	-	H L͡H	H L H
g.	-	L L͡H	L L H
h.	-	H H͡L	H H H

The notations L͡H and H͡L indicate a rising and falling tone respectively. We see here that we have the same tone patterns in forms of one, two and three syllables. If there are not enough syllables to allow for a one-to-one relationship between syllables and tones, the tones are realised as rising or falling tones (so-called *contour* tones).

This has led to the development of the following *Association Conventions:*

(4) *Association Conventions*

a. **Mapping**
Insert association lines between *one* tone and *one* TBU – going from left-to-right/right-to-left – starting with the leftmost/rightmost tone and TBU.

b. **Dumping**
Leftover tones are associated to the nearest TBU to their right/left.

c. **Spreading**
Leftover TBU's are associated to the nearest tone to their left/right.

Let us now see step by step how these principles apply in the Etung case. In Etung, mapping takes place from left to right. (3a) and (3b) are forms that have only one tone. The low tone in (3a) and the high tone in (3b) are linked to the leftmost syllable by the principle of mapping, after which spreading to the following syllable in the bisyllabic forms and to the following two syllables in the trisyllabic forms has to take place.

In (3c) and (3d) there are two tones. In the case of the monosyllabic forms the first tone is linked to the syllable by mapping. The second tone is then dumped on this same syllable. In the case of the bisyllabic forms, mapping takes place from right to left, and after this process neither unlinked tones nor unlinked tone bearing units are left. Hence no spreading or dumping needs to take place.

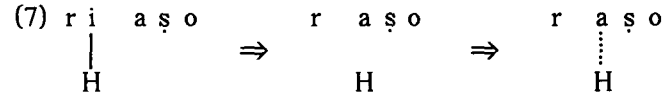
In (3e-h), there are three tones. In the case of the bisyllabic forms the first two tones are linked by left-to-right mapping. The third, leftover, tone is then linked to the rightmost syllable by dumping. In the case of the trisyllabic forms, left-to-right association (mapping) between tones and syllables takes place, and all the nodes are satisfied; there are no empty nodes left over, neither syllable nor tonal nodes.

After Goldsmith had formulated these principles, Halle and Vergnaud (1982) rejected the idea of universal spreading, by showing that prelinked tones (i.e., tones

which are linked to a TBU in the lexicon) do not spread. Subsequently it was shown by Pulleyblank (1983: 117ff) that at least for some languages spreading simply does not apply at all, or not in certain word classes.[2] If it does not take place, a *default value* (usually a low or a mid tone) is assigned to the relevant empty tone-bearing unit. (Although Pulleyblank claims that spreading takes place by rule, it in fact remains a general principle. Whether it applies or not is a parametrised choice.) A comparison of the Yoruba forms in (5) and (6), taken from Pulleyblank (1983: 123-125), shows how default assignment works ("´", "`" and "¯" stand for a high, a low and a mid tone respectively.)

(5) ṣē ò̩ré ⇒ ṣò̩ré 'to be friends'
(6) rí āṣō ⇒ ráṣō 'see a cloth'

We see that a process of vowel deletion is operative here, deleting the leftmost vowel in a sequence of two vowels. In (5), the mid tone which belonged to the deleted vowel has disappeared as well, but in (6), the second vowel has become high, i.e. it has adopted the tone of the first vowel. This is explained as follows: some vowels in Yoruba bear a tone of their own, others are toneless, i.e. without tone of their own. If these vowels end up having no tone, eventually a default tone value, here a mid tone, is assigned to them. In (5), the deleted vowel is toneless (in cases where it is not deleted it eventually receives a (default) mid tone). In (6) however we are faced with the following situation:

(7)


Here the first vowel is deleted, but not the tone which belonged to it. The now floating H (= high tone) is mapped to the next vowel, the *a*, which was toneless (in other cases this vowel shows up with the default mid tone). Since spreading is not operative, the following *o* remains toneless and receives a mid tone by default tone assignment.

We thus have four major principles in autosegmental phonology which, as we will see below, all play a major role in syllabic phonology also: *mapping*, *dumping*, *spreading*, and *default value assignment.*

These four principles reflect the tendency of both tones and TBU's to avoid remaining unlinked. Mapping is either driven by the tones or by the TBU's or both; spreading and default value assignment are driven by unlinked TBU's; dumping is driven by unlinked tones. We will see below that in similar cases where two kinds of superimposed elements are to be linked, it is not always the elements on both layers that trigger the linking processes; in the case of a morphologically induced syllable assignment pro-

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[2] Smith (1985) shows that for Sierra Miwok it has to be stated for each prosodic morphological process in the phonological grammar whether spreading is switched on or not. This shows that spreading can be fully morphologically conditioned.

cesses, like the reduplication cases to be treated in section 1.4, it is only the elements on the higher level, that need to be linked to the lower level, while elements on the lower level may remain unlinked.

1.3 Syllabic structure and empty nodes

Having outlined the principles of autosegmental phonology, we now come to the structure of the syllable. A classic way of looking at the syllable is in terms of a division between onset and rhyme, where the onset contains all the material before the syllabic sonority peak, and the rhyme the remainder of the syllable. The division is given in (8).

(8) 

(σ = syllable; O = onset; R = rhyme)

Thus, a syllable *ta* has the structure given in (9).

(9) 

The bipartition between onset and rhyme has been advocated by, among others, Pike & Pike (1947) and Fudge (1969). One reason that is usually mentioned is that these constituents are relatively independent of each other with respect to syllable weight and phonotactic restrictions; while it is observed that relatively few restrictions hold between *onset* and *rhyme*, there are many restrictions applying within the domains of the onset and of the rhyme themselves.

Because syllable structure is normally predictable, syllable structure is usually taken to be assigned by rule or algorithm rather than to be underlyingly present in the lexicon (but cf. note 1). The process of assignment of syllable structure, syllabification, can be thought of as assigning a specific structure like (8) to a string of segments. According to this conception, the basic subsyllabic nodes like onset and rhyme are always assigned if there is material present in the string that requires to be syllabified. For instance, if a syllable starts with a vowel, (which has to be linked to a rhyme), the onset will be present but empty.

The fact that the onset is present can be demonstrated by a very common type of process, the filling of empty onsets. As a first example, let us consider the optional pronunciation of the word *piano* in French: [pijano].[3] We assume a possible initial syllabification as in (10).

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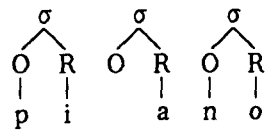
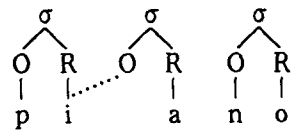
[3] Other possible pronunciations of *piano* in French are [piano] and [pjano]. For an explanation of this variation, see chapter 6, section 6.6.

(10)



The process we are faced with here is one of spreading of the high unrounded front vowel to the empty onset of the second syllable. The behaviour of the *i* is parallel to that of tones and the role of the onset to that of a tone bearing unit, cf. (11).

(11)



Because of the fact that *i* spreads to the onset, which is not the peak of the syllable, it is realised as a homorganic glide, i.e. a non-syllabic high vowel. We thus see that the notion of spreading can be used to explain a phenomenon for which otherwise a rule would have to be formulated. In the SPE-framework, such a rule would be formulated as in (12).

(12) *Glide insertion*

$$\emptyset \rightarrow \begin{bmatrix} -\text{syll} \\ -\text{cons} \\ +\text{high} \\ \alpha\,\text{round} \\ \beta\,\text{back} \end{bmatrix} \Big/ \begin{bmatrix} +\text{syll} \\ +\text{high} \\ \alpha\,\text{round} \\ \beta\,\text{back} \end{bmatrix} \_\_\_\_ \; V$$

This rule, of course, explains nothing. It explains neither why the glide inserted after the high vowel is homorganic to that vowel, nor why glide insertion takes place precisely before a vowel and not before a consonant. Other syllabification theories which do not employ the notion of empty nodes have the disadvantage of having to state specific linking rules. In such a framework (see, e.g., Hayes (1989)), a rule like the following one has to be formulated:[4]

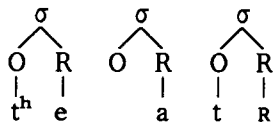
(13)

[4] Hayes (1989) does not use the concept of rhyme, but uses morae instead. For reasons of exposition, we have maintained the rhyme node in (13). We will come back to mora theory in the next chapter. There it will be shown (section 2.3.1.1) that the linking of the V directly to the syllable node (i.e. without an intervening onset-node as in (13)), presents additional problems in that in doing so the principles of autosegmental phonology are violated in a fundamental way.

Although here we are faced with a far more general and elegant rule than the SPE type rule in (12), it still does not explain why the process of linking the high vowel to the second syllable takes place precisely if and only if this syllable starts with a vowel.

Another example of an autosegmental process can be seen if we consider a process of onset filling in German. In German and indeed many other languages, foot-initial vowel which is underlyingly in word-initial position or which is word-internally preceded by a nonhigh vowel, automatically gets a glottal stop in front of it.[5] Hence a word like *Theater* is pronounced as [t^he?atʀ].[6] We can thus say that the syllable structure assigned by syllabification is as in (14).

(14)



It can be assumed that a neutral, or default consonant is now assigned by an automatic process. This default consonant is usually a glottal stop, but it can also be, for example, a *t* as in the case of Axininca Campa described by Payne (1981: 107ff).

The process of onset-filling can be schematised as in (15).

(15)

$$\emptyset \rightarrow ? \; / \; \text{Foot}\left[\begin{array}{l} / \\ O \\ | \\ \_\_ \end{array}\right.$$

(15) says that an empty onset is filled with a glottal stop. It should be noted that (15) is not really a rule that needs to be stated. One only needs to state in the grammar that a foot-initial onset cannot be empty in German, and that the glottal stop is the neutral (or: default) consonant; language independent principles will take care of the rest. We are thus faced here with *default value assignment*, which, as we have seen in section 1.1., is an autosegmental principle, along with spreading.

If this process were accounted for in a linear framework, then we would have to write the following rule:

(16) *SPE type glottal stop insertion*

$$\emptyset \rightarrow ? \; / \; \left\{\begin{array}{l} V \\ \# \end{array}\right\} \_\_ \; V$$

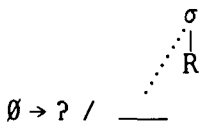
---

[5] In the case of a high vowel as first part of a heterosyllabic vowel sequence, instead of default *?*-insertion, spreading takes places as in the French case. Hence *Hiat*, 'hiatus' is pronounced as [hija:t]. In Dutch (and also in certain varieties of German) also mid vowels spread and hence *theater* in Dutch is pronounced with a glide: [te·ja:təʀ]. We will come back to this in chapter 2, note 7.

[6] In a large number of varieties of German, a postvocalic or syllabic *r* is fully vocalised and is transcribed as [ɐ], [ʌ] or [ɒ]. In this book we have opted not to show this full vocalisation (which must be a late process) and to use [ʀ], for greater transparity. See also on this chapter 5, section 5.2.

Again we see that a consonant is inserted before a vowel and not before another consonant, something a linear framework cannot explain. If we try to formulate a rule in a hierarchical syllabic framework, but without empty subsyllabic nodes, we get a rule like the following:

(17)



Although, like rule (13), this rule is more elegant than its respective linear counterpart, it does not explain why a glottal stop is inserted before a rhyme and not before a consonant.

The type of phenomena discussed here suggests that syllabification can generate empty syllabic nodes. It is these empty nodes that then trigger syllabic adjustment processes. The nature of the processes that occur is completely governed by the principles of autosegmental phonology. Here we have seen two cases of onset filling. Onset filling takes place either, as in the French case, by spreading of the high vowel to the empty onset position, or, as in the German case, by insertion of the neutral (or default) consonant glottal stop. It indeed seems that if there is a segment that needs to be syllabified, a complete syllabic structure consisting of onset and rhyme is superimposed onto the string of segments, and processes to fill the empty nodes can take place (although this will not necessarily happen in all languages).

1.4 Reduplication phenomena

Up to now, syllabic structure has been represented with only two basic nodes, onset and rhyme. We will claim that this syllable structure is not universal. Below, we will see that syllabic structure contains empty nodes in certain cases. Assuming that empty nodes trigger readjustment processes like those exemplified in the preceding section, we shall shortly focus our attention on reduplication phenomena.

But first we have to settle a terminological question. In the discussion above we referred to a syllable consisting of two nodes by using the traditional terms onset and rhyme. In the following discussion we will make a distinction between this kind of syllable, which is binodal, and a syllable type consisting of three nodes. These nodes are termed *onset*, *nucleus*, *coda*. In order to avoid terminological confusion we will refer to the nodes of a binodal syllable as *onset* and *nucleus*. *Nucleus* will thus indicate the second node of a syllable regardless of whether this syllable is binodal or trinodal in nature.

We now come to the reduplication phenomena. Recently, these phenomena have attracted the attention of a number of linguists. McCarthy & Prince (1986) convincingly

show that in many languages, reduplication can be seen as the assignment of an extra syllable of a specific shape to a copy of the string of the root. Consider the following data from Mokilese taken from Harrison (1976: 60-61) by McCarthy & Prince (1986: 21).

(18) *Mokilese Reduplication*

	Verb stem	progressive	
a.	pɔdok	pɔd-pɔdok	'plant'
b.	wadek	wad-wadek	'pick'
c.	kookɔ	koo-kookɔ	'grind coconut'
d.	caak	caa-caak	'bend'
e.	pa	paa-pa	'weave'
f.	wi.a	wii-wi.a	'do'

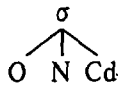
In (18f) "." indicates a syllable boundary. We see here that the reduplicative prefix has the form of a long syllable, which either has the form CVC (in the cases of (18a,b)) or CVV in the cases of (18c-f). In the cases of (18a-d) the reduplicative prefix is simply a copy of the first three elements of the stem. This is not the case in (18e,f). Here, the reduplicative prefix cannot simply be a copy of the first three segments of the stem, since the stem itself consists of just two segments. In these latter forms, the vowel of the stem has apparently been copied into the reduplicative prefix and subsequently lengthened. As mentioned by McCarthy and Prince, this can adequately be accounted for by assuming that the reduplicative prefix is a heavy syllable.

They state that the reduplicative prefix simply has the form given in (19) (μ stands for mora).

(19) *Reduplicative prefix:* $\sigma_{\mu\mu}$

By this they mean a heavy syllable, which contains two morae. As is well known, the mora is the weight unit used by the Prague school and literature on poetic metre. McCarthy and Prince do not assume that a syllable consists of nodes like "nucleus" (or "rhyme"), but contains one or two (in exceptional cases three) morae. For present purposes, we translate their assumption into our framework and shall assume that such a bimoraic syllable has the following form:

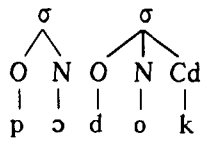
(20)

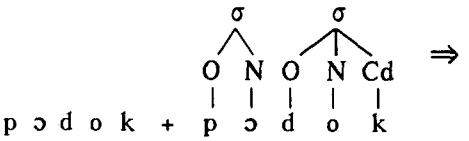


(N = nucleus
Cd = coda)

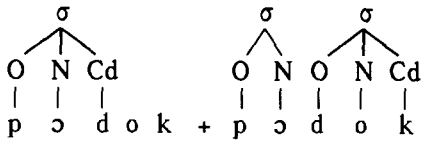
The process of reduplication in Mokilese can then be assumed to take place as follows: on the melodic (or segmental) tier, a copy of the stem is prefixed place to the stem itself. The reduplicative syllable is then superimposed onto this form and one-to-one association (mapping) takes place from left to right. Examples of this process are

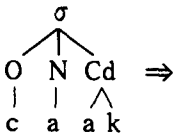
given in (21) and (22), which correspond to (18a) and (18d) respectively:

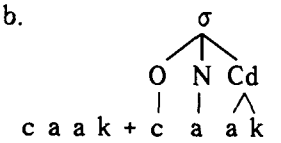
(21) a. 

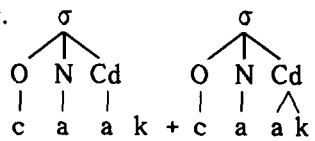
⇒ b. 

⇒

⇒ c. 

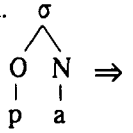
(22) a. 

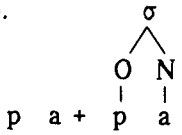
⇒ b. 

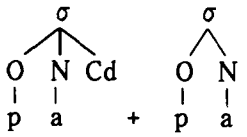
⇒ c. 

The reader may wonder why in the reduplicated form in (22) the final *k* of the copy of the stem is not linked to the coda of the reduplicate syllable, or to the onset of the second syllable. Below, at the end of the next section (1.5), we will show that this is because reduplication, unlike regular syllabification, is a morphological operation. We will demonstate that this type of morphological operation does not involve linking of as yet unlinked segments to a subsyllabic node which itself is already linked to another node. (Even if dumping applied here, *k* could not be not linked to the onset of the second syllable for the additional reason that *kc* is not a possible onset in Mokilese).

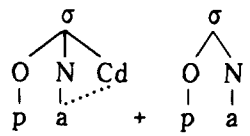
Now consider what is going on in (18e). Here mapping of elements on the melodic tier to subsyllabic nodes will fail to fill the third subsyllabic node, cf. (23):

(23) a. 

⇒ b. 

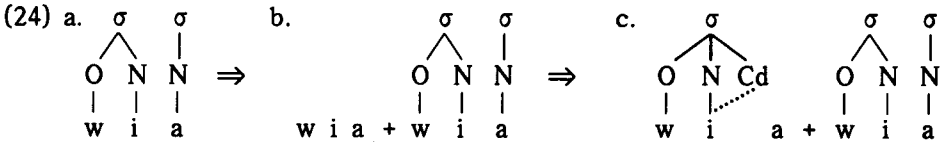
⇒ c. 

Then, as in the tonal literature, spreading will take place, producing the outcome *paa*:

(23) d. 

That reduplication in Mokilese really involves assignment of a heavy syllable and not copying of the first three segments of the stem is confirmed by the data in (18f). If only copying were involved the outcome would be *wia-wia*, instead of the observed *wii-wia*. Assignment of a heavy syllable explains why we do not find w*ia-wia*. A reduplicate of

the form *wia-* would not consist of one (heavy) syllable, but of two syllables. Instead the first two segments of the melodic tier are incorporated into the reduplicative affix and subsequently spreading takes place:[7]

(24) 

Apart from examples involving filling of the third position of the syllable in reduplication, we also find examples of onset filling in reduplication phenomena. Compare the following examples from Oykangand, again quoted from McCarthy & Prince (1986: 15), whose source is Sommer (1981: 237):

(25) *Oykangand Reduplication*

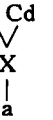
a. /eḍeṛ/	'rain'	eḍeḍeṛ	'heavy rain'
b. /algal/	'straight'	algalgal	'straight as a ram rod'
c. /igu-/	'go, walk'	igigun	'keeps going'

---

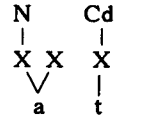
[7] Unlike (24), the coda node in (22) does link to an *a*. This vowel, however, is preceded by another *a*. The two subsequent *a*'s in (22) must in fact be seen as a simplified representation for two adjacent slots on the CV- or X-tier linked to the same segment: (i) 

The configuration in (i) represents an underlyingly long vowel. In a language where long vowels are permitted, but diphthongs like *ia* are disallowed, only slots on the CV or X-tier that are the second member of an underlying long vowel can be incorporated into the right margin node.

We thus see that there are two possible representations for vowels that are long on the surface, those given in (ii) and those given in (iii): (ii) 

(iii) 

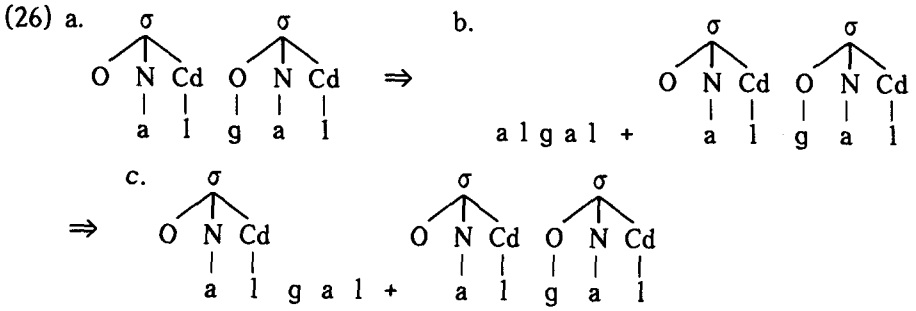
The structure in (ii) represents an underlyingly long vowel which is syllabified into two subsyllabic nodes, and hence is also long on the surface. The structure in (iii) represents a vowel that is not long underlyingly but which has acquired surface length by the process of spreading: the single X-slot has been linked to two subsyllabic nodes. This lengthening process takes place only in a language where the process of spreading such as in (24c) is operative.

A vowel can also be underlyingly long but short on the surface. This type of case can be found when the syllable structure does not permit the second X slot of the long vowel in (i) to be connected to the coda. This may happen if the coda is already filled with a segment. Such a case is displayed in (iv), where the syllable is closed by a *t*. (iv) 

An example of such a shortening process can be found in Yawelmani (see chapter 4, section 4.4.1).

We see here that the reduplicate sometimes consists of two, sometimes of three segments. This can be explained in the following way: the reduplicative syllable is a heavy one. The initial syllable of the stem contains an empty onset. Cf. (26), which refers to (25b).

(26)



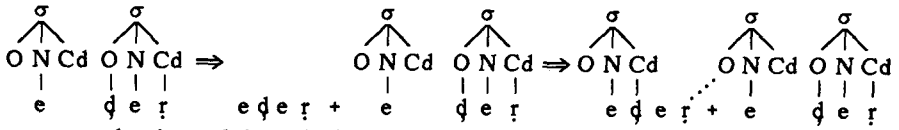
Apparently, the mapping of the elements of the reduplicative copy on the segmental tier onto the tier containing the subsyllabic nodes (also called segment bearing units, cf. section 1.5) does not stop at the end of the syllable inserted by the process of reduplication. There is another empty node, the onset of the stem syllable, that is open for linking. Because of the process of reduplication, which involves the insertion of a copy of the melodic elements of the stem, the onset can now be filled.[8]

---

[8] In Oykangand, words may not begin with a consonant. Sommer (1981) has analysed this restriction as a restriction on the syllable. In his view, the *g*'s in *algalgal* belong to the first and second syllable respectively, because a syllable also cannot start with a consonant. This position has been criticised by McCarthy & Prince (1986: 15-16), who point out that the reduplication does not support this unusual claim. We have here adopted McCarthy & Prince's view, and rephrased their analysis in terms of our framework.

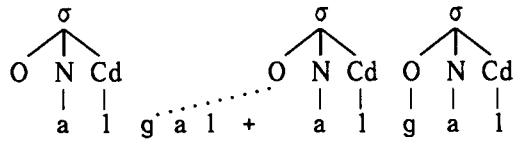
The reason why we do not get spreading in the reduplicated forms in (25a,c) (e.g. **eḍḍeḍeṛ* and **iggigun*) is not known, but there are two possible explanations. The first possibility is that spreading does not take place in this language, but only association. The second is that although spreading is available in the language, there is a general constraint against geminates. In both cases, the intervocalic consonant will be transferred from the right margin position of the first syllable to the onset position of the second syllable due to a general constraint on a third position filled with a consonant followed by a syllable with an empty onset.

One can also raise the question why the reduplicated form in (25a) is not **eḍṛeḍeṛ*, which would be derived in the following way:



The reason why the *ṛ* of the reduplicate does not map to the onset of the second syllable is possibly that the mapping should be contiguous, i.e., the mapping process stops whenever a segment is encountered (here *e*) which cannot map to a subsyllabic node.

(26) d.



After having seen the application of the autosegmental principle of spreading to a basically syllabic process (in the French case in (8)), as well as the application of the process of default value assignment, also an autosegmental principle (in the German case in (11)), we are here faced with the application of a third autosegmental process, the most fundamental of all, i.e. that of one-to-one association (mapping). Below, in section 1.5, where we define more precisely our concept of syllabification, we will see that the fourth fundamental principle of autosegmental phonology, viz. dumping, also has a role to play in syllabic phonology.

1.5 Syllabification and the true constituent model

Here we will treat in more detail our theory of syllabification. Generally, up till now, two types of theory of syllabification have been proposed. The first one is the *rule approach*, advocated in different versions by, among others, Kahn (1976), Steriade (1982), Levin (1985). In essence, it says the following:

(27) *Rule approach to syllabification*

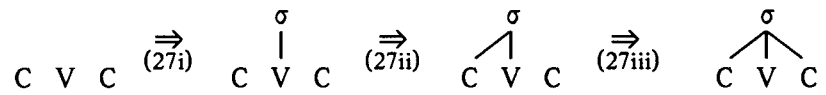
(i) one syllable is associated with each [+voc] segment of the string;

(ii) a maximum number of consonants is associated with the syllable containing the [+voc] segment following them. The consonants must form a permissible syllable-initial cluster;

(iii) the remaining consonants are associated with the syllable containing the [+voc] segment preceding them. These consonants must form a permissible syllable-final cluster.

An example is given in (28).

(28) (string to be syllabified: CVC)

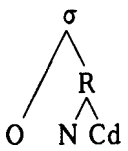


As Itô (1986: 4-7) points out, this approach has to stipulate syllabification rules, while other models of syllabification can derive the desired result by invoking independently needed principles. The rules in the rule approach duplicate part of the well-formed-

ness conditions on syllable structure (in Itô's terms: prosodic licensing) which are needed independently.

The second type of syllabification is known as the *template matching approach.* General mapping procedures map the string of segments to a syllable template, which functions as a set of well-formedness conditions. Such an approach is adopted by among others, Halle & Vergnaud (1978), Selkirk (1982), Noske (1982, 1988a), Itô (1986, 1989). The form of a template varies according to the authors, but often has a structure as in (29):[9]

(29)



(N = nucleus, Cd = Coda)

Additional conditions can be applicable to the template. For an example, see the template and conditions proposed for French in Noske (1982: 259-261, 1988a: 46-48). These conditions have to state, e.g., which constituents are obligatory and which are optional. For example, it can be assumed that the nucleus (or peak) of the syllable must always be present. In some languages also the onset is obligatorily present. In addition, it must be stipulated how many segments may be linked to a specific node, and what their cooccurence restrictions are.

It must be realised, however, that if the template were only a set of well-formedness conditions, the template would not itself trigger phonological processes. It would only block derivations in two types of cases: (i) in the case in which a node must be present and phonetically realised and there is no segment which can be linked to this node, and (ii) in the case where one finds segments in the string that cannot be parsed into subsyllabic nodes, because it contains segments that cannot cooccur. This latter situation would arise e.g. if the string contained a sequence of three intervocalic consonants or a sequence of two consonants and the syllable template allowed only for a single consonant in both the onset and the coda.

In contrast to the concept of the template as a set of pure well-formedness condi-

---

[9] The structure is (29) is a hierarchical one, in the sense that there is branching at a level below the syllable node. Davis (1982, 1985) has argued that the arguments for a such a hierarchical structure are at least questionable by showing among other things that many distributional restrictions do not apply between constituents in the rhyme, but, e.g., between the coda and the onset. He instead assumes a flat structure:

We have assumed here tacitly a non-hierarchical structure of this type. In addition, as we show in this chapter, syllable structure is sometimes bipositional and sometimes tripositional. As mentioned, we refer to the second node in a bipositional syllable structure (which is called "rhyme" by many authors) as well to the second node in a tripositional structure (which is called "nucleus" by many authors) as in a tripositional syllable as "nucleus". This is done to avoid the use of a confusing terminology.

tions, it has often been proposed that template mapping actually involves the creation of empty nodes which are present in the template but to which no segments correspond, as a result of the mapping process. Subsequently, either default segments are inserted into these empty nodes, or linking of the nodes to segments that are already linked to other nodes takes place, i.e., spreading. Above we have seen that this takes place in German and French respectively for empty onsets. Insertion of a default vowel can take place in empty nuclei (see ter Mors (1985) for Klamath, Noske (1985) for Yawelmani, Itô (1986, 1989) for Axininca Campa, Icelandic, Arabic, Temiar). Linking of empty nuclei to vowel segments already linked to other nuclei takes place in many Bantu languages when these languages adjust loan words of a more complex syllable structure to their own syllable structure requirements, because they allow in general only for open syllables.

We thus see that in the literature cited, the template is not exclusively used as a set of well-formedness conditions, but as the superimposition of a certain hierarchical structure. We think that there has been a general failure to realise that a theory in which the template approach triggers syllable repair mechanisms like onset and nucleus-filling crucially involves the imposition of a certain hierarchical structure. It thus seems that in such a theory, the template is of a complex and hybrid character: it is the expression of a set of well-formedness conditions as well as the assignment of a certain structure.[10]

It is clear that this double role for the template shows that the theory is not well developed on this point. In the last decade, generative linguistics has in both syntax and phonology developed into a framework in which the interaction of very simple submodules accounts for the complex processes which are observed in language.

Therefore, it is better to separate the two roles of the template. As mentioned above, not all conditions are expressible within a template. In our view, then, syllabification is *only* the *assignment* of syllable structure, while *conditions*, which now can take a more simple form, are expressed separately. Most of these conditions will be applicable to one of the domains defined by the nodes onset, nucleus, coda.

In order to distinguish the type of syllable structure we propose from that of the template matching approach (where as we have seen its status is unclear), we will refer to our model of the syllable as the *true constituent model.*

The syllabification theory we propose derives from the assumptions of autosegmental phonology. It makes use of the same association conventions. These conventions apply between the tier containing segments and the one containing subsyllabic

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[10] In Itô (1986, 1989) the word *template* seems to have an unstable meaning. At the only place where she (vaguely) explains what a template is, it is a well-formedness condition: "A template is a kind of wellformedness condition defining the possible skeletal sequences of a language ..." (1986: 4). However, at other places she refers to it as a structure: "... the template is already filled ..." (1986: 70), "... epenthesis is formally association of a segment to a syllable template ..." (1986: 133), "associate *r* to the postnuclear position in the syllable template" (Icelandic Syllable-Mapping Epenthesis, 1986: 183), "... epenthetic segmental material is inserted to satisfy a syllable template *already present*" (1989: 239, italics ours).

nodes, just like they apply between the tier containing tones and the one containing tone bearing units. Because of this parallelism, we will refer to the subsyllabic nodes as segment bearing units (SBU's).

We assume, then, that syllabification takes place as follows:

(30) *Syllable Assignment Theory*

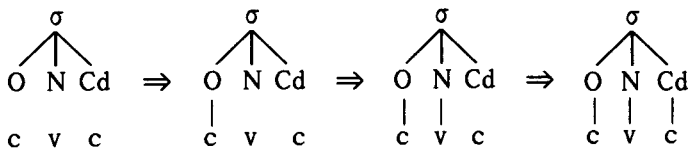
> The string of segments is scanned for nonsyllabified segments in a directional way (RL or LR). If a nonsyllabified segment is encountered, a syllable of the canonical shape is superimposed onto the string of segments. Then, optimal linking between the segments and segment bearing units takes place, according to the general conventions of autosegmental phonology. Then the scanning process begins again, etc.

The directionality of syllabification has been proposed by many linguists, e.g. Steriade (1984), ter Mors (1985), Noske (1985, 1987, 1988b), Dell and Elmedlaoui (1985), Itô (1986, 1989). In chapter 4, sections 4.4.1 and 4.4.2, we will give evidence that the direction of syllabification is determined by a genuine parametrised choice in that several seemingly independent phenomena can be explained by the parameter setting.

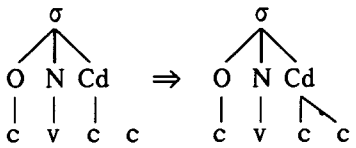
The linking according to the general autosegmental phonology conventions simply involves association in a one-to-one fashion (mapping) of the segments to the subsyllabic nodes. This mapping is triggered by the subsyllabic nodes that were inserted when the first unsyllabified segment was encountered by the syllabification mechanism. Then, inasmuch as the well-formedness conditions permit, dumping takes place. It is in this way that an onset can be filled with more than one element. If an SBU has not been linked to any segment by one-to-one association or by dumping, then either the SBU will be filled with a default segment, or a segment already linked to another SBU will spread to it.

Here we see that all four major autosegmental principles concerning the linking of elements to their bearing units apply. The diagrams in (31) illustrates the workings of the four principles (*v* = vowel, *c* = consonant; we have abstracted away from intervening skeletal nodes or hierarchical branching of features within the segments; the default segment we have assumed for the nucleus in (31d) is *ə* (which is perhaps the default segment most frequently observed in languages, along with *i*)).

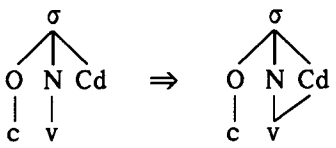
(31) a. *mapping* (direction in this example: left to right)



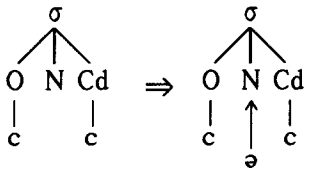
b. *dumping*



c. *spreading*

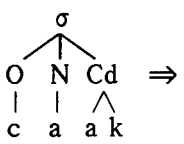


d. *default value assignment* (assumed default value here for nuclei: ə)

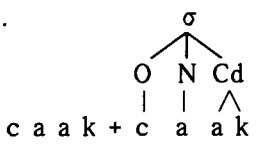


By assuming the syllable assignment in (30), we have considerably narrowed the gap between normal syllabification and the processes of reduplication in e.g. Mokilese and Oykangand, as outlined in section 1.3. Recall that in these languages reduplication is the imposition of a specific syllabic structure on a copy of the verb root. Afterwards, association takes place. There remains only one major difference. The assignment of a syllabic structure to a verb root copy is a morphological operation, and is thus *driven by the SBU's* of the specified syllable, inserted by reduplication (this applies here especially to reduplication in Mokilese), while in regular syllabification it is the result of the phonological requirement that all normal elements (i.e. not forming part of a reduplicate copy) are required to be syllabified. Hence, with reduplication, there is only an obligation for the SBU's to be filled (i.e. linked to a segment) while the segments, on the other hand, do not need not to be linked to the SBU's. Therefore, one-to-one association (mapping) will take place, as well as spreading, but not dumping. It is for this reason that in Mokilese the reduplicated form in (18d) is *caacaak* and not **caakcaak* (cf. (22), which is repeated here).

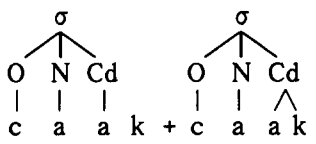
(22) a.



⇒ b.



⇒ c.



This also explains why in general in reduplication, if the root contains a complex onset, the onset of the reduplicate usually contains only the first element of that of the original.

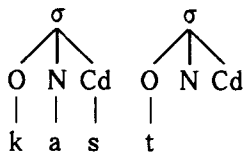
In the formulation of the Syllable Assignment Theory (30), it was mentioned that the string of segments is scanned for nonsyllabified segments. This statement should be amended on one point: for the case of Tonkawa, to be treated in chapter 3, we will see that segments of a particular category (in this case vowels) do not by themselves induce the superposition of a syllable. Therefore, it may be a parametrised choice as to

which segments induce the superposition of a syllable. Usually all segments do, so the choice for a particular group of segments (as in the case of Tonkawa, where only consonants trigger the superposition of syllables), is the marked one. We should briefly mention here shortly a situation that can logically arise after the syllabification algorithm (30) has applied. A conflict can arise between the syllable assigned by the algorithm in (30) and the (separate) conditions on wellformedness of the syllable. Let us take a case in Afrikaans. Cf. the forms in (32) (Norval Smith, personal communication).

(32) a. kas /kast/ [kɑs] 'cupboard'
b. kaste /kast+ə/ [kɑstə] (plural)

Because of the *t* in the plural of this form (which is not predictable), the underlying form of the singular must contain a *t*. However, the syllable structure conditions of the language do not allow a syllable to end in *-st*. Therefore, the syllable assignment algorithm and the association conventions will produce the following situation. (For the sake of the argument we assume that the algorithm applies from left-to-right (the choice is not critical here, right-to-left syllabification would lead to the same results, be it in a slightly more complicated way), and that the assigned syllable contains three nodes as we will shortly make plausible below for Dutch (in section 1.6.1)).

(33)



The second syllable in (33) is ill-formed: the nucleus is not linked to any segment, a situation forbidden in any language. We are therefore faced with a conflict here between the fact that *t* needs to be dominated by a syllabic node and the fact that the second syllable is ruled out by the syllabic well-formedness conditions. This situation can be resolved in three ways.

The first one is that there is a spreading process filling the empty nucleus with another segment. However, no such segment is available. Only *t* could spread to the nucleus, because otherwise, association lines would be crossed (and as well known, this is generally forbidden by a most fundamental principle (perhaps the most fundamental) principle of autosegmental phonology). The segment *t*, however, cannot itself spread to the nucleus node, since Afrikaans, like nearly all other languages does not allow for syllabic *t*'s. In addition, as will be argued for in chapter 5, there is a general prohibition against the spreading of a segment from the onset position to nucleus position.

The second possibility for resolving the conflict indicated above is that a default segment be assigned to the nucleus node in (33). The assignment of a default segment for a given node may not be operative in a given language (in this way, onsets can remain empty).

If it is now assumed that there is no default segment assignment for nuclei in Afrikaans, then only one way out (i.e., our third possibility) remains. Because the second syllable in (33) is illicit (since its nucleus is not linked to a segment), this syllable is ultimately deleted. As a result, *t* is also deleted because it is not linked to a syllable anymore. Hence *t* is phonetically not realised. This type of conflict resolution plays a major role in Unification Grammar (Carlson & Linden 1987, Shieber 1986, for an application to phonology see Wiese 1990). We will return to this in chapters 2 and 4.

1.6 The nature of the assigned syllable

The reader will have noticed that the reduplicated syllables in section 1.4 contain three basic nodes. This is in contradistinction with the usual onset-rhyme (in the terminology employed here: onset-nucleus) bipartition, which is usually adopted as universal. We have also seen some spreading effects to the third position (e.g. in (23d)).

We now come back to the theme this chapter started with. It seems that these same spreading effects take place during regular syllable assigment for certain languages. Let us consider a few cases.

1.6.1 Dutch

In Early Middle Dutch, there was a process of vowel lengthening in open stressed syllables (van Bree 1977: 281-282, van Loon 1986: 86-90, Schönfeld 1970: 30).[11] Although the process is no longer productive, the functioning of the process can still be seen in present-day forms:[12]

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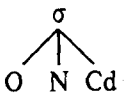
[11] It is claimed by some that in Middle English essentially the same process has taken place. See, e.g., Strang (1970: 249), Steponavičius (1987: 167-168). In the opinion of others, however, (e.g. Dobson 1962) the process in Middle English was not that general and was subject to other factors.

[12] The lengthening as displayed in (34) is sometimes reproduced in modern loan words. Hamans (1989: 140) reports that the plural of the name of the Kanak tribe in New Caledonia, which was quoted on the radio and in certain newspapers as [ka:na:kən] (orthographically *Kanaken*), while another newspaper used the form [ka:nɑkən] (orthographically *Kanakken*). The lengthening seems to be regular in the plural formation of certain learned word categories, mostly belonging to the areas of physics or chemistry. Examples are *neutr[ɔ]n/neutr[o:]nen, alkan[ɑ]l/alkan[a:]len, g[ɛ]n/g[e:]nen.*

(34)	*orthographic form*	*phonetic form*	*underlying form*	
a.	dak	[dɑk]	/dak/	'roof'
b.	daken	[da:kən]	/dak+ən/	(plur.)
c.	god	[χɔt]	/χod/	'god'
d.	goden	[χo:dən]	/χod+ən/	(plur.)
e.	weg	[ʋɛχ]	/ʋeχ/	'road'
f.	wegen	[ʋe:χən]	/ʋeχ+ən/	(plur.)

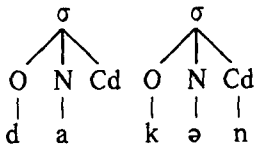
The singular form in (34c) also shows the working of the well-known process of final devoicing. It can be assumed that the syllabification of the plural forms involved the superimposition of a syllable of the form:

(35)



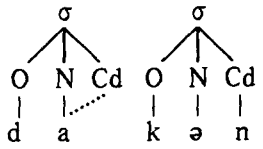
After one-to-one association but before spreading we arrive at the following structure for (34b):

(36) a.



We then get spreading:

(36) b.



As mentioned above, this process is no longer productive. A plural of the form in (37b), is not pronounced with a long vowel.

(37)	*orthographic form*	*phonetic form*	*underlying form*	
a.	heg	[hɛχ]	/heχ/	'hedge'
b.	heggen	[hɛχən]	/heχ+ən/	(plur.)

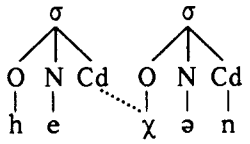
Cf. also the forms in (38) of which the singular forms in (38a,c) are homophonous, but the plural forms in (38b,d) constitute a minimal pair:

(38)

	orthographic form	*phonetic form*	*underlying form*	
a.	pad	[pɑt]	/pad/	'path'
b.	paden	[pa:dən]	/pad+ən/	(plur.)
c.	pad	[pɑt]	/pad/	'toad'
d.	padden	[pɑdən]	/pad+ən/	(plur.)

According to Van der Hulst (1984: 103) forms like (37b) and (38d) contain an ambisyllabic consonant, which is short on the surface. In a recent article Smith et al. (1989) reminded phonologists that phonetic measurements have revealed that this shortening does not fully take place. Indeed Nooteboom (1972: 33, 39-40) has found that consonants following short vowels in Dutch are statistically significantly longer than those following long vowels. This can be explained elegantly by assuming that in the course of history of Dutch the direction of spreading has simply been reversed. Instead of spreading from the left, spreading from the right takes place, hence the following consonant is linked to the empty third syllable position:

(39) *Modern Dutch:*



Hence the difference between Early Middle Dutch and Modern Dutch in this respect can be explained by the change in the setting of a single parameter. The fact that there are still plurals in Dutch behaving like the ones in (34) must be due to diacritical marking in the lexicon. The diacritic would indicate that the direction of spreading is reversed for these forms. Children learning Dutch frequently overregularise and pronounce the form in (34b) as [dɑkən]. In each case, it must be concluded that the syllable assigned during syllabification in Dutch contains three positions and not two, in Modern Dutch as well as in Early Middle Dutch.

1.6.2 German

The situation in German is not very different from the one in Dutch. Writing in a somewhat different framework from ours (i.e. that of CV Phonology, based on Clements & Keyser (1983)), Wiese (1988: 87) stresses that in his framework the minimal syllable nucleus in German must contain two elements:

(40) Nucleus

Wiese (1988: 67) mentions that

> Ein langer gespannter Vokal kann in der Umgangssprache als kurzer ungespannter Vokal realisiert werden [...]. In diesen Fällen muß der folgende Konsonant aber in den Auslaut der ersten Silbe übernommen werden, d.h., er wird ambisilbisch, falls nur ein einziger Konsonant zur Verfügung steht. Eine auf gekürzten Vokal endende Silbe ist ausgeschlossen.
>
> ('A long tense vowel can be realised as a short lax one in colloquial language [...]. In these cases however, the following consonant will become associated with the end of the first syllable, i.e. it becomes ambisyllabic in cases where there is only one consonant available. A syllable ending in a shortened vowel is impossible.')

After having mentioned that this phenomenon of vowel shortening typically, but not exclusively, takes place in non-native words especially when the vowel does not carry the main stress, Wiese (1988: 68) gives the following examples of this type of alternation (a dash over the consonant means that it is ambisyllabic):

(41)	a. Afrika	[a:-fri:-ka:]	vs.	[af̄-rīka:]	'Africa'
	b. Metall	[me:-tal]	vs.	[mɛt̄al]	'metal'
	c. zumal	[tsu:-ma:l]	vs.	[tsum̄a:l]	'even more so because'
	d. Philosophie	[fi:-lo:-zo:-fi:]	vs.	[fīlo:-zōfi:]	'philosophy'
	e. Kalender	[ka:-lɛn-dɐ̯]	vs.	[kal̄ɛn-dɐ̯]	'calender'
	f. Kuli	[ku:-li:]	vs.	[kūli:]	'coolie'

We can conclude that in German, when a vowel is shortened, the position it occupied in the third SBU of the syllable in question becomes empty and it then undergoes spreading from the following consonant.[13] This, combined with the fact that a syllable

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[13] In chapter 5, we will see that the schwa/zero alternations in German can be explained as a direct consequence of syllabification. The analysis presented there crucially involves directional syllable assignment exactly as in the proposal in (30), with the direction set from right to left, and a tripositional syllable. That analysis will provide additional arguments for a tripositional syllable in German, independently of the phenomena mentioned by Wiese.

For reasons of exposition we have deliberately simplified matters somewhat. The usage of the term "canonical syllable" is slightly misleading in the case of German and Dutch. In these languages, syllables are always long, except in the case of schwa syllables (see Van der Hulst 1984, Lahiri & Koreman 1988). If during the right-to-left scanning process, a schwa which is as yet unlinked to syllable structure is encountered, then a binodal syllable is imposed. If during the same process, another unlinked segment is encountered, a trinodal syllable structure is imposed. In order not to confuse the reader at this early stage of the exposition of our theory, we have also rendered schwa syllables as trinodal.

ending in a short vowel is excluded in German, demonstrates that the syllable in German tripositional.[14]

1.6.3 Wiyot

Wiyot is an Algonquian language spoken in North Western California. The main source is Teeter (1964). In Wiyot, the syllable is nearly always heavy. Teeter writes (1964: 16-17):

> Wiyot syllables always begin with a consonant or cluster followed by a vowel. Where the vowel is short they must also phonetically end in a consonant, the same as that of the beginning of the next syllable, except at the end of a word.

It is clear that the situation in Wiyot is quite similar to that in Modern Dutch. There are apparently three positions in the syllable, and spreading takes place from right to left. Thus the third position of the syllable is filled by the preceding consonant. At the end of a word, where there are no following segments from which spreading can take place, nothing happens, and this is thus the only position where we find light syllables. Apparently there is no filling of subsyllabic nodes by default segments in this language.

1.6.4 Navaho

In their monograph on the phonology and morphology of Navaho, Sapir and Hoijer (1967: 3-4) report that when "an initial or medial CV (sc. syllable, R.N.) precedes another syllable that begins with a consonant, the consonant of the second syllable is mechanically lengthened" (the process is reported as "consonant doubling" by Young and Morgan (1987: xv). Sapir and Hoijer give the following examples:[15]

(42) a. dišaah ⇒ diš.šaah 'I start to go'
b. tążii ⇒ t^{x}ąž.žiih 'turkey'
c. niyol ⇒ niy.yol 'wind'

In (42b) and (43) (below) If we assume that a syllable contains three positions, it is quite clear that this "mechanical" lengthening can be understood as the result of a spreading process, just as is the case in Wiyot and the Germanic languages. There is more evidence for a canonical three-place syllable in Navaho, as Sapir and Hoijer continue:

---

[14] Open syllables with shortened tense vowels do occur in certain circumstances e.g. in *Mutti* [mʊti] 'mama'.

[15] In (41b) the effects of a velar aspiration process (Sapir & Hoijer 1967: 6) can also be seen, changing *t* and *k* to *t*^{x} and *k*^{x} respectively.

> CV syllables that occur independently in final position in the word are invariably closed with an h. Strictly speaking, then, CV does not occur independently or in final position: the h which closes a CV syllable is phonemically identical with the final h of a CVh syllable.

As examples Sapir and Hoijer give:[16]

(43) a. to ⇒ t^{xw}oh 'water'
b. to.n̥.li̥ ⇒ t^{xw}o.n̥.li̥h 'river'

This can be explained by the assignment of a default consonant, *h*, to the final (third) SBU in the syllable. It may be no accident that *h*, like the glottal stop we encountered in the German case, is a glottal consonant. These segments are probably the most neutral consonants of all because they have no supraglottal articulation: they can be considered as minimal consonants.

Finally, Sapir and Hoijer note:

> Followed by n̥, n̥C, or VV, (V and the other syllabic consonants do not follow CV), the boundary of the CV syllable is marked by a fall of sonority between its vowel and the n or V which follows.

This is the case in e.g. (43b) (in the first syllable), as well as in the following forms cited by Sapir and Hoijer. (The drop in sonority is not indicated):

(44) a. n̥.di.nɬ.ti̥ 'you have found him'
b. n̥.lo.ee 'Hail Chant'

We think that this "drop in sonority" must be interpreted as the same kind of default assignment as the h-insertion at the end of a word. *h* in fact also constitutes a drop in sonority, more specifically a drop in voicing. If it is assumed that this is one and the same process, and that the introduction of the drop in sonority equals the insertion of a segment, the picture becomes quite clear. V's and syllabic nasals cannot spread to preceding coda positions, because they are syllabic by nature: there is no evidence of gliding in Navaho, so it must be assumed that an element cannot spread from a nuclear position to a nonnuclear position, or that syllabic elements are subcategorised for exclusively nuclear positions). Hence, only the principle of default value assignment remains in order to fill the empty SBU.

It can be concluded, then, that Navaho also has basically a tripositional syllable.

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[16] The aspiration referred to in note 14 is labiovelar before *o*, *ɔ*, hence changing *t*, *k* to *t* and k^{xw} (Sapir & Hoijer 1967: 6).

1.7 Summary of the Syllable Assignment theory

In this chapter, we have presented an outline of a theory of syllable structure and syllabification, which explains the nature of syllabically conditioned epenthesis and deletion processes. In saying *explained* we mean that these processes can be seen as the direct result of syllabification. We went through the following steps:

First, it was demonstrated that very general insertion processes like glide insertion (in hiatus position) or glottal stop insertion (in hiatus position as well as at the beginning of a word starting with a vowel) can best be seen as the filling of empty positions. By assuming this, these processes can be seen as the result of the general application of the principles of autosegmental phonology, in this case spreading and default value assignment. These principles have found their motivation elsewhere in phonology. Not assuming empty nodes means that one has to posit specific rules. This would of course result in a failure to capture generalisations.

Second, we showed that reduplication in certain languages involves the superimposition of a specific syllable type, involving three positions (or subsyllabic nodes), to a copy of the stem. In addition, we saw that in the case of Oykangand, spreading takes place from the copy of the stem to the empty onset position of the syllable to which the stem itself is linked.

Third, we posited a syllabification theory in which, as in reduplication, a specific syllable is superimposed on the segments. The only difference is that this superimposition is segment driven (or more precisely, skeleton driven if one adopts the presence of the skeleton as an intervening layer between the segmental melody and the subsyllabic nodes) and not triggered by the morphology, as in the case of reduplication. It is this type of syllabification, which, in conjunction with the independently motivated principles of autosegmental phonology, will be shown to account for syllabically conditioned alternation processes in a very natural way.

Fourth, we adduced evidence from the Germanic languages Dutch and German, as well as from the Amerindian languages Wiyot and Navaho that the syllable superimposed by syllabification contains three positions and not two, just as the syllable superimposed by Mokilese reduplication contains three positions. This was done by showing how spreading applies in all of these languages, as well as default assignment in the case of Navaho.

We can thus conclude that the observed difference between the West Germanic languages and languages like Wiyot and Navaho on the one hand and many other languages on the other is the result of a difference in the nature of the syllable assigned by syllabification.[17]

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[17] In Noske (1985, 1987) and in chapters 3 and 4 below we show that for Tonkawa and Yawelmani respectively we need to posit a basic tripositional syllable as well. In these languages, syncope processes like "two sided open syllable deletion" (C → Ø / VC __ CV) are clearly syllabically conditioned. Michaels (1989: 4-5) shows that the same is true for stressed syllables in English. This seems to disprove Vennemann's claim (1988: 2) that no syllabically conditioned process can go in the direction of a more complex syllable than CV.

This latter result is of great importance for the following chapters. We will see that the concept of a tripositonal syllable is crucial to the understanding of the nature of the syllabically conditioned alternation processes in Tonkawa (chapter 3) and Yawelmani (chapter 4). The difference between a bi- and a tripositional syllable will also be shown to play a role in the explanation of the differences in schwa/zero alternation in German and French (chapters 5,6). The choice between a bipositional syllable and a tripositional syllable is one of the parameters along which languages vary. The second parameter, concerning the directionality of syllabification, was mentioned in section 1.5, in our formulation of the syllable assignment theory (cf. (30)). A demonstration of the existence of this parameter will be given in chapter 4, regarding Yawelmani.

But before we go on exemplifying our own theory and the analysis of specific languages therein, we will first treat, in chapter 2, a competing type of theory for reasons of comparison and clarification.

We have already mentioned the rule and template matching approaches, and have mentioned that they are both unsatisfactory from the point of view of the analysis of alternation processes related to syllable structure. However, apart from labelling theories based on the way syllabic structure is built, theories can also be classified by the type of subsyllabic structure they use.

For this, we return to the issue of empty subsyllabic nodes, and the role the subsyllabic nodes are require to play to play during the erection of syllable structure. Most theories of syllabification do not provide for empty nodes.[18] In the template matching approach (inasmuch the theory is not equivocal on this point and hence meaningless), this is so because templates are wellformedness conditions and not imposed structures.

In the rule approach, nodes are projected from segments or skeletal slots. Hence empty nodes like onset cannot come into existence if there is originally not a segment or skeletal slot to project it from.

In a theory as we propose it, the subsyllabic nodes have a dual role: they are there for skeletal slots to be mapped to, and they contain subcategorisation features. An onset node can only be mapped to a consonant (or glide), a nucleus node can only be mapped to a vowel (or, inasmuch the language permits, e.g., syllabic liquids and nasals, also to liquids and nasals).

Another type of theory of syllable structure does not recognise the existence of subsyllabic nodes at all. Instead, this type of theory uses the concept of *mora*, which stems from metrical theory and incorporates this into syllable structure. In the next chapter, we will treat this moraic theory in some detail.

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[18] The government based phonology as proposed by Kaye, Lowenstamm and Vergnaud (1990) also allows for empty nodes.

2 Moraic versus constituent syllables

2.1 Introduction

Recently, there has been a trend, particularly among linguists in the United States, (e.g., Hyman (1984, 1985), McCarthy & Prince (1986), Itô (1986, 1988), Hayes (1989), Archangeli (1989, 1991)), towards models in which the concept of mora, defined as the element which expresses phonological weight, plays a major role in syllable structure. More specifically, syllabic subconstituents and elements expressing syllabic weight have been identified with each other.

Hyman (1984, 1985) was the first to contribute to the current wave of interest in the mora as a syllabic building block. In his theory, moras replace syllables altogether. He takes the radical view that it is not the *syllable* which is basic, but *syllabicity*. The basic concept expressing syllabicity is the Weight Unit (WU). Each segment has a WU. Onset consonants become weightless by the working of the universal Onset Creation Rule (OCR), given in (1) (1985: 15):

(1)

The circle around the *X* indicates that this element is delinked and subsequently deleted. The OCR reduces the underlying two WU's of the sequence *ta* to one. Hence it expresses the fact that onsets are generally not weight-bearing. At the same time, the OCR accounts for the general observation that in a CVCV sequence, the second C belongs to the second syllable.

Hyman does not wish to distinguish between C's and V's. In his theory, the most sonorous element dominated by a WU is the 'bearer' of syllabicity. This assumption was strongly criticised in a review by Odden (1986). Odden shows that under Hyman's assumptions it is not possible to distinguish between elements which only differ in syllabicity, e.g., English 'ear' [ir] vs. (reduced) 'your' [jr̩] (1986: 670). Odden also points out (1986: 670-671) that Hyman's theory cannot account either for the contrast between syllabic and nonsyllabic C's in comparable environments. This contrast occurs in certain languages, e.g. Kimatuumbi.

Hayes (1989) tries to remedy Odden's objections to Hyman's theory. In this article the author devises a different moraic syllable model and tries to show that this particular version of moraic theory is capable of explaining compensatory lenthening phenomena (henceforth: CL). According to Hayes, his theory predicts the existing types of CL and excludes the nonexisting types.

Hayes' theory, which has been quite influential during the past two years, has been widely accepted as a theory of the internal structure of the syllable. We wish to challenge this theory and the concept of an internal syllable structure based on the mora in general, and to show that a true constituent model of the syllable, based on autosegmental principles of structure building, is more adequate.

Below, we will give a summary of Hayes' theory. Then, we will show that this theory entails a breach of fundamental and necessary assumptions in nonlinear phonology. We will also show that some important presumed facts on which the theory is based are incorrect.

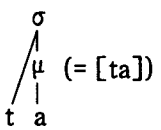
Finally, we will show that the theory presented in chapter 1, viz. the combination of the true constituent model of the syllable and the syllable assignment theory based on autosegmental principles, predicts the existing types of CL and excludes the non-existing types, while it does not encounter the theoretical difficulties characterising mora theory.

2.2 The moraic theory of Hayes (1989)

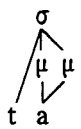
2.2.1 Syllable structure and syllabification

Hayes argues that various types of compensatory lengthening phenomena provide evidence for a model in which segments are dominated by moras, rather than by skeletal elements (X's, or C's and V's). By using moras, syllable weight is expressed directly in the syllable structure. Vowels normally bear a mora underlyingly, while consonants do not. It is in this point that Hayes' theory differs significantly from Hyman's: elements which are not usually syllabic do not underlyingly bear a mora in Hayes' theory (except for geminate consonants, see below).

In a language in which both CVV and CVC syllables count as heavy, the following structures are assumed for the three types of syllables (μ = mora):

(2) a. 

(= [ta])

b. 

(= [ta:])

c. 

(= [tat])

In a language where a CVC syllable does not count as heavy the structure of this syllable is:

(2) d. 

In this theory, there are two sources for moras. Moras can be underlying or can be assigned by rule. Let us first take underlying moras. The three way contrast between nonsyllabic vowels (glides), short vowels and long vowels is expressed by the contrast in domination by zero, one and two moras respectively. The forms in (3a,b,c) represent a glide, a short vowel and a long vowel respectively (Hayes 1989: 256).

(3) a. i = /j/ b. μ | i = /i/ c. μ μ \ / i = /i:/

As for consonants, geminates are underlyingly represented as being dominated by one mora, while single consonants are not dominated by a mora:

(4) a. n = /n/ b. μ | n = /nn/

Syllabification in Hayes' mora theory takes place by "(a) selection of certain sonorous moraic segments, on a language-specific basis, for domination by a syllable node; (b) adjunction of onset consonants to the syllable node, and of coda consonants to the preceding mora" (1989: 257):

(5) a. σ σ σ
μ ⇒ μ ⇒ μ
t a t a t a

b. σ σ σ
μ μ ⇒ μ μ ⇒ μ μ
t a t a t a

c. σ σ σ
μ ⇒ μ ⇒ μ
a t a t a t

d. σ σ σ
μ ⇒ μ ⇒ μ
a n t a n t a n t

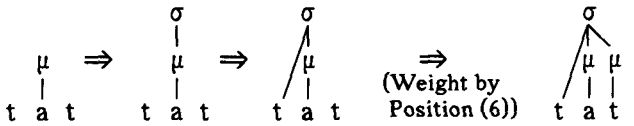
Hayes treats syllabification only in a cursory manner. He does not explain why coda consonants are linked to a mora while onset consonants are linked directly to the syllable node. Note that the second part of his syllabification proposal (the adjunction of the onset and coda consonants) in fact consists of the working of the autosegmental convention of *dumping*. In (5c) the derivation produces a light CVC syllable, because there is only one mora. Languages in which a CVC syllable counts as heavy, are assumed to have an additional language specific rule, which *assigns* a mora to a consonant in a specific position: the *Weight by Position* rule (1989: 258):

(6) *Weight by Position*

σ σ
| \
μ → μ μ where σ dominates only μ
| | |
α β α β

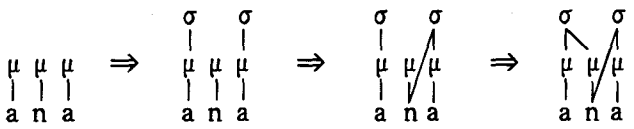
If this rule is present in the rule inventory of the language in question, the derivation of a CVC syllable proceeds as follows:

(7)



Heterosyllabic geminates are syllabified as follows:

(8)



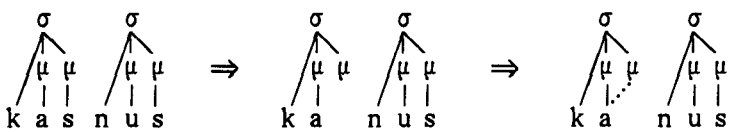
The consonant melody linked to the second mora is "flopped onto the following vowel-initial syllable. This creates an onset (hence a preferred syllable structure)." (Hayes 1989: 258). This is all Hayes says about the mechanism of flopping. It is apparently conditioned by the fact that the following syllable is vowel-initial and that the preferred syllable structure is consonant-initial. Note that although Hayes uses the term 'onset', the onset has no formal status as a node in Hayes' theory.

Note also that the mechanism of 'flopping' is different from normal onset formation in Hayes' model. As we have mentioned above, normal onset formation is an instantiation of the autosegmental concept of dumping. 'Flopping' however is not dumping, because the element (the consonant) which is linked to the second syllable node is already linked to syllabic structure. Neither is it spreading, because the node (σ) to which the consonant is linked is already linked to other elements. We will come back to the question of 'flopping' below in section 2.3, when we evaluate the merits of Hayes' theory. For reasons that will become clear below we will refer to this type of 'flopping' as 'simple flopping' (as opposed to 'double flopping', to which we will come shortly).

2.2.2 'Classical' compensatory lengthening

We now come to the processes of CL. The role of moras in CL is that they are preserved when the elements they dominate are deleted. Then, other, nondeleted, elements can spread to them. An example is pre-Latin *cānus* /kasnus/ → [ka:nus] 'grey' (a case of 'classical' CL (Hayes 1989: 262)):

(9)

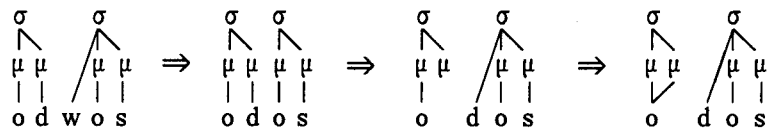


Apart from this 'classical' type of CL, Hayes presents other types. We mention a few of them here, as an illustration.

2.2.3 The 'double flop'

First, the 'double flop'. This term refers to CL phenomena where the loss of the onset of a syllable results in the lengthening of a vowel in the preceding syllable. Examples are the following forms in Ancient Cyrenaean and Ionic Greek:[1] *ξενϝος ⇒ ξηνος (*ksenwos ⇒ kse:nos*) *'stranger'*, *ὁδϝός ⇒ ὠδός (**odwos ⇒ o:dos*) *'threshold'*. The lengthening process resulting from the loss of the *ϝ* (*w*) is usually classified by philologists of Ancient Greek (like Bartoněk 1966: 68-70) as the third compensatory lengthening of Ancient Greek.[2] Of this process, Hayes gives the following account (1989: 266):

(10)



Here the *d* is detached from the second mora and is linked to the second syllable. Presumably, because the *d* cannot be a geminate in this dialect (Hayes remains silent on this point), the mora is emptied, and the vowel can spread to the mora, hence it is lengthened. The double flop differs from the 'single flop' in that the *d* is detached from the first syllable. Hayes does say why the 'double flop' occurs. He writes (p. 266) "when the /w/ deletes the /d/ desyllabifies, eliminating the highly marked syllable juncture *od.os*. The resyllabification empties a mora and allows the preceding vowel to lengthen." We could interpret this in two slightly different ways. Either the *d* delinks

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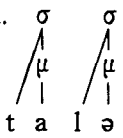
[1] Hayes mentions that the form as shown here could be found in Ionic (his sources are apparently Steriade (1982: 118) and Wetzels (1986: 310)). However, as Buck (1955: 49-50) and Lejeune (1972: 82, 159) indicate, the forms *o:dos* (ὠδός) and *kse:nos* (ξηνος) are found in Cyrenaean (a Doric dialect), while in Ionic the forms are found as οὐδός and ξεῖνος respectively. The ου and the ει here indicate vowels (often transcribed as o̜, e̜) whose quality was more closed than the sound indicated by ω [o:] and η [e:]. The ου in time became raised to *u:* in the relevant dialects (Lejeune 1972: 230). The reason for the difference between ω, η and ου, ει is that in many dialects, (as Attic and Ionic) the omikron and the epsilon differed in quality from the omega and the eta respectively, the short vowels being more closed. As a result, the lengthened varieties of ο and ε retained the quality of their short counterparts and did not fuse with ω, η (Buck 1955: 28).

[2] The process termed by Hayes as 'double flop' is by no means limited to the 'third CL'. It is also displayed by forms where the lengthening was the result of the loss of another consonant like in Attic-Ionic *ἀγγελσαι ⇒ ἀγγεῖλαι (*aŋgelsaj ⇒ aŋge:laj*) 'announce' (inf. aor.), Homeric (= Early Ionic) *ἔκρινσε ⇒ ἔκρῖνε (*ekrinse ⇒ ekri:ne*) 'judge' (3rd pers. sing. aor.) (Lejeune 1972: 126-128) (see also Bubeník 1983: 58, Steriade 1982: 148 and Wetzels 1986: 306).

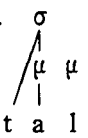
first and is then linked to the second syllable, or the linking to the second syllable is an independent process, identical to the 'simple flop' (see above), but which this time triggers the delinking of the consonant from the second mora of the first syllable, because the language in question does not allow for geminates (i.e., multiply linked consonants). Although Hayes is not explicit on this matter, the name 'double flop' seems to suggest the second possibility.

2.2.4 CL through vowel loss

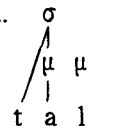
A third type of CL we wish to exemplify here as an example of the treatment of CL in Hayes' theory is CL through vowel loss. An example is the Early Middle English form [talə] which changed into [ta:l], Modern English *tale* (Hayes 1989: 268, quoting Minkova 1982 and Hock 1986). After the deletion of the schwa dominated by a mora the principle of Parasitic Delinking takes effect. This principle reads (Hayes 1989: 268): "Syllable structure is deleted when the syllable contains no overt nuclear segment." The effect of Parasitic Delinking on the output of the schwa deletion process is as follows:

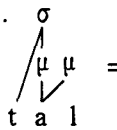
(11) a. 

(schwa drop) b. 

(parasitic delinking) c. 

Note that the mora has been conserved, due to a stability effect. When the form in (11c) has been arrived at, the CL process of Middle English, which says "fill empty moras by spreading from the left" (Hayes 1989: 269), takes effect. This results in the following derivation:

(12) a. 

b. 

c. 

2.3 Criticism of Hayes' theory

So far the illustration of Hayes' theory. At this point a short and preliminary evaluation of the mora theory is in order. The advantages of Hayes' theory are at first sight twofold: (i) there is a direct representation of the syllable weight in the syllabic structure and (ii) the phenomena of CL can be accounted for easily. Hayes contrasts his theory on CL with theories involving other types of syllable structure and demonstrates that

under the assumption of these types, one can just as easily derive nonexisting types of CL as existing ones. Therefore, these theories are devoid of explanatory power. This type of theory is termed 'X-theory' by Hayes, because the processes take place at the skeletal level. We will come back to this in a moment.

2.3.1 The nature of the representation

However, there are severe drawbacks to Hayes' theory. Let us first consider the nature of the multilinear structure Hayes uses. Since the type of representation Hayes uses is in fact a set of dominance relationships, one would consider his representation to be a metrical one. However, as we have seen, he also uses autosegmental principles like spreading and dumping. Therefore, one would think the representation is autosegmental. This leaves us with a question. Autosegmental and metrical representations each have their own defining restrictions. In each of the subtheories, autosegmental and metrical, there are theory-specific notions which have received their motivation through these restrictions. Therefore, for both theories, we need to consider whether Hayes' theory complies with the respective restrictions.

2.3.1.1 Moraic syllable structure and autosegmental theory

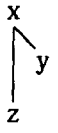
Let us first consider Hayes' type of representation from an autosegmental point of view. To do this, we should investigate whether his representations in fact comply with the constraints of autosegmental phonology. One immediately notices a lack of congruence in the theory of mora assignment: while a syllable initial consonant (or *onset* consonant, but note that the onset has no formal status as a node in mora theory) is directly linked to the σ-node, in the case of vowels there is an intervening μ-node. This particular type of configuration has been devised, as we have seen, to express the fact that syllable-initial consonants do not contribute to syllable weight, while vowels (and sometimes postnuclear consonants) do, as well as to provide a medium, through the principle of moraic conservation, for the preservation of syllable weight (i.e., compensatory lengthening).

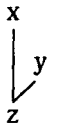
Hayes uses the mechanisms of spreading and dumping which have their motivation in autosegmental phonology, as a device for establishing links between elements on differents tiers. In the autosegmental model, the multi-layered phonological representation is a metaphor for relationships between members of different ordered sets of elements. The ordered sets are the tiers which in themselves constitute linear sequences of elements (hence the ordered character of the sets). The relationships between members of the sets are the association lines between these tiers. One of the essential constraints which define autosegmental phonology is the constraint that if association of one element to another element takes place, this second element

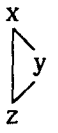
should be on an adjacent tier. Association cannot *skip* tiers on which elements are located and link elements which are in the same plane (or bidimensional space), but not on adjacent tiers. In other words, the restriction is that elements of a given set can only be linked with members of one other *single* set of elements above them and another *single* set of elements below them. We call this restriction the principle of *planar tier locality.*[3]

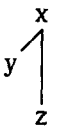
In fact, planar tier locality is a necessary consequence of the idea of the plane. To see this, one should realise what happens if one makes it possible for an association line to go through a tier without being linked to an element on it. If one wishes to link three elements x, y and z which are on three different tiers in one plane, there is only one possibility if planar tier locality is to be obeyed, i.e. the configuration in (13a).

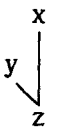
(13) a.

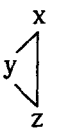
b. 

c. 

d. 

e. 

f. 

g. 

If, on the other hand, one does not wish to obey this principle, the representations in (13b,c,d,e,f,g) become equally possible. We see that the number of possible representations is septupled. Not without understatement perhaps, one could say that non-observance of planar tier locality makes the theory less restrictive. In fact, with this demonstration it is easy to see that if there is no requirement to be local for a link, the whole idea of tier ordering is meaningless and there is consequently no difference (in terms of possible relationships between elements) between a plane (a bidimensional space) and a space with an infinite (or more precisely: unspecified) number of dimensions.

A related problem is the one concerning the interpretation of the possible representations. If one drops the requirement of planar tier locality, e.g. the following configurations would be possible.

(14) a. 

b. 

The only reason why these particular configurations do not occur is that Hayes' rules happen not to generate them. The configurations in (14) are, however, not ruled out in principle by any geometrical principle in Hayes' theory, and at least it should be possible to ascribe interpretations to (14a,b) (and also to representations of the type of (13b-g)). But it is totally unclear what the systematic phonetic interpretations of (14a,b) could be. In a theory which uses autosegmental principles, as Hayes' theory seems to

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[3] We owe part of this argument to Richard Wiese.

do but which, in addition, obeys the principle of planar tier locality, configurations like in (14) cannot occur.

Planar tier locality, together with the prohibition of crossing association lines (perhaps the most fundamental principle of nonlinear phonology, introduced by Goldsmith (1976)), and the general principles of euclidian geometry (only one line can be drawn between two points, lines cannot 'jump' one another) are defining properties of autosegmental phonology. If one does not obey them, the mechanisms of association, spreading and dumping in autosegmental theory become infinitely powerful. This is so, because then any element on any tier can be linked to any other element on any tier. If one accepts this as a possibility, anything goes and there are no restrictions on representations whatsoever (and there is no theory). As we have just seen, Hayes' theory, although it crucially uses the autosegmental mechanism of dumping, fails to obey planar tier locality.

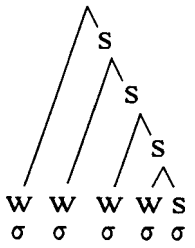
2.3.1.2 Moraic syllable structure and metrical theory

As mentioned, Hayes' theory seems in fact also part of metrical phonology. One of the defining notions of metrical theory is the notion of hierarchy and, related to this, the notion of dominance (in autosegmental theory, only the notion of multilinear representation is crucial). But one of the results of the representation adopted in Hayes' theory, in conjunction with the fact that autosegmental conventions like spreading and dumping are operational in syllable structure in this theory, is that the notion of dominance has become meaningless.

To see this, recall from the previous subsection the fact that in this representation planar tier ordering is not obeyed. As a result, by the working of the association conventions, or by the application of a rule, it is possible to link any element to any other element through any element in the same plane, regardless of the intervening tiers. This situation is intolerable for any solid theory using multitiered representations, including metrical theory. It cannot be used to express *dominance* since it cannot be decided what the relationship (in terms of dominance) between two elements is. In dominance relationships, a starting symbol (in syntax: *S*, *CP*, or *E*, in metrical phonology $\overline{U}$ for utterance, in one version of autosegmental phonology *X* for a skeletal slot) is linked to the lowest element through intermediary elements.

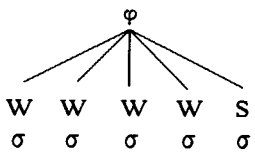
Let us now look at restrictions proper to metrical theory. Metrical theory, just like the $\overline{X}$-theory in syntax (Jackendoff 1977), crucially uses the notion of *head* (or *designated terminal element*) and the principle of *binary branching*. Originally (as in Liberman & Prince 1977), metrical theory used the binarity involving the nodes *s* (strong) and *w* (weak). The simplest form of metrical phonology does not use nodes with categorial labels, as in the following example (taken from the introductory article by Van der Hulst and Smith (1985: 30)):

(15)



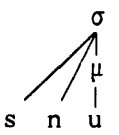
Very early in the development of metrical theory (in fact starting with Liberman & Prince 1977), labeled nodes (like feet) within the metrical tree were assumed. But the branching remained strictly binary, because this is the result of a very fundamental principle: in the metrical theory proposed by Hayes himself (1981, 1982, 1987), even for the unbounded feet (where a designated terminal element can be preceded or followed by an in principle unlimited number of elements within the same foot, in contrast to binary feet) the branching principle of the foot itself is binary.[4] For instance, a right dominant foot containing five syllables has the structure as in (15) (with a foot symbol (φ) dominating the tree), and not as in (16), which is an ill-formed structure in Hayes' (1981, 1982) theory:

(16)



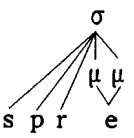
Binary branching is in fact the expression of the idea of *relative strength* of elements with respect to each other on a given tier. Let us now look at syllable structure again. Hayes (1989: 269, 277, 292) assumes the following structures for syllables starting with more than one consonant:

(17) a.



b.

c.



The *i* in (17b) is interpreted as a glide because it is not dominated by a mora (cf. (3a)) (the example is from the putative Middle English form [pasiens] ⇒ [pa:sjens] (Modern English [pejʃəns])).[5]

The n-ary branching here is a result of the syllabification model chosen by Hayes. This syllabification model, which lacks intermediary nodes, through which binary

[4] In his 1987 article, Hayes uses grids instead of trees. These grids, however, can be translated into trees, and are equivalent to them in the relevant aspects. Hence the criticism expressed here is also valid for Hayes (1987).

[5] See section 2.4.7 (below) on the working of CL in the word *patience*.

branching can take place, is itself the result of the fact that no difference is made between subsyllabic nodes and moras. If one does assume branching nodes below the level of the syllable for onset consonants, this means that one has to identify which nodes contribute to weight, and which do not. The direct representation of syllable weight in geometrical terms, which as we have seen is one of the advantages of Hayes' theory, would be lost. In fact, we would be back in the same old situation in which one had to state that certain nodes (e.g. the onset (= the branching node before the mora)) do not contribute to syllable weight, while elements dominated by the other nodes, like nucleus and coda (or rhyme) do.

It has to be concluded that Hayes' theory obeys the defining properties and restrictions of neither autosegmental nor metrical theory. This leaves us with the question of what the defining restrictions on representation of his theory are (if there are any). Unfortunately, we cannot answer this question, since Hayes does not provide us with any further theoretical basis. We are therefore forced to conclude that Hayes (1989) uses notions of autosegmental and metrical theory that, because they have been taken out of their theoretical context, have no motivation.

2.3.2 The principle of moraic conservation

There is a second major point on which Hayes' theory violates the basic assumptions of metrical theory. As we have seen in CL by vowel loss (cf. (11), the mora continues to exist, although the element which it dominated *as well as* the element it was dominated by, have been deleted. It is peculiar that this element continues to exist, while a higher element, the syllable node, *in the same dominance structure* is deleted as a result of the deletion of a lower element, the segment (as a result of parasitic delinking).

Therefore, one could ask why the mora does not undergo parasitic delinking as well in this case, just as the syllable. This question in fact remains unanswered: 'moraic conservation' is vital to the theory, but is not needed for any other phenomenon than CL. It is therefore not independently motivated, and is just an axiom needed in the theory. We will come back to this question in section 2.3.5, when we take a close look at Minkova's (1982, 1985) accounts of CL through vowel loss.

2.3.3 High vowels and glides

Another interesting point is the behaviour of high vowels and glides. As was mentioned in the introduction, one of the drawbacks of Hyman's theory reported by Odden, is the fact that there can be no contrast between otherwise identical elements in the same environment. This was remedied by Hayes through allowing syllabic segments (e.g. high vowels) to be dominated by a mora underlyingly, while he assumed that corresponding non-syllabic elements (e.g. glides) are not dominated by a mora. This, how-

ever, has other, but related, undesirable consequences. Although in many languages, one can observe a contrast between syllabic segments and corresponding nonsyllabic ones in the same environment, perhaps the more normal case is that there is an alternation in syllabicity of the segment type in question, conditioned by syllable structure. Thus, normally, a high vowel in front of a non-high vowel will become a glide. In order to account for this state of affairs, Hyman developed his universal Onset Creation Rule (given in (1), above). A drawback is that there are a fair number of exceptions which cannot be accounted for, because it is claimed that the rule is universal. The change made by Hayes makes it indeed possible to account for otherwise identical segments to be syllabic or nonsyllabic in the same environment. But in the majority of cases, the choice of the realisation of a segment as a high vowel or as a glide depends on whether the segment is in prevocalic position or not.

For these cases Hayes' (1989) theory cannot account. To account for them, one would have to devise a rule that deletes the mora from an underlying element (assuming that it underlyingly bears a mora, as a high vowel would do), or one that adds a mora to an element (e.g. to a liquid when this liquid becomes syllabic under certain conditions). If one posits that these rules are universal, we are back to the original problem pointed out by Odden, namely that (i) there are certain languages which do not obey these rules and that (ii) certain forms in certain languages do not obey these rules, whereas otherwise they do obey the rules.[6] In fact, Hayes seems not to have really solved the problem noted by Odden.

2.3.4 Spreading and 'flopping'

There is another problem concerning glides. Although the notion of spreading plays a crucial role in the account of CL in moraic theory, other apparent occurrences of this mechanism cannot be accounted for because the node to which spreading should take place is lacking. A clear case is the spreading to onset position. An example is the apparent insertion of a homorganic glide after a high vowel followed by a heterosyllabic vowel in many languages (Dutch, English, French, German, just to mention a few) in a word like *piano*. We have already seen this in section 1.3, form (11), of chapter 1 (for German, see note 5 of chapter 1). In a theory involving full subsyllabic constituents, the spreading can be described in a fully autosegmental way:

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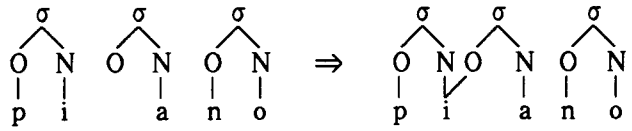
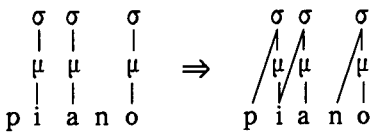
[6] This latter situation is found in French, where there is free alternation between high vowels and homorganic glides, if a postconsonantal high vowel is in hiatus position, e.g, *lier* [lie] ~ [ljе] 'to bind', *l'ouest* [luɛst] ~ [lwɛst] 'the West'. In certain words, however, especially of foreign origin, the element in this position is always a glide (and as such does not trigger the deletion of schwa in the article *le*) e.g., *le yaourt* [lə jauʀ(t)] 'the yoghurt' (see Kaye & Lowenstamm 1984: 135ff).

(18) 

In Hayes' theory, this would have to be accounted for by the syllabification rule of adjunction of prevocalic consonants (mentioned above):

(19) 

Because the *i* is adjoined to the following syllable node and is not dominated by a mora which itself is dominated by the second syllable, it is realised as *j* in this syllable (cf. 3a). In this way, the high vowel functions in a way identical to the geminate *n* mentioned above (the (single) 'flopping' case, see (8)). This is the moment to take a closer look at 'flopping'.

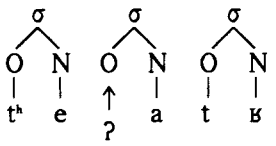
In fact, the mechanism of 'flopping' receives no motivation at all in Hayes' theory. All that is said about this is that it takes effect if there is a following vowel- initial syllable (1989: 258). "This creates *an onset* (hence a preferred syllable structure) ..." (ibid., italics ours). Although Hayes identifies the reason for this linking, he cannot in effect achieve this by spreading, since the onset is not a node in the syllable geometry he proposes. Hence he has to invoke flopping in a teleological way: it "creates an onset, the preferred syllable structure" (ibid.). If onset is a genuine node, the reason why the linking takes place is independent of any 'goal'. In fact, 'flopping' is not a general principle and will therefore have to be stated as a rule (although Hayes does not formulate one).

Whereas 'flopping' is a specific rule, in a theory where empty onsets are genuine nodes (and not just mnemonics for potential geometrical configurations), it can be replaced by a general spreading process (here spreading of the glide to the empty onset). In contrast to 'flopping', spreading is the result of a general convention, and need not be stated as a separate rule for this specific occasion. Because it is an instantiation of a general convention, this linking (which here boils down to glide formation) provides us with insight as to why it actually takes place.

The drawbacks of the moraic model of the syllable in this respect become even more apparent if one looks at an alternative to this type of glide formation, viz. glottal stop insertion. If there is no high vowel available for spreading to onset position, a default consonant may be inserted into an empty onset position, which is often a glottal stop. Recall form chapter 1, section 1.3, form (14), the word *Theater* in German, which

may be pronounced as [tʰe:ʔa:tʁ].[7] The mechanism of default value assignment is one of the basic conventions of autosegmental phonology, as developed by Goldsmith (1976) and others. Pulleyblank (1983) has shown that spreading of an adjacent element (originally this was limited to tones) is not always automatic, and may be replaced by default value assignment. This means that the neutral value is assigned to a specific position. For onsets, we can assume that the default element assigned is the neutral consonant, which is often a glottal stop:

(20)



In a moraic model of the syllable, a specific rule would have to be devised. Because this rule would have to be specifically stated, the fact that the processes of glottal stop insertion and of high vowel spreading are complementary is not accounted for, while it is accounted for in the constituent model of the syllable, because both are conditioned by the empty status of the onset.

In addition, this rule would be of a complex nature: a glottal stop would have to be inserted in intervocalic position *and* would have to be adjoined to the second syllable.

2.3.5 Ignoring arguments for a foot-based account

Having discussed the theorical basis of Hayes' theory, we must now say a word about its empirical basis. For this, recall from section 2.2.4 the CL through vowel loss *(talə ⇒ ta:l)* which occurred in Middle English. This kind of CL is well attested for many languages, but not exactly in the way as Hayes suggests. Arguing against the general idea that there was simple open syllable lengthening in Middle English whenever this syllable was stressed, he states that Minkova (1982) "who took the trouble to collect all the forms of early Middle English that have undergone the rule" stated the "real generalization which holds for 97% of the relevant cases", which would be that "a stressed penult in an open syllable lengthened just in case a word-final schwa was dropped" (Hayes 1989: 266).

If one takes the trouble to look for oneself and see what Minkova has actually written, a slightly different picture emerges. Hayes is correct in stating that the leng-

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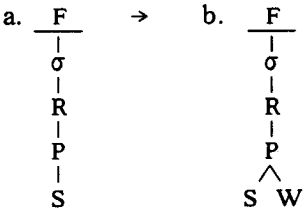
[7] As already mentioned in the previous chapter (note 5), in Dutch there is also spreading if the left vowel in a hiatus is a mid vowel. Hence *theater* in this language is pronounced with a glide: [te·ja:təʀ]. If one adopts the idea that the glottal stop and the glide in this position are indeed the result of the workings of two competing mechanisms, instead of idiosyncratic rules, the difference between the two closely related languages becomes a minor one. This is what one would expect in the first place. Under the moraic model of the syllable, however, the difference between the two languages is considerable.

thening process should be concomitant to the deletion of the vowel in the following syllable. But it turns out that there is a second condition: "MEOSL [Middle English Open Syllable Lengthening] affects only *fully stressed disyllabic* words, and we can think of them as major class words. In terms of *rhythmic organization* this would mean that the first light syllable will in all likelihood be a *foot-initial* syllable" (Minkova 1982: 48, italics ours). Words of more than two syllables were not affected by MEOSL. Hayes fails to mention this important detail.

The reason for this second condition is, according to Minkova, metrical: more specifically it is foot-based. "Phonologically, the syllable affected must be characterized as 'weak' rather than 'open'. [..] The lengthening of the short vowel should be attributed to the principle of preservation of the overall rhythmical weight of the foot" (Minkova 1982: 51). In a later article (Minkova 1985), not discussed by Hayes (1989), Minkova elaborates and formalises her theory. She refers to Giegerich (1981, 1985), Nakatani and Shaffer (1978), O'Connor (1973) who all mention (in different ways) "that monosyllabic lexical items are distinguished from the syllables stressed or unstressed, of polysyllabic words in terms of greater duration" (Minkova 1985: 169, quoting Giegerich 1985: 12). She then says (1985: 170) that the answer must lie in "the principle of phonological isochrony in stressed-timed languages as English." The only option for a monosyllabic foot to achieve durational parity with other, polysyllabic, feet is to lengthen the syllable.

She postulates that the well-balanced foot in English has the form [S W (W)]. She explains the fact that forms of more than two syllables were not affected by syllable lengthening as follows: "Though schwa was lost in words of three and more syllables, the resulting structures were well-balanced [S W (W)] metrical frames: there was no significant change in the category of foot type" (1985: 173). Monosyllabic forms resulting from vowel loss like in *talə* ⇒ *ta:l* underwent the lengthening in order to conform to the well-balanced metrical frame. In fact, for the same reason, not only monosyllables resulting from vowel loss, but *other* lexical monosyllables also underwent this vowel lengthening. Monosyllabic forms imported from Anglo-Norman like *peak, boot, coat, gout, gown* also got lengthened once they became part of the Middle English lexicon (1985: 166, 174). Furthermore, this lengthening has also taken place in Late Old English words like *wēl* 'well', *wēr* 'man', *bēt* 'better' (1985: 173).

Minkova assumes that feet dominate syllables, syllables rhymes, rhymes syllabic peaks, peaks segments. Under her theory the change took place as follows (1985: 171):

(21) a. 

→ b.

(F = foot; R = rhyme; P = peak; S = strong; W = weak)

The process depicted in (21) is the result of the fact that the foot structure in (21a) was 'imperfect'. This "calls for a change down the ranks; [..] the 'orders' for change percolate down to the peak level, where 'strengthening' takes the shape of branching" (1985: 171) (we will return to this idea in section 2.3.7, where we present the treatment of CL through vowel loss in our own model).[8]

The process was undergone by originally monosyllabic words of Anglo-Saxon and Anglo-Norman origin, and by monosyllables that had arisen from vowel loss. Additional motivation for this foot-based analysis is that nonlexical, words like *have*, *were*, *are* which were also subject to schwa loss, did not undergo the lengthening. "They will not normally constitute feet in isolation and will therefore be ineligible for readjustments following schwa loss" (1985: 173). Apart from these arguments there are more arguments in favour of a foot-based account in Minkova's (1985) paper. It would lead us too far astray to reproduce them here, but we feel that the ones presented above are convincing enough.

Hayes does not provide the reader with an explanation as to why he chooses to ignore the arguments in favour of Minkova's foot-based account. In contrast to a foot-based account, his analysis cannot explain why (i) words of more than two syllables and (ii) function words like *have*, *were*, *are* do not undergo the lengthening. Neither does it explain the lengthening of originally monosyllabic words, to which the CL through vowel loss in Early Middle English seems clearly related.

With Minkova's analysis, we can safely assume that the rhythmic organisation is responsible for the lengthening phenomenon. Rhythmic organisation in fact cannot be expressed within the syllabic structure. It seems that the CL is here not the result of moraic conservation, but of a *minimal foot quantity requirement.*

Note that the idea of foot conservation is much more straightforward than that of moraic conservation: we have seen above (section 2.3.3) that moras were conserved although the material they dominated (segments) *as well as* the material they were dominated by (the syllable) had been deleted. We also mentioned that this fact, i.e., that moras are not subject to parasitic delinking, is an otherwise unmotivated axiom of Hayes' theory. If CL through vowel loss is the result of foot conservation rather than of mora conservation, one does not run into problems like this. We do not have to state idiosyncratically that feet are conserved and do not undergo Parasitic Delinking because they are not eligible for parasitic delinking in the first place: they are still dominating material other than the material just deleted. Lengthening takes place because the quantity of this material does not suffice for the foot in question to meet minimality requirements.

As mentioned, Hayes cannot account for the fact that the lengthening takes place only in disyllables. Hayes refers to Hock (1986) for examples of the same type of CL in

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[8] The final *l* in the newly formed foot of *ta:l* does not contribute to syllable weight, according to Minkova because the language does not allow gemination. This supposes that gemination indicates whether adjunction of a consonant to a syllable ending makes a syllable heavy. A more straightforward explanation is that a word-final consonant is extrametrical.

Balto-Slavic, Hungarian, Jutland Danish, Korean, various dialects of German, as well as the Slavonic languages.[9] If one looks at the examples adduced by Hock (1986: 435-438), one sees nothing that contradicts a metrical foot analysis for this type of CL, while, as we have seen, there is evidence against an analysis where moras are integral part of syllable structure.

Because Hayes cannot limit the working of CL to disyllables in his theory and can not exclude the CL from operating in function words like *have*, *were*, *are*, his proposal suffers in fact from the same flaws as Streitberg's (1893, 1894) law for Indo-European (of which in the relevant respect it seems a modernised edition). This law reads 1893: 30):

> Schwindet eine akzentlose Silbe, so wird eine vorausgehende Silbe zirkumflexiert, wenn sie lang, gedehnt wenn sie kurz ist.
>
> ("If a syllable not bearing the accent disappears, a preceding syllable becomes circumflex if already 'long' and 'long' if previously 'short'.")
> (Translation by Collinge 1985: 181).

In fact, Streitberg lists the same reason as Hayes, though slightly differently formulated. The reason for the process is "Morenverlust" ('mora loss') (1894: 313). He seems to use Fick's concept of mora replacement (see Collinge 1985: 181). Streitberg's law, because ithas been found inapplicable in many cases, has received little attention. In fact, it is purely based on Proto-Indo-European reconstructions. All attested occurrences of effects of the law were heavily disputed: "what happens after the PIE period is either irrelevant [...] or even contradictory to the law. [...] Not surprisingly, Streitberg's law is well out of the limelight these days" (Collinge 1985: 182). Indo-Europeanists could of course not foresee its (forseeably) short-lived resurrection.

We end this main section with the conclusion that Hayes' theory has some doubtful theoretical consequences, especially concerning the nature of possible representations. On top of that, with the observation that Hayes cannot account in a principled way for the syllabically conditioned change in syllabicity in certain environments, it can be said that his theory contains some empirical inadequacies. Thirdly, one of the types of CL, which Hayes presents as one of the main motivations for his theory, turns out to be conditioned differently from the way suggested.

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[9] Hock (1986) argues against Clements' (1982, 1986b) treatment of CL in the latter's framework of CV-phonology. Hock argues in favour of an autosegmental treatment of CL, where a mora has the role of an autosegment. He does not, as Hayes does, propose that the mora is a building stone of the syllable. Apart from the type of CL illustrated by the Middle English case *talə* ⇒ *ta:l*, and CL through glide formation (see section 2.4.7) (both of which are metrically based), in our framework not moras, but the subsyllabic nodes assume an autosegmental role in CL (in that spreading takes place to them, see the next section). Our framework also differs fundamentally from Clements' in that spreading does not take place to elements (i.e., Clements' C's and V's) whose nature and number are a function of the segments, but to subsyllabic nodes like onset, nucleus, coda), whose nature and number are determined by the syllable assigned by the syllabification mechanism.

Apart from the criticism raised in this section we will criticise the idea of flopping (exemplified above in (8) and (10)) in the next section.

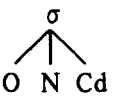
2.4 Comparison with a true constituent model of the syllable

As mentioned, Hayes only compares his theory with a syllabic theory in which the skeleton and not the subsyllabic constituents has a role to play in CL. He argues that his theory is more restrictive. More specifically, he shows that two types of CL which, under "X-theory", would be predicted to occur and which do not, are effectively excluded by mora theory. We will now review these cases and show that a concept of the syllable in which onset, nucleus and coda are genuine nodes and not just mnemonics for a specific type of branching, also exclude this type of CL phenomena. Then, we will review the catalogue of CL types which Hayes lists in his typology, and show that the constituent model can effectively account for these cases. But first we should briefly recall some essential points regarding syllable assignment and the true constituent model of the syllable, as treated in chapter 1.

In chapter 1 we proposed that syllabification is the *imposition* of syllabic structure onto a string of segments. According to the languages and depending on other things (to be treated below) the syllable is bi- or trinodal, cf. (22):

(22) a. 

(σ = syllable; O = onset; N = Nucleus)

b. 

(Cd = Coda)

The nodes onset, nucleus and coda have been taken as mnemonics only. What is important is that a syllable is either bi- or trinodal. The links between the segment (or better: skeletal slots) are established by the normal association conventions of autosegmental phonology which were originally devised for tones only.

In chapter 1, we argued further that the autosegmental conventions of *mapping*, *dumping*, *spreading* and *default value assignment* also apply to syllabification. Recall the formulation of the syllable assignment theory given in (30) in chapter 1, repeated here as (23):

(23) *Syllable Assignment Theory*

> The string of segments is scanned for nonsyllabified segments in a directional way (RL or LR). If a nonsyllabified segment is encountered, a syllable of the canonical shape is superimposed onto the string of segments. Then, optimal linking between the segments and segment bearing units takes place, according to the general conventions of autosegmental phonology. Then the scanning process begins again, etc.

The 'canonical shape' of the syllable is dependent on the language in question. Some languages only impose binodal syllables, others only trinodal syllables. In yet other languages the choice is dependent on the type of segment encountered during the scanning process.

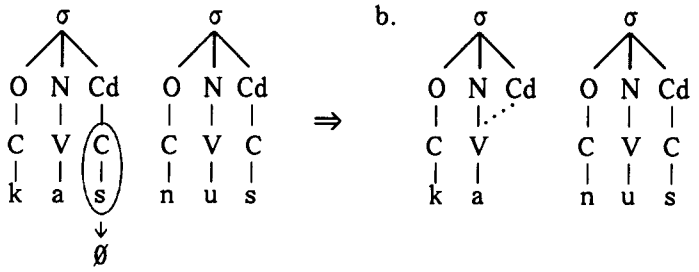
By positing the 'flat' syllable structure as in (22b) for a trinodal syllable, instead of a structure where there is a rhyme node which subdivides into nucleus and coda, we are able to comply with the requirement of planar tier locality (a notion outlined in section 2.3.1.1), to which this model is subject because it is autosegmental in nature.

This summary of the model suffices for present purposes. For more details and a full motivation of the model, see chapter 1.

2.4.1 Classical CL in the true constituent model

We will now show, by way of illustration, how the most straightforward and nondisputed type of CL is accounted for in the constituent model. This type, 'classical' CL, concerns cases like (9), Latin *kasnus* ⇒ *ka:nus*. The deletion of the *s* in the first syllable takes place as in (24a). We are then left with the structure as in (24b), in which there is spreading to the coda from the vowel to its left:

(24) a.



The CL is here the result of the application of the spreading convention. Note that this operation of the autosegmental conventions is perfectly natural: since they are needed for syllabification between the same levels, it need not be stated just for this case of CL that they are operative here. Quite to the contrary, it would have to be stated as an idiosyncracy if the conventions were not operative anymore after they had performed their role in syllabification.

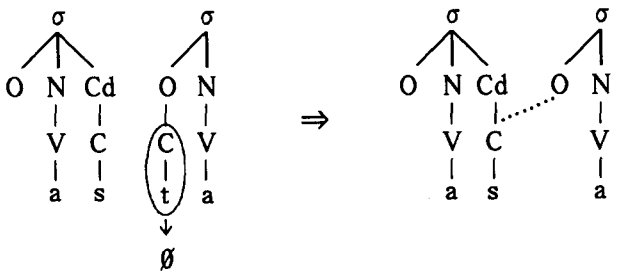
2.4.2 Progressive and regressive assimilation as CL

We will now treat other types of CL and show how they can be accounted for by the same model. First, progressive and regressive assimilation of consonants. Schematic examples are given in (25) (from Hayes 1989: 279):

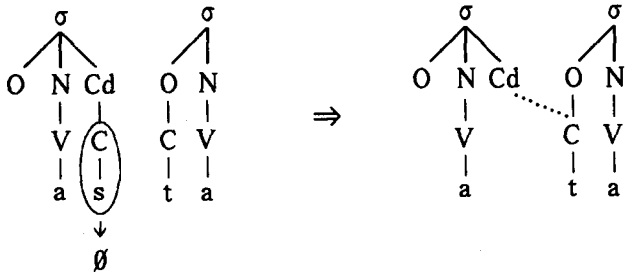
(25) a. asta ⇒ as:a b. asta ⇒ at:a

This type of CL can be easily accounted for in the true constituent model:

(26) a.

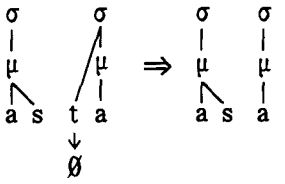


b.

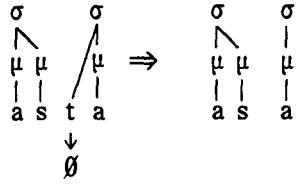


In fact the progressive assimilation (25a) can be accounted for more easily than under Hayes' theory. While in our theory it is simply the result of a spreading operation (after deletion, the onset node is left empty, hence spreading from the *C* dominating *s* to the onset node can take place. In Hayes' moraic theory, however, the spreading of *C* dominating *s* to the following syllable cannot easily be accounted for, because there is no onset, and hence no empty node after deletion of the *C* and the *t* it dominates.

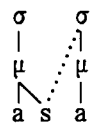
(27) a.

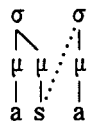


b.



In (27a) we see the case where the *s* is not counted as heavy, and (27b) represents the case where it does count as heavy, hence has received a mora by virtue of the Weight by Position rule (6). Although Hayes does not mention this explicitly in this case, the mechanism of 'flopping', mentioned in section 2.1 (see (8) and (10)), would have to be invoked in order to let the *C* dominating *s* link to the following syllable:

(28) a. 

b. 

We have seen the theoretical drawbacks of 'flopping' in section 2.3.4.

The case of regressive assimilation presents no such difficulties in Hayes' framework (or in ours as shown in (26b)). It can be accounted for straightforwardly, provided the deleted consonant is linked to a separate mora:

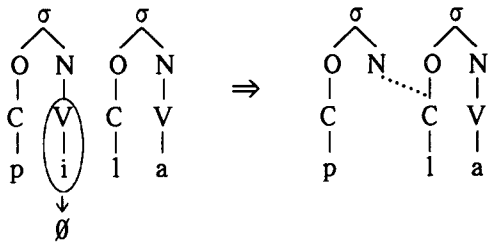
(29) 

2.4.3 Inverse CL

The case of regressive assimilation is parallel to 'inverse' CL (Hayes 1989: 280). Cases like these are found in Luganda (Clements 1986b) and in Pali (Hock 1986: 441):

(30) a. aika ⇒ akka b. a:ka ⇒ akka c. ila ⇒ l̥la d. pila ⇒ pl̥la

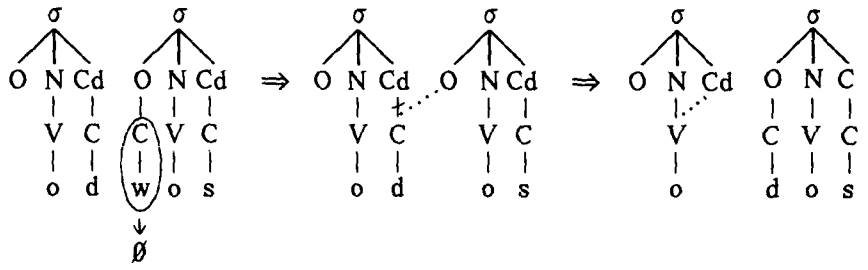
The latter two cases, which occur in Luganda and other Bantu languages, are interesting in the true constituent model, because here spreading does not take place to the third position, the coda, but to the second position, the nucleus, which is here part of a binodal syllable structure.

(31) 

2.4.4 The 'double flop'

The next type of CL is the type which Hayes terms the 'double flop'. We have already shown how this type of CL is accounted for in the moraic model (see (10)). There too, the teleological notion of 'flopping' was involved. In the true constituent model, instead of a specific rule, the general mechanism of spreading can be invoked:

(32)



In (32), the *C* dominating *d* spreads to the onset, because an intervocalic *d* must be linked to the second onset. Geminate *d*'s are not found in Cyrenaean and Ionic Greek (in contrast to Boeotian, Thessalian, Elean, Cretan, Lacedonian and possibly Megarian (Buck 1955: 71)). It may be hypothesised that this sequence is forbidden and that as a result the *C* is automatically delinked from the coda of the first syllable.[10] This coda is now open for spreading from the V-slot. Thus, what we see is a sequence of spreading, delinking, spreading. Hence we propose to rebaptise this type of CL as 'double spreading'.

2.4.5 CL through prenasalisation

Yet another type of CL is CL through prenasalisation. Hayes (1989: 280) points out that the this type of CL is widespread in Bantu languages. He refers to Odden (1981) and Clements (1986b). It takes place as follows (*m͡b* represents a prenasalised stop):

(33) am ba ⇒ a: m͡ba

This type of CL can be accounted for in both theories. In the true constituent model the *m* fuses with the *b* in that it becomes dominated by the same skeletal slot). The skeletal slot which has been unlinked deletes by Parasitic Delinking, and the coda position to which the skeletal slot was linked is open for spreading from the skeletal

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[10] Delinking did not take place in certain dialects (like Thessalian and Lesbian) for certain consonants. Therefore, instead of vowel lengthening, consonant doubling took place: ξενϝος ⇒ ξεννος (*ksenwos* ⇒ *ksen:os*) *'stanger'* (Buck 1955: 49-50, Sheets 1974: 40ff, see also Wetzels 1986: 304). Interestingly, Sheets (1974: 42) relates this to a postulated difference in the direction of syllabification, which distinguishes the Aeolic dialect group (to which Thessalian and Lesbian belong) from other Greek dialects, basing this on a difference in the stress system noted by Meister (1882: 31ff). Meister writes "Die (sc. antiken, R.N.) Grammatiker berichten einhellig, die Äoler seien βαρυυχοί gewesen, d.h. sie hätten die letzte Silbe der Wörter nicht betont." ('The (sc. ancient, R.N.) grammarians report unanimously that the Aeolians were βαρυυχοί, i.e., they did not stress the final syllable of a word.') Although present theories do not link directly the nature of stress patterns and the direction of syllabification, there may nevertheless be such a link. This question is certainly a point for future joint philological and theoretical phonological research.

slot dominating the first vowel. In the moraic model, the *m* is linked up to the second syllable (or, possibly, also fuses with the *b*, although it is not clear how), and the emptied mora is open for spreading form the *a*.

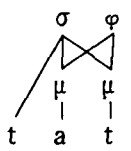
2.4.6 CL through vowel loss

Two other types of CL listed by Hayes cannot be explained readily in the true constituent model by a reshuffle of the association lines between the skeletal and the constituent tier, as in the previous examples. The first type is CL through vowel loss. This type is exemplified by Early Middle English *talə* ⇒ *ta:l*; the account in Hayes' theory was given above in (11) and (12). Recall from section 2.3.5 that Hayes' interpretation of the facts is wrong. As pointed out by Minkova (1982, 1985), the lengthening is the result of a requirement of minimal foot quantity rather than of the number of moras. The true constituent model cannot explain this type of CL, as Hayes portrays it, by a reorganisation of the links between the skeletal units and the syllabic constituents. This is fortunate, as this type of CL does not take place in this way. This shows that our model is restrictive where it should be.

We should then ask how the minimal foot quantity requirement can be integrated in Hayes' model. The crucial question is here how feet are linked to moraic structure. The normal assumption here would be that foot structure is linked to the syllable nodes. In the case of *talə* ⇒ *ta:l*, however, the syllable node dominating the schwa has ceased to exist, due to parasitic delinking. As a result, the foot which contained this element would not possess the amount of phonological quantity required for its existence anymore. Since the syllable through which the foot was linked to the quantity element is deleted, extra syllable weight is imposed on the syllable to which the foot is still linked ('downward percolation' in Minkova's (1985) terms (see (21) in section 2.3.5, above)). Since it is the foot, not the mora, which drives this process, this in itself is no reason that syllable weight should be encoded through moras rather than by any other means. It seems that precisely because of this, Hayes has chosen to ignore the fact that CL is foot-based here.

Another possibility would be to assume that feet are *directly* linked to moras in another plane, as in (34) (the lines cross each other only on this paper).

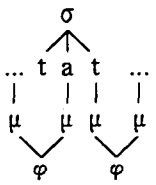
(34)



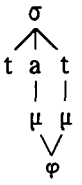
In this case, there would not be a uniplanar structure above the moras. There would be two planes, each with a dominance structure of its own, with moras as shared elements. The prosodic dominance would go from the moras directly to the feet. In addition, there would be a 'side-plane' from the moras to the syllables. Hence, syllables

would not be part of prosodic structure anymore. It is, in fact, totally unclear what the role of the syllable would be, other than a node to which to attach onset elements. We have seen above, that for reasons of geometrical definition, this is very problematic, due to the multiplication of possible planes. But apart from this problem, the only reason to do this is the fact that they do not count as a quantity element. This is in fact a (negative) *prosodic* reason. Thus, paradoxically, the (only) reason for the existence of a separate plane apart from the prosodic one is itself prosodic. Therefore, the postulation of a separate plane in this case would only serve to express that prosodic theory can not explain the fact that onset consonants do not contribute to syllable weight. With much less fuss, one could just plainly state this fact. There is yet another, very compelling argument against such a structure. If moras were not linked to the syllable node, the material in a syllable could belong to different feet, cf. (35a):

(35) a.



b.



This would go against basic assumptions of metrical phonology. If a language has, e.g., left dominant bimoraic feet, the *t* in the syllable in (35a) would have to be strong and the *a* weak. In the same language, however, a syllable like the one in (35b), where the prominence relationship between the two segments has been reversed, could not exist. No languages have been attested where otherwise identical syllables are distinctive in the metrical prominence of their constituting segments.

It has to be concluded that Hayes' model cannot cope with foot-based CL, because one would have to make assumptions which would render his theory meaningless (or tautological to the facts). The model is not capable to account, in a straightforward geometrical way, for the process of foot-based CL.

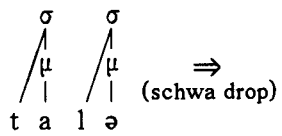
The question then is how the conservation of foot structure should be expressed in our or any theory. While we do not wish to give a full account here, we do want to indicate a possible solution. It seems that higher prosodic nodes sometimes *induce* a certain quantity of elements. As we have seen in section 2.3.5, this is precisely what is proposed by Minkova (1985). It is well known that in certain languages certain categories of morphemes and words should contain a minimum number of syllables (for this, see McCarthy & Prince 1986: 12-44). If a base form does not comply with the quantity requirement, a number of elements is simply imposed, just as in our model of syllabification subsyllabic constituents are imposed. It could be hypothesised that quantity information in the foot comes into existence by *derivation* from syllabic structure. If a syllable is deleted and hence a mismatch has arisen between foot quantity information and syllable structure, the syllable structure will be *minimally* modified to acquire concordance in quantity between syllables and feet. If there is a lack of quan-

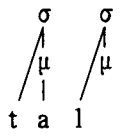
tity in the syllabic material a certain foot dominates, it will first be attempted to lengthen a syllable. If this is not possible, e.g., if a syllable is already long (or heavy), then an additional syllable is imposed. In the case of Early Middle English *talə* ⇒ *ta:l*, the first solution was possible.

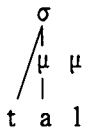
The idea outlined here has the advantage that through the concept of match and mismatch, no choice has to be made between a bottom-up and top-down model of structure building and adaptation.[11] Clearly, operations in both directions are at issue here.

In fact there is no alternative to a derivative model of syllable weight (i.e., weight information is *derived* from syllable structure, and is not a primitive of it) such as the one outlined here, because of the fact that, as mentioned above, the information of quantity will have to pass through the syllable node (see (35)). It is possible to use moras in such a model, but the process of CL through foot conservation as such does not provide support for the existence of moras. And, as we have seen there are several objections against the moraic model of the syllable independent of this type of CL.

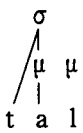
In the case of *talə* ⇒ *ta:l*, the approach has an added advantage over Hayes'. Recall from section 2.2.4 (forms (11), (12)) the way CL takes place in this case:

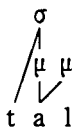
(36) a. 

⇒ (schwa drop) b. 

⇒ (parasitic delinking) c. 

⇒

⇒ d. 

⇒ e. 

⇒ f. 

The question can be raised here why in (36d) the *l* does not link to the empty mora, but spreading of the *a* to this mora takes place first. The reason would be "Itô's (1986) principle that syllable structure (indeed, all prosodic structure) is created maximally" (Hayes 1989: 269). We fail to understand what exactly is meant by "maximal creation". In fact, Itô (1986) does not use the concept of maximality, contrary to Hayes' suggestion. But Itô (1989) does use it. She writes (1989: 219): "The maximality principle holds that 'units are of maximal size within the other constraints of their form' (Prince 1985)." Then the discussion continues regarding matters such as the necessity of constructing disyllabic feet whenever possible. Cases like the one in (36) cannot be subject to this principle. It is easy to see why. In a language where CVC syllables count as heavy, and which allows for long vowels, syllables like (37a) (*tal*) could not exist; they

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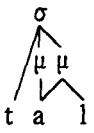
[11] The concept of structure building by matching plays a major role in unification grammar (see Shieber 1986 and Carlson & Linden 1987). We will come back to this in section 4.4.3.2 of chapter 4.

would necessarily be of the form in (37b) (*ta:l*). Yet, languages of this type usually abound in syllables like *tal*.

(37) a. 

b. 

The question can be raised why Hayes has to make use of this peculiar interpretation of the concept of maximality. The relevant case in Early Middle English seems to be one of foot conservation. Apparently, the formation of a syllable *tal*, without a long vowel, did not satisfy the quantity requirement of the preserved foot. Therefore it can be assumed that CVC syllables do not count as heavy in Early Middle English. By contrast, a CVV syllable does, as does a CVVC syllable. Therefore, by way of the unificationist matching principle, a CVV syllable is created, by the lengthening of the vowel (in our model, by the creation of a right margin node).[12] The *l* is subsequently linked to the coda node, probably as a result of a genuine principle of maximality (which says that no node or element may stay unlinked if it can somehow be linked).[13]

Hayes' theory cannot express the relationship between the fact that a CVC syllable counts as light and the idea of the quantity preservation. This is so because he does not have a statement in the phonological grammar saying "CVC syllables are not heavy." The fact that CVC syllables do not contribute to weight is explained in his theory by the assumption that there is no Weight by Position rule, which works during syllabification, in the language in question. Hence the fact that CVC syllables do not count as heavy is simply not available as information at the moment of the application of CL. The reason is the direct relationship between moras and syllables.

In a theory where, in contrast to Hayes' model, there is a derivational interface between syllable structure and the expression of weight, this interface *contains* information equivalent to the statement "CVC syllables count as light." Therefore, in such a theory, this information *is* available at the time of the working of CL. In Hayes' theory, by contrast, the need to resort to an awkward interpretation of 'maximality' is the result of the model chosen.

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[12] On matching, see note 11.

[13] Note that the crucial difference between this kind of maximality and the one apparently invoked by Hayes is that not the number of links should be maximal, but that a maximal number of nodes (on whatever level) should be linked. This means that the fact that disyllabic feet are created wherever possible is the result of the requirement that a maximal number of syllables should be linked to a foot. Only if there is no place anymore in an existing foot and as a result syllables remain unlinked, a new foot is created, to which as yet unlinked syllables can be linked.

2.4.7 CL through glide formation

The second type which in the true constituent type cannot be explained through a reshuffle of association lines concerns glide formation. Hayes (1989: 280) reports that this type is widespread among Bantu languages (Odden 1981, Clements 1986b), Japanese (Poser 1986), Old Icelandic (Hock 1986), and Old English (Wright & Wright 1925). The following form exemplifies this type of CL:

(38) tia ⇒ tja:

In other versions of this type of CL, segments of the previous syllable can be lengthened:

(39) a. akia ⇒ ak:ja b. eria ⇒ e:rja

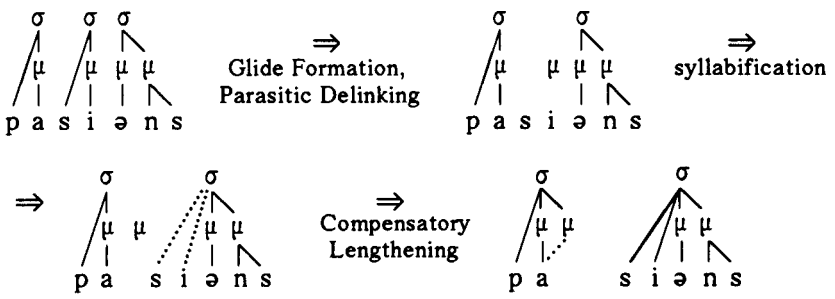
The type exemplified in (39a) is found in Ilokano, the type in (39b) in Middle English (Hayes 1989: 269-279). The reason why the constituent model cannot provide us with an explanation of the lengthening in these three cases is, just like in the case of CL by vowel loss (*talə* ⇒ *ta:l*), that the syllable of the vowel that has been deleted or turned into a glide has ceased to exist. Hence there are no empty subsyllabic nodes for other elements to spread to. We have seen in the case of CL through vowel loss, however, that there was another, foot based reason for CL to take place. Therefore, we could hypothesise that here too, a podic factor can be involved.

To test this, we should look into the foot structure of the languages concerned. Unfortunately, we have no information at our disposal about the foot structure of the languages where the lengthening types in (38) and (39a) are found. Information is available on the foot structure of Middle English (39b). Recall from section 2.3.5 that Minkova posits the foot structure to be of the form SW(W). A form where the type of CL applies is given in (40) (Hayes 1989: 277).

(40) pasiəns ⇒ pa:sjəns 'patience'

Hayes (ibid.) quoting Jespersen (1909) points out that the glide formation (iV ⇒ jV) was completed by the early Middle English period. The lengthening took place in roughly the same period. Hayes accounts for the CL in the following manner:

(41)

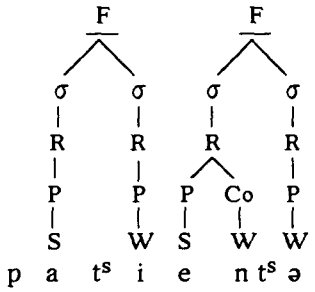


As we will now show, this analysis is ill-motivated, because the original form as given by Hayes is incorrect. For this, one has to consider the underlying form for 'patience'. As one can read in any manual on Old French or in any description of the historical development of the French sound system (e.g., Fouché 1958: 524, Raynaud de Lage 1970: 12, Pope 1956: 118), the schwa in word final position was pronounced in this language. When the form was imported from Anglo-Norman into English, this form still contained a final schwa in *all* dialects of Old-French, including Anglo-Norman. The drop of the final schwa occurred much later in the history of French than the period of the borrowing of this word from Anglo-Norman into Middle English. The process of final schwa drop started only in the 14th century and was completed in the 18th century (Guiraud 1972: 75), well after the adoption of the word in Early Middle English, and the working of CL.[14] In reality the initial form was as in (42):

(42) pat^{s}ient^{s}ə

The date of the earliest noted occurrence of the word is listed by lexicologists as 1120, when it was written *pacience* (Robert 1973: 1250). It occurs in this form also in Anglo-Norman (Rothwell 1988: 485). Contemporary sources indicate that the French spoken in England became progressively pronounced with Middle English accentuation (Olga Fischer, personal communication). Therefore, we may assume that Middle English metrical structure was imposed on words like *pat^{s}ient^{s}ə*. We have seen in section 3.5 that the foot structure in early Middle English, as postulated by Minkova (1985), is S W (W). This gives us the following foot structure for *pat^{s}ient^{s}ə*. For reasons of transparency, we use the same version of the constituent model as Minkova in (1985: 172) (cf. (21), above), although the model can easily be converted in our particular version of the constituent model. The onset nodes, irrelevant for syllable weight, have been omitted. A heavy rhyme in Minkova's model is dominated by two podic branches.

(43)



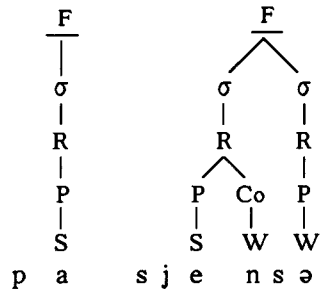
(R = rhyme, P = peak, Co = coda)

This is the only way in which this form can be parsed into permissible Middle English feet, because, as discussed in the previous section, a heavy syllable cannot belong to

[14] According to Fouché (1958: 524) schwa-drop in word-final in postconsonantal position began to develop only in the middle or towards the end of the 15th century. Pope (1956: 118) mentions that in the educated speech of Paris schwa was retained in this position into the later 16th century.

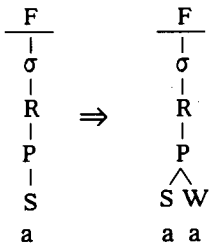
two different feet. The affricate t^s reduced to *s* in the course of the 13th century. The form then became [pasiensə]. Because of the full spirantisation $t^s \Rightarrow s$, the high vowel *i* could become a glide: $*t^s$j was not a permissible onset, but *sj* was. This means that after the gliding of the *i*, the metrical structure of the
form was as follows:

(44)



Note that the first syllable of (44) is illicit, because it contains only one branch, while it should contain minimally two. In principle, there are two options to resolve this situation. The first one is to incorporate the material of the illicit foot into another foot. This solution is viable if a foot is available. However, in (44), the second foot is maximally filled already: it contains three branches. Therefore, the only way out, the second option must be chosen, the enlargement of the first foot. This operation is already familiar to us, because it is exactly the same as the one which has taken place in the cases of CL through vowel loss (*talə* ⇒ *ta:l*), see section 2.3.5. The only option to make the foot structure of (44) well-balanced is to lengthen the syllable which constitutes the first foot.

(45)



This long *a* is exactly what we get: *pasiensə* ⇒ *pa:sjensə*. The drop of the final schwa and the reduction of *e* to *ə* have taken place later. This is confirmed by the fact that words like 'patience' were used mostly in the South, where the Anglo-Norman and Parisian influence was greatest, while as indicated by Minkova (1982: 43) and others, word final schwa loss started in the North, and reached the South only later.

The analysis of CL through glide formation presented here has, as Minkova's analysis of CL through vowel loss, the advantage mentioned in section 2.3.5, that one does not have to assume that there are elements, in this case moras, that are not subject to parasitic delinking.

2.4.8 Excluding nonexisting CL types

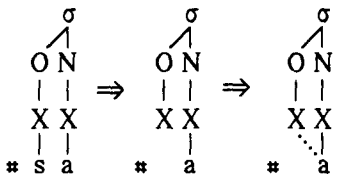
We now come to the two hypothetical types of CL which are excluded in Hayes' model, and which he says are not excluded in 'X'-theory. We will see that our theory too, excludes this type of CL.

The two nonoccurring types of CL ("asymmetries") excluded in Hayes' moraic theory concern (i) onset deletion and (ii) vowel deletion in an initial syllable. Let us first consider onset deletion. If an onset is deleted, this does not result in the lengthening of a specific element. This is exhibited in the following hypothetical, but nonoccuring cases (Hayes 1989: 281):

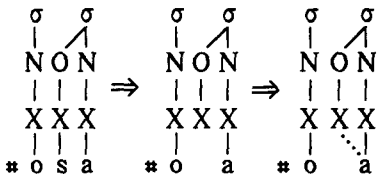
(46) a. #sa ⇒ #a b. #osa ⇒ #oa: c. #osa ⇒ #o:a
b. #sla ⇒ #sa: e. #sta ⇒ #ta

This type of CL is excluded in Hayes' theory because, as we have seen, onset consonants are not dominated by moras, so there is nothing to spread to. Under X-theory (the term is used for all theories where CL is explained by processes on the level of the CV-tier), the process can easily be derived (we are taking here (46a,b,c) as examples, copied from Hayes 1989: 284):

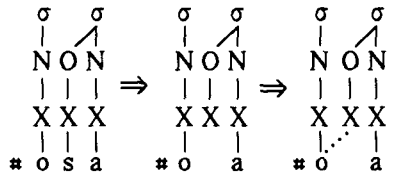
(47) a.



b.



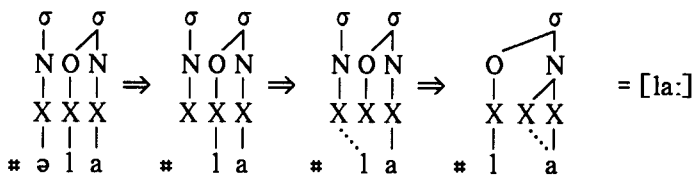
c.



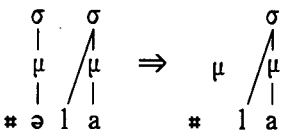
The other asymmetry, CL in the case of vowel loss in an initial syllable, if it occurred, would take place as follows (Hayes 1989: 284):

(48) #əla ⇒ #la:

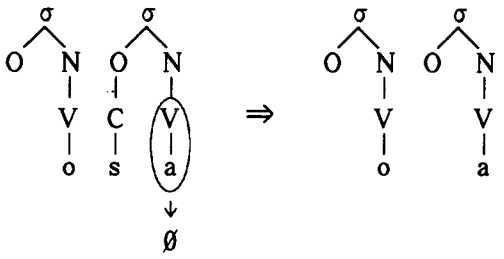
As Hayes points out, X-theory could easily derive this result, in a way which resembles the "double flop", cf. (49) (Hayes 1989: 286).

(49)  = [la:]

Under the moraic model, this type of CL is claimed to be excluded.[15] This theory "derives vowel loss cases using Parasitic Delinking. For Middle English, this disassociates the /l/ of /talə/ from its mora, thus rendering the mora accessible for the spreading of /a/ ..." (Hayes (1989: 286), referring to the case in (11), (12) (*talə ⇒ ta:l*)). If a vowel on the left is deleted, Parasitic Delinking is not applicable. The *l* remains linked to the second syllable, and association of the vowel to the empty mora is impossible due to the prohibition against crossing association lines:

(50) 

The fact that the two non-occurring CL types are excluded by the moraic model seems to provide important additional evidence for this model. However, the constituent model of the syllable *also* predicts that this type of CL cannot occur, at least not by spreading within to a syllabic constituent. Let us first consider the onset deletion case. Here the explanation is as straightforward as under the moraic model. The spreading of the vowel to the emptied onset in cases like (46a,b,c) (*#sa ⇒#a:, #osa ⇒ #oa:, #osa ⇒ #o:a*) does not take place, simply because the onset is not accessible (or subcategorised) for vowels (except the elements that can be syllabic as well as non-syllabic, frequently, for example, high vowels and sometimes liquids and nasals).

(51) 

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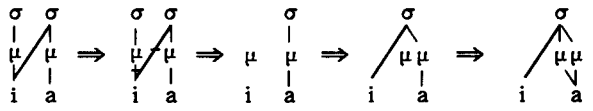
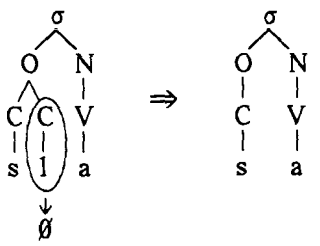
[15] Contrary to Hayes' claim, the CL type displayed in (48) is not fully excluded under the moraic theory. The following CL is conceivable, *ija ⇒ ja:* (Norval Smith, personal communication): 

In cases like (46d,e) (*sla* ⇒ *sa:*, *sta* ⇒ *sa*), the spreading does not happen for an additional reason: the onset in these cases is still filled by an element, the *s*.

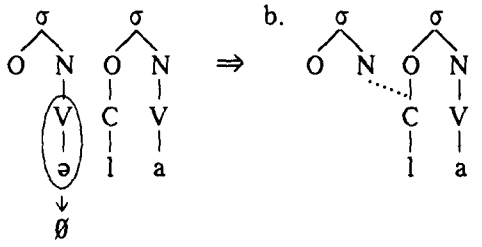
(52)



In contrast to the moraic model, in the constituent model of the syllable linking takes place through the normal association conventions of autosegmental phonology. Recall from chapter 1 that it is through the workings of the autosegmental association conventions (mapping, dumping, spreading) that the links between the segments (or skeletal slots) and the subsyllabic nodes are established. These conventions were originally devised only for linking tones to tone bearing units (TBU's), but later they were also assumed to be applicable for linking between other levels. Now in (46d,e) the *s* and the *a* remain linked to, respectively, onset and nucleus (first and second nodes of a binodal syllable structure). Therefore, there will not be a one-to-one association, because both segments are already linked to a segment bearing unit. In addition, neither spreading nor dumping will take place for the same reason (respectively: because there are no unlinked segment bearing units or unlinked segments). Hence, there will be no CL in this case.

The second non-occuring CL type, the case of vowel loss in an initial syllable (cf. (48)), is also ruled out in the true constituent model. To see this, let us consider the configuration that would arise after initial vowel loss in the true constituent model taking (48): (*#əla* ⇒ *#la:*) as an example:

(53) a.



b.

In (53a), the V dominating *a* cannot spread to an empty subsyllabic node, as this would involve crossing association lines. Hence, the outcome [la:] is impossible. The only thing that can happen is inverse CL, as already described in section 4.4. As displayed in (53b), the C dominating *l* can spread to the nucleus position of the first syllable, provided the language in question can have syllabic liquids. The outcome would be [l̩la]. This is fully parallel to the *pila* ⇒ *pl̩la* case, given above in (37d), (38).

2.5 Conclusion

In this chapter it was our aim to show the inadequacy of a syllable model in which the mora is a *constituent part*. Our second objective was to show that the *true constituent model*, as proposed in chapter 1, does not suffer from the flaws of the moraic model.

First, it was argued that the lack of an adequate account for the behaviour of glides, which was mentioned in the literature as a severe drawback of Hyman's (1985) model, remains a problem in a moraic model where consonants are intrinsically nonmoraic, as in Hayes' model. In such a model, one cannot account for the free variation between high vowels and glides which is often found in languages. In a model such as Hyman's where glides are moraic, one cannot account for the fact that sometimes high vowels and glides do not always alternate with each other. In a true constituent model, such as ours, the problem does not exist, since subsyllabic nodes are labeled and segments are categorised, partially on a language specific basis, for the node or nodes to which they can be linked.

Then, taking Hayes' (1989) model as representative of the moraic model of the syllable, we have shown that major problems arise because of the hybrid character, partly autosegmental, partly metrical, of the type of representation which a moraic syllable model entails. There is practically no constraint in the possibilities of association. In this, the moraic model contrasts with the true constituent model which, for its part, is fully autosegmental in nature and is subject to the well-defined constraints of autosegmental phonology.

Third, Hayes has to posit, idiosyncratically, that moras are not subject to Parasitic Delinking, a principle which he himself invokes for the deletion of other nodes.

Fourth, we have shown that the crucial types of compensatory lengthening which Hayes adduces as motivation for a moraic model, may also be described by a true constituent model, where spreading takes place to the subsyllabic constituents.

Fifth, the two types of CL which cannot be accounted for by the spreading of a segment to a subsyllabic constituent in the true constituent model, i.e., CL through vowel loss and CL through glide formation, were shown to be represented in an empirically inadequate way in Hayes (1989). As Minkova (1985) has shown for CL through vowel loss, and as we have shown above for CL through glide formation, these CL types are the result of a minimal foot quantity requirement.

Sixth, the nonexisting CL types excluded in the moraic syllable model proposed by Hayes are also excluded in the true constituent model.

We can conclude that the moraic model of the syllable proves unsatisfactory and that the true constituent model, proposed in the previous chapter, is a better alternative.

3 Syllabification in Tonkawa

3.1 Introduction

This chapter deals with the phenomena of vowel deletion and vowel shortening in Tonkawa. Hoijer, our main source on Tonkawa, describes the Tonkawa tribe as follows (1946: 289):

> The Tonkawa appear to have been an important and war-like tribe who lived in central Texas during most of the 18th and 19th centuries. The remnants of the group, less than forty in all, today live in the vicinity of Tonkawa, Texas.

Hoijer also reports that Swanton (1915) grouped Tonkawa among the Coahuiltecan languages. Sapir (1920, 1925) has shown that these languages may be remotedly related to the Hokan languages of California. Given the date of the text quoted from Hoijer, it is likely that the language is now extinct. Long after Hoijer wrote these words, the language has been the object of a debate in Generative Phonology.

The issue concerns the vowel deletion phenomena in this language. These phenomena are interesting because of their apparent complexity, and because of the inability of classical generative phonological theory to cope with them properly. Kisseberth (1970a) proposes three rules, one of which is extremely complicated. He therefore concludes that derivational constraints are needed in order not to make the rules excessively complicated. He does not, however, formulate such a constraint. Phelps (1973, 1975) shows that with help of the notion of iterative rule application the most complicated rule proposed by Kisseberth can be simplified considerably. In this chapter, it will be shown that this latter rule, as well as the two other rules needed in Kisseberth's analysis, are not needed either. It will be demonstrated that the vowel deletion phenomena are all the result of a specific parameter setting for syllabification.

3.2 Kisseberth's and Phelps' analyses

Consider the following set of forms given by Kisseberth:[1]

(1)	a. notxo?	< notoxo+o?	'he hoes it'
	b. wentoxo?	< we+notoxo+o?	'he hoes them'
	c. notxono?	< notoxo+n+o?	'he is hoeing it'

[1] The following summary of Kisseberth's analysis has been taken and adapted from the thorough presentation given by Phelps (1975).

d. wentoxono? < we+notoxo+n+o? 'he is hoeing them'
e. notox < notoxo 'hoe'

(2) a. netlo? < netale+o? 'he licks it'
b. wentalo? < we+netale+o? 'he licks them'
c. netleno? < netale+n+o? 'he is licking it'
d. wentaleno? < we+netale+n+o? 'he is licking them'

(3) a. picno? < picena+o? 'he cuts it'
b. wepceno? < we+picena+o? 'he cuts them'
c. picnano? < picena+n+o? 'he is cutting it'
d. wepcenano? < we+picena+n+o? 'he is cutting them'
e. picen < picena 'steer, castrated one'

Kisseberth lists the following affixes:

(4) a. we- 3rd person plural, pronominal object
b. -o? 3rd person sing., declar., present tense
c. -n- progressive (continuative)
d. (unmarked) 3rd person singular, pronominal object

The following phonetic variants are exhibited by the stems:

(5) a. notx-, -ntox-, notxo-, -ntoxo-, notox, /notoxo/ 'hoe'
b. netl-, -ntal-, netle-, -ntale-, /netale/ 'lick'
c. picn-, -pcen-, picna-, -pcena-, picen, /picena/ 'cut'

In order to account for these data, Kisseberth posits the following rules:

(6) a. *Word-Final Vowel Deletion*

$$V \rightarrow \emptyset \; / \; \_\_\_ \#$$

b. *Vowel Elision*

$$V \rightarrow \emptyset \; / \; \# CVC \_\_ C \left[\begin{matrix} V \\ +stem \end{matrix} \right]$$

c. *Vowel Truncation*

$$V \rightarrow \emptyset \; / \; \_\_\_ V$$

Sample derivations are given in (7) (cf. (3)):

(7)

	(a)	(b)	(c)
Underlying representation	picena+o?	we+picena+o?	picena+n+o?
Deletion (6a)			
Elision (6b)	picna+o?	we+pcena+o?	picna+n+o?
Truncation (6c)	picn+o?	we+pcen+o?	
Surface representation	picno?	wepceno?	picnano?

	(d)	(e)
Underlying representation	we+picena+n+o?	picena
Deletion (6a)		picen
Elision (6b)	we+pcena+n+o?	
Truncation (6c)		
Surface representation	wepcenano?	picen

A schematisation of the phenomena presented thus far is given in (8) (the lower case letters refer to the rules given in (6)).

(8) a. #CVCVCV+VC#
↓ ↓
Ø Ø
b c

b. #CV+CVCVCV+VC#
↓ ↓
Ø Ø
b c

c. #CVCVCV+C+VC#
↓
Ø
b

d. #CV+CVCVCV+C+VC#
↓
Ø
b

e. #CVCVCV#
↓
Ø
a

The specification is [+stem] for the final vowel in the structural description of Vowel Elision (6b) is needed in order to prevent this rule from applying in (9c, 10c):

(9) a.	pilo?	< pile+o?	'he rolls it'
b.	weplo?	< we+pile+o?	'he rolls them'
c.	pileno?	< pile+n+o?	'he is rolling it'
d.	wepleno?	< we+pile+n+o?	'he is rolling them'
(10) a.	cano?	< cane+o?	'he leaves it'
b.	wecno?	< we+cane+o?	'he leaves them'
c.	caneno?	< cane+n+o?	'he is leaving it'
d.	wecneno?	< we+cane+n+o?	'he is leaving them'

In (9c) and (10c) the second vowel of the word does not elide, although it is in the environment CVC__CV. The final vowel in these forms does not belong to the stem, but to the suffix *-o?* (see 4b). Things are even more complicated, however. Kisseberth ad-

duces additional paradigms in order to show that, apart from the vowel follo wing the vowel that is to be deleted by Vowel Elision, this vowel itself must also belo ng to the stem:[2]

(11) a. yakpo? < yakapa+o? 'he hits it'
b. weykapo? < we+yakapa+o? 'he hits them'
c. wexaykapo? < we+xa+yakapa+o? 'he hits them with force'

(12) a. xamco? < xamace+o? 'he is broken'
b. yaxmaco? < ya+xamace+o? 'he breaks it'
c. keyaxmaco? < ke+ya+xamace+o? 'he breaks my bones'

In (11c, 12c), it is not the second vowel of the form that elides, (which is what rule (6b) would predict), but its third vowel, which is the first stem vowel. Therefore, Kisseberth restricts Vowel Elision further so that only a vowel that is specified as [+stem] is affected by the rule. He observes (1970a: 117) that if there is a CV prefix, the first stem vowel deletes and that if there is no prefix, the second vowel of the stem deletes. Kisseberth reformulates Vowel Elision as:

(13) *Kisseberth's reformulation of vowel-elision*

$$\begin{bmatrix} V \\ +stem \end{bmatrix} \rightarrow \emptyset \; / \; \left\{ \begin{matrix} V + C \\ \{ \begin{smallmatrix} \# \\ C+ \end{smallmatrix} \} \; CVC \end{matrix} \right\} \_\_ C \begin{bmatrix} V \\ +stem \end{bmatrix} \quad \begin{matrix} (a) \\ (b) \\ (c) \end{matrix}$$

Subrule (a) accounts for stems preceded by a CV prefix; subrule (b), for stems without a prefix and subrule (c) for stems preceded by a CVC prefix. The three subrules restrict elision to the context VC__CV.

The complexity of rule (13) does not satisfy Kisseberth and he therefore mentions the need for a simpler rule, combined with a derivational constraint.

Phelps (1975: 169) proposes the following iterative rule instead:

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[2] The postvocalic glides shown in these forms are given as high vowels (as is frequently done with the second part of falling diphthongs or postvocalic glides) by Kisseberth and his source (viz. Hoijer (1933)). To account for the change of the glides into high vowels, a rule of vocalisation is postulated by Kisseberth (1970: 113-114) (also in Kenstowicz & Kisseberth 1979: 70):

$$\begin{bmatrix} +high \\ -cons \end{bmatrix} \rightarrow [+syllabic] \; / \; \_\_ \left\{ \begin{matrix} C \\ \# \end{matrix} \right\}$$

Since it can be assumed that these high vowels and the preceding vowels are tautosyllabic, and that the high vowels are not the syllabic nuclei, there can be no phonetic difference between high vowels and glides here. Therefore, the alternation predicted by this rule follows automatically in frameworks that take syllable structure into account, which makes the rule superfluous.

(14) *Phelps's rule of Vowel Elision* (iterative, rightward)

$$\begin{bmatrix} V \\ +stem \end{bmatrix} \rightarrow \emptyset \; / \; V\,C\,((?)V) \_\_\; C \begin{bmatrix} V \\ -suffix \end{bmatrix}$$

The environment of this rule has three different expansions:

(15) a. $VC?V\_\_\; C\begin{bmatrix} V \\ -suffix \end{bmatrix}$ b. $VCV\_\_\; C\begin{bmatrix} V \\ -suffix \end{bmatrix}$

c. $VC\_\_\; C\begin{bmatrix} V \\ -suffix \end{bmatrix}$

The more specific expansions of this rule apply to shortening phenomena that will be treated below, in section 3.4. At this point we are only concerned with the more general expansion of rule (15), repeated here as (16):

(16) $$\begin{bmatrix} V \\ +stem \end{bmatrix} \rightarrow \emptyset \; / \; VC \_\_ C \begin{bmatrix} V \\ -suffix \end{bmatrix}$$

This iteratively rightwardly applying rule replaces Kisseberth's rule (13). Apart from this simplification, Phelps, along with Kisseberth, needs the rules (6a,c), in order to account for the vowel deletion phenomena not covered by (16). In the analysis that follows, we will see that the vowel deletion phenomena can simply be analysed as the result of a specific parameter setting of the syllabification process, involving the number of places within a syllable, the domain in which syllabification applies, the fact that the process is directional, and the actual direction of the process, as well as the elements triggering the process.

3.3 An alternative analysis

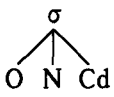
The vowel elision rules proposed by Kisseberth and Phelps both refer to morphological information. In the actual state of development of phonological theory, in which a modularisation has taken place, such reference is undesirable. Phonological rules and processes should in principle only have access to phonological information. During the past decade, and especially after the introduction of Kiparsky's (1982a,b) Lexical Phonology, it has time and again been shown that earlier analyses of phonological processes in which a direct reference was made to morphological information can be reanalysed as processes which refer to morphological or phonological *levels*, not directly to morphological boundaries or categories.

Apart from this, the context VC__CV appear in the rules of both proposals. As was mentioned in chapter 1, footnote 16, deletion in this environment (a "two sided open syllable" hints at a syllable related phenomenon, or, more specifically, can be seen as a

direct consequence of syllabification. Below, it will be demonstrated that deletion in Tonkawa can interpreted in this way.

We will assume that in Tonkawa the shape of the canonical syllable is set to three places:

(17)



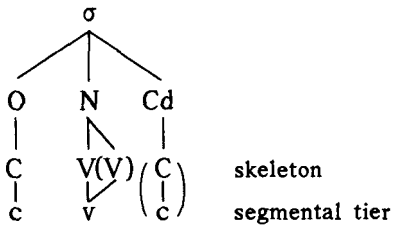
It is this type of syllable which, by virtue of the syllable assignment algorithm (30) of chapter 1, is superimposed onto the segmental tier in Tonkawa syllabification. As we will see below, in contrast to the coda in certain other languages, the third node of the syllable in Tonkawa can contain consonants only, in other words it is subcategorised only for these elements. There are also a few other restrictions applicable to the subsyllabic nodes with respect to the elements which can be linked to them. To the central node, nucleus, can only vowels can be linked, while the onset node is subcategorised for consonants only. Tonkawa allows the following syllable types:[3]

(18) *possible Tonkawa syllables*

a. CV b. CVC c. CV: (CV_iV_i) d. CV:C

The expression of the possible syllable in Tonkawa is:

(19) *Tonkawa syllable* (first version)



As we will see below, the maximal syllable (i.e. a closed syllable containing a long vowel) occurs only in underived environments. We will amend the representation slightly below in section 3.4.2, when we deal with the phenomena involving a consonant followed by a glottal stop. In (19), the parenthesised elements of the skeletal tier are optional, viz. they do not have to be present in syllabic structure, while the other elements are obligatorily present.

In order to eliminate any possible misunderstandings, it should be stressed that in

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[3] Hoijer (1946: 293) mentions that the "exceptional combinations" *ʔs, lʔ, yʔ* and *sʔ* can occur only "as syllable finals in syllables terminating an utterance". Because of this very limited distribution, we believe there are good reasons to consider the final consonant of these combinations here to be extrametrical, and therefore not to be part of normal syllabic structure.

contrast with Itô's template matching approach (cf. chapter 1, section 1.5 for a summary criticism of this approach), the figure in (19) is purely a way to express a set of positive and negative wellformedness conditions. It is *not* itself a structure, but merely a *set of conditions* on structure. (Recall from chapter 1, section 1.5 that Itô's theory is ambiguous on this point).

We come now to the second language-specific characteristic of Tonkawa syllabification. Tonkawa is a *vowel deleting* language, i.e. vowels are deleted in certain (syllable related) environments, but consonants are always maintained. As already mentioned in chapter 1, section 1.5, we can explain this here by the assumption that consonants, in contrast to vowels, *must be incorporated into syllabic structure.* Hence, consonants *trigger* the syllabification process. A vowel, on the other hand, *can* be incorporated into syllabic structure (by virtue of the application of the general linking principles; this of course only happens if place is available in the syllabic structure), but *need not* be incorporated. If a vowel is not incorporated, it receives no phonetic realisation and hence is perceived as deleted. The question of whether a vowel is actually incorporated into the syllabic structure or not is decided by the application of the general linking conventions (cf. (4) of chapter 2). If there is no place in the syllabic structure for it to be linked to, it will remain unlinked, and hence phonetically not realised. As we will see below, the assumption that vowels do not by themselves induce syllabification not only explains the apparent deletion of a vowel in a "two sided open syllable", but also the word final vowel deletion, for which Kisseberth has posited his rule (6a).

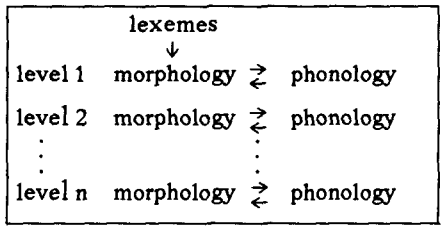
The third characteristic is the directionality parameter. As we will see below, the actual direction of the syllabification process (in conjunction with cyclicity) plays an important role in explaining the deletion sites in Tonkawa. The setting of this parameter is from right to left. As mentioned above, we will see that this setting can explain the seemingly disparate distribution of the deletion sites.

A final characteristic of Tonkawa syllabification is that, as we will see, syllabification is crucially cyclic, or, in terms of Lexical Phonology, lexical.

For the uninitiated reader, we give here a very concise summary of the basic idea of lexical phonology. (For more background on lexical phonology, see Kiparsky (1982a,b, 1985), Booij & Rubach (1984), Halle & Mohanan (1985) and Kaisse & Shaw (1985)). According to this framework, the lexicon is seen as a system of interconnected levels. On these levels, morphological processes like derivation, inflection and compound formation (specified for the level in question) take place, as well as phonological processes. It is further often assumed that there exists cyclicity within a single level, such that a morphological process may take place (e.g., the addition of a morpheme), followed by a phonological process, such as an assimilation process. Then, still on the same level, another morphological process can take place (e.g., the addition of another morpheme), followed by the application of a phonological process, such as a reapplication of the same assimilation process that has already applied on the previous cycle at the same level. Morphological processes and phonological processes are specified

for the level at which they apply. The diagram in (20) shows the model just outlined:[4]

(20)



According to Kiparsky (1985), there are two levels in English. On the first level class I derivation takes place. Class I derivation involves affixes which affect main word stress, as well as those which belong to irregular inflection types. On level 2, all other morphological operations, i.e., derivation of class II, compound formation and inflection take place.

We now return to Tonkawa. We assume that the first time syllabification takes place is *after* the first morphological operation. This is because the vowel deleting effect of syllabification (cf. above) gives syllabification not only a structure building, but also a structure changing effect. As is well known, in lexical phonology, neutralisation rules apply only in derived environments, i.e., after the first morphological operation. This principle is embodied in the Strict Cycle Condition which Kiparsky (1982a: 154) formulates as:

(21) *Strict Cycle Condition (SSC)*

a. Cyclic rules apply only to derived representations.

b. *Definition:* A representation φ is derived w.r.t. rule R in cycle j iff φ meets the structural analysis of R by virtue of a combination of morphemes introduced in cycle j of the application of a phonological rule in j.

The working of this condition ensures that cyclic, i.e. lexical syllabification is not triggered by segments in the stem. This does not mean that segments in the stem are never incorporated into syllabic structure during the lexical derivation. If an empty subsyllabic node (onset, nucleus, rhyme) is available, the general linking convention may link a stem segment to this node. Examples will be given below. It is the triggering of syllabification that is subject to the Strict Cycle condition, *not* simply the application of the general linking conventions, because these, in themselves, have only a structure building effect.

At this point one further specification must be made about the way the syllable assignment algorithm operates. In the syllabification algorithm stated in (30) of chapter 1 it was stated that "optimal linking between the segments and segment bearing units

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[4] The model as given here is the one presented by Kaisse & Shaw (1985: 9). In certain other versions of lexical phonology it is assumed that phonological processes are ordered before morphological processes on the same level.

takes place, according to the general conventions of autosegmental phonology." We have seen that this linking consists of three different mechanisms, i.e., mapping, dumping, spreading. The specification we have to make concerns the level from which the mapping starts. It could in principle start from the segments and it could start from the subsyllabic nodes. We argue here that mapping starts from the segments, in the same direction as the syllable structure imposition takes place. The reason for this is that it is the elements on the segmental level that have triggered the imposition of syllable structure. This is the result of the fact that these elements 'demand' to be part of syllable structure. Another result of this tendency is that, once a syllabic structure has been imposed, mapping originates from the segmental elements.

Because in Tonkawa it is only the consonants that trigger syllable imposition, the initial mapping originates from these elements only, whereas in many other languages, where syllabification is triggered by nearly all segments, mapping originates from all segmental elements. (In the following chapters we will add the level of the skeleton and we will consequently say that mapping starts from the level of the skeleton and takes place between the skeleton and the subsyllabic nodes. For reasons of exposition we have omitted this level here, because it does not seem to play any role with respect to the phenomena concerned). The mapping between the vowels and the subsyllabic nodes (in fact the nuclei, the only type of node a vowel can be linked to in Tonkawa) takes place if possible, but does not start the mapping process.

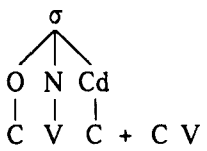
We now raise the question of what happens if regular syllabification (i.e., the application of the syllable assignment algorithm (30) of chapter 1) fails to incorporate all consonants into the syllabic structure. We are then faced with a conflict, since, as stated before, consonants *must* be incorporated. A second possible situation that we must consider is that syllabification fails to produce a structure which conforms to the well-formedness conditions as expressed by template (19): situations may arise in which no well-formed syllable can be formed. This can be the case, e.g., if the regular application of the linking conventions fails to produce a syllable with a filled onset. The following measures are taken when regular syllabification fails:

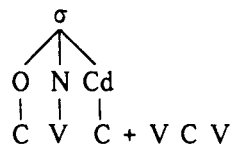
(22) *measures taken when syllabification fails*

a. reversal of the direction of mapping of the skeletal elements to the subsyllabic nodes (now: left to right);
b. when this also fails: obligatory elements at the left side are delinked from the coda of the syllable to the left and incorporated into the onset of the syllable under construction.

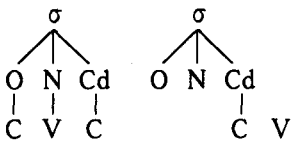
The fact that (22a) takes effect is merely a natural consequence of the fact that in principle two directions of syllabification (and hence mapping which is part of the syl-

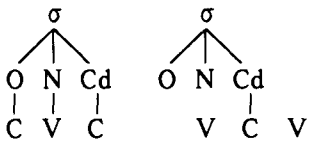
labification process) are available to a language.[5] Tonkawa has opted for RL. If, however, syllabification in this dominant direction fails, syllabification in the recessive direction, LR, will be attempted. This will happen in the following two basic situations, which can arise during syllabification:

(23) a. 

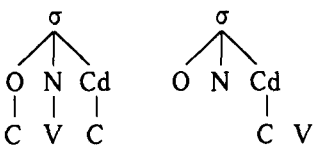
b. 

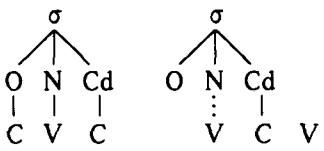
In these cases, there is a C that is not yet syllabified and therefore, at a given cycle or postcyclically, triggers syllabification. (The postcyclic triggering takes place in the case of a C in a nonderived environment (recall from above that syllabification is triggered only *after* the first morphological operation, and that, since it has a structure changing effect, it is subject to the Strict Cycle Condition)). Because of the directional parameter setting (right to left), syllabification will go leftward. The following thus happens: by virtue of syllable assignment algorithm (30) of chapter 1 (more specifically, the optimal (i.e. maximal) mapping of subsyllabic constituents to C's and V's), and because of the nature of the syllable which is assigned in Tonkawa, which is tripositional, we arrive at the situation depicted in (23'a,b):

(23') a. 

b. 

Then, because of the right-to-left directionality, and because mapping originates from the consonants, in both forms it will map the empty unlinked consonant to the coda node of the imposed syllable. In (23'b), the vowel will subsequently map to the nucleus node (indicated in (23"b) by a dotted line). We thus arrive at the following situation:

(23") a. 

b. 

With the material on the left, however, no permissible syllable can be formed: there is no free consonant that can function as the beginning of the syllable (the wellformedness conditions in (19) require that a Tonkawa syllable always start with a C). There-

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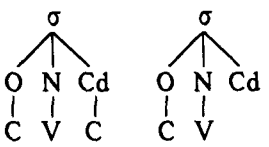
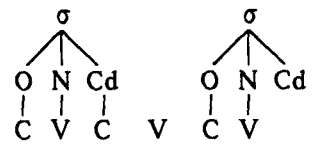
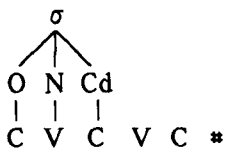
[5] See chapter 4, section 4.4.2, where it is demonstrated that the systematic differences in epenthesis and deletion sites between a South-Semitic language, Tigrinya, and its closely related neighbours (as well as with Yawelmani) can be explained by a difference in the direction of syllabification.

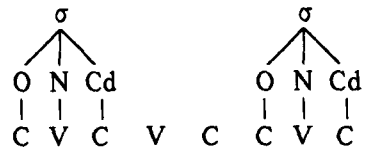
fore, the direction of the mapping of the skeletal elements to the subsyllabic nodes will be reversed and the V to the right will be incorporated into the syllable. The CV syllables thus formed are permissible, and syllabification has succeeded:

(23''') a. 

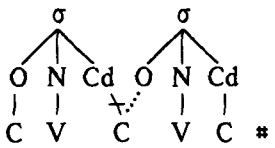
b. 

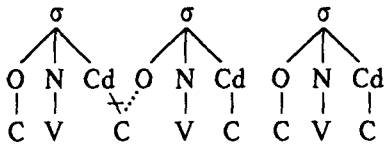
The configurations in (24) illustrate two situations where the reversal of the direction is of no avail: it also fails to syllabify all consonants:

(24) a. 

b. 

In this situation, there is no V to the right of the unsyllabified C that can be incorporated. Now measure (22b) takes effect: the C to the left is detached from the preceding syllable (note that the syllable to the left remains licit (CVC → CV)), and this C is incorporated into the newly formed syllable. Notice that the syllable from which the C is detached remains well-formed according to template (19):

(24') a. 

b. 

Having outlined our analysis of Tonkawa syllabification, we will provide illustrations for each of the type of cases mentioned in section 3.1. We will show that in these cases, the correct deletion is forecast by our syllabification algorithm. Let us look first at the cases (3a-d & 7a-d), repeated here as (24):[6]

(25) *Underlying forms* a. picena+o? b. we+picena+o?
c. picena+n+o? d. we+picena+n+o?

As mentioned before, lexical syllabification takes place only in derived environments, subject to strict cyclicity. In these forms, therefore, during the first cycle the morphemes which straddle the stem will be syllabified:

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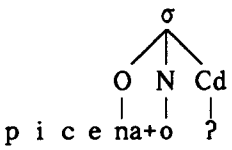
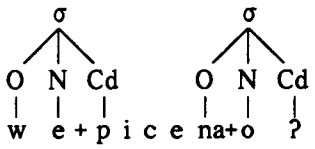
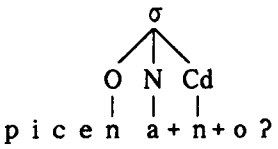
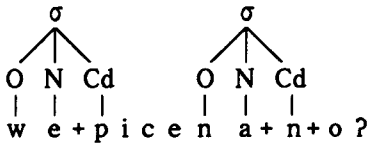
[6] *In the forms (25-28), the skeletal slots have been omitted, for reasons of exposition. A vowel, e.g., should in fact be read as:* V *skeletal element*
|
v *element on the vocalic segmental tier*

(25') *First cycle*

a. 

b. 

c. 

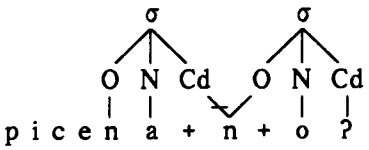
d. 

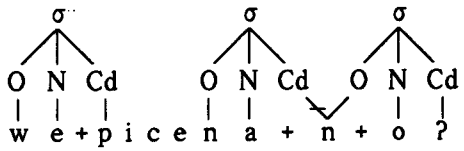
It is assumed that in these forms, the prefix and suffix bordering the stem are attached on the same cycle. However, this is not crucial. In (25a,b), it is the glottal stop that triggers syllabification. Syllabification, in accordance with the right-to-left directionality setting, now goes leftward, and the *o* is incorporated into the syllable. Next, *a* is ignored by the syllabification mechanism, because it cannot incorporate this in its syllabic structure (cf. the wellformedness conditions (19)). It is thus that the data for which Kisseberth has formulated his rule of Vowel Truncation (6c) are accounted for. In (25b,d), the *w* of the prefix also triggers syllabification. Because there are no elements to the left, the direction of syllabification is reversed by virtue of (22a), cf. (23). Note also that on this first cycle, the morphemes of the second cycle are not yet present (although we have shown them in (25') in order to keep the forms identifiable). Let us now look at the second cycle:

(25") *Second cycle*

a. (vacuous)

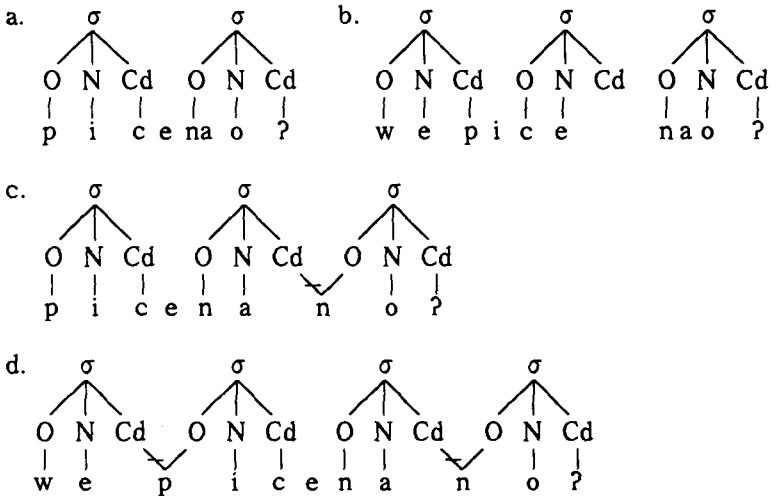
b. (vacuous)

c. 

d. 

Here, we see that in (25"c,d) the syllabification mechanism has delinked the *n* from the preceding syllable (by virtue of (22b), cf. (24)). We now come to the postcyclic (postlexical) syllabification, in which unassociated consonants belonging to the stem trigger syllabification:

(25''') *Postcyclic (postlexical) syllabification*

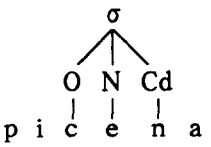


When postcyclic syllabification takes place, in (25a,c) both *p* and *c* are still unsyllabified (cf. (25'a), (25''c). Going from right to left (by virtue of (19a), the syllabification algorithm creates a syllable incorporating the *c*, *i* and *p*. (cf. 25'''a,c). Now, all the consonants are incorporated into the syllabic structure. Hence there is no need to incorporate the *e* and therefore the phonetic outcomes are *picno?* and *picnano?* respectively. It was in order to achieve the apparent deletion of the *e* that Kisseberth formulated his rule of Vowel Elision (6b).

When postcyclic syllabification takes place in (25b,d), one stem consonant is still unsyllabified, viz. *c*. (cf. (25'b), (25''d)). Leftward syllabification fails, because there is no C to its left. Therefore, by virtue of direction reversal (22a), the direction of syllabification is reversed, (cf. (23)). The syllabification mechanism will incorporate the *e* to the right of the *c* into the syllabic structure. The subsequent *n* is already syllabified and therefore will not be incorporated into the just formed syllable, cf. (25b,d). The syllable created in this way (*ce*) has the form CV. According to template (19), this is a permissible structure. The *i* has been left unsyllabified and is hence not realised (a phenomenon for which Kisseberth formulated his Vowel Elision (6b)). Our model thus correctly predicts that *picnano?* and *wepcenano?* are the correct surface forms.

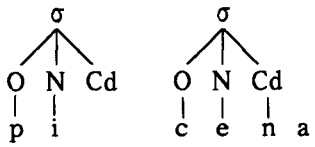
We still have to explain the vowel deletion in examples (3e), (7e), for which Kisseberth has formulated his rule of Word Final Vowel Deletion (6a). Our model accounts for this deletion in a straightforward manner. Since there are no morphemes attached to the stems, there is only one, postcyclic, application of syllabification. Syllabification starts from the right, starting with the first consonant, because of the setting of the directionality parameter and because only consonants trigger the superimposition of a syllable:

(26) *Postcyclic (postlexical) syllabification*



Thus, the syllable *cen* is formed. Arriving at the *p*, this element will also trigger syllable structure imposition and will map to it in a right-to-left fashion. Hence *p* will be linked to the coda node. However, no material can be found to the left of this element. Therefore, the direction of mapping is reversed by virtue of (22a) (cf. (23)):

(26')



Now, all consonants, which are the syllabification triggering elements have been syllabified. The final *a* has been left unsyllabified, and hence is not realised, which is the correct prediction.

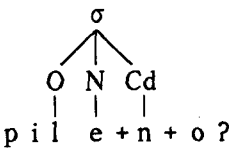
Let us now turn to the examples given in (9c,10c) where the second stem vowel is not elided.

Underlying forms:

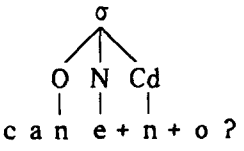
(27) pile+n+o? (28) cane+n+o?

First cycle:

(27')

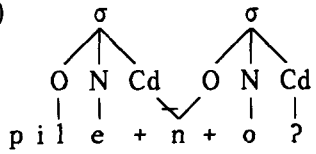


(28')

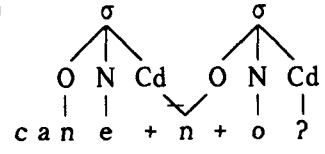


Second cycle:

(27")

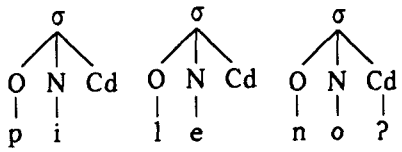


(28")

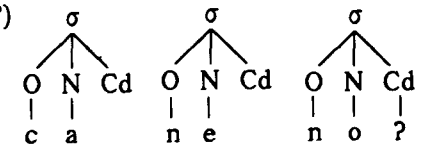


Postcyclic (postlexical) syllabification:

(27''')



(28''')



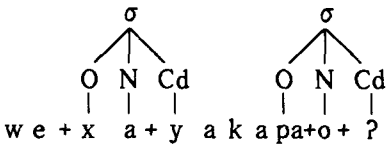
We thus see here that the nonerasure of the *e* (the vowel which finds itself in the environment VC__CV) is a consequence of the fact that syllabification in Tonkawa is cyclic: the *e* had to be incorporated into syllable structure on the first cycle, during which syllabification was triggered by *n* (the progressive morpheme).

Finally, let us look at the forms in (11c, 12c). Here it was the third V and not the second one that was deleted. We will take the derivation of (11c) here as an example.

(29) *Underlying form*

we+xa+yakapa+o?

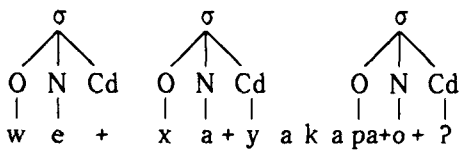
(29') *First cycle*



For the syllabification of the morpheme preceding the stem, the direction of syllabification has been reversed by virtue of (22a). We see here that the *y* of the stem has been syllabified, as part of the syllable in which the prefix directly preceding the stem has been syllabified. The reader will notice that without the incorporation of the *y* of the stem, the syllable would also be well-formed, because the result would be a CV syllable, viz. *xa*. It thus seems that an element of the stem, is incorporated into syllabic structure, while this does not seem strictly necessary in order to fully syllabify those elements which must be syllabified at the relevant cycle. This objection, however, would be based on a misunderstanding. It is the process of syllabification that is triggered cyclically, not the linking or association of the segments with the subsyllabic nodes. As mentioned in chapter 1, empty nodes are avoided if possible, as a result of the association conventions. With the incorporation of the *y* into syllabic structure, an empty coda node has been avoided, and we have arrived at the desired one-to-one relationship between the subsyllabic nodes and the segments. Still, the reader could ask the following question: if cyclicity counts only for the syllabification-triggering elements, why then has the direction of syllabification in (29') been reversed by virtue of (22a)? Syllabification could have gone in its normal direction, RL, and the syllable *wex* would have been formed. The answer to this is that in contrast to the stem, the second prefix, *we*, is simply not yet present during the first cycle. (On the cycles where certain morphemes are not present, like (29'), we have nevertheless given them, in order to make our representations as transparent as possible).

We now come to the second cycle:

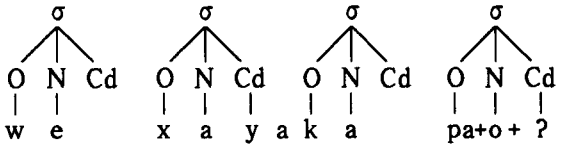
(29") *Second cycle*



During the second cycle, the morpheme *we-* is introduced. This morpheme contains a consonant, hence a canonical trinodal syllable structure is superimposed on this segment. Right-to-left syllabification will cause the consonant *w* to be linked with the Coda node. However, it is not possible to form a well-formed syllable in this way. Therefore, the other direction of syllabification will now prevail and the consonant *w* will be linked to the Onset node. The association convention now proceeds rightwards and the vowel *e* is incorporated into the syllabic structure. There is no unlinked consonant left which can be linked to the Coda node, but nevertheless, according to the wellformedness conditions expressed in (19), the syllable is well-formed.

Finally, postcyclic syllabification takes effect:

(29''') *Postcyclic (postlexical) syllabification*



Here, the *k* was the only consonant that was not yet syllabified during cyclic syllabification. Leftward syllabification will fail, because the preceding consonant *y* is already incorporated into a syllable. Therefore, by virtue of (22a) (cf. (23)), the direction of the application of syllabification is reversed and the following *a* is incorporated into the syllabic structure. The first stem vowel is left unsyllabified, because all consonants are already syllabified, and there is no need for further syllabification. It is thus correctly predicted that *wexaykapo?* is the phonetic outcome.[7]

We have thus seen that the phenomena for which Kisseberth's truncation rule (6c) as well as his vowel elision rule (13) and expansion (15c) of Phelps's rule (14) were formulated are all correctly predicted in our syllabification model. Hence, there is no need to formulate separate rules.

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[7] Seeing the numerous reversals of the direction of syllabification in Tonkawa, one might raise the question whether syllabification cannot simply work outwards from the stem (Norval Smith, personal communication). There are, however, a number of objections to such a proposal. First, recall that because of the Strict Cycle Condition, the stem itself does not trigger syllabification lexically. Therefore, one can argue that the syllabification algorithm cannot "view" the stem, and therefore cannot determine the direction. A second argument against outward syllabification is that it would entail an incorrect prediction in the case of the site of the deleted vowel in the forms is (25a,b). In these cases outward (i.e. rightward, if one is to the right of the stem) syllabification would delete the *o* instead of the *a* in cases like *picena+o?* and *we+picena+o?*. Third, outward syllabification would be incompatible with the general phonological theory, as developed up till now, in which processes of structure assignment (e.g., metrical structure assignment, as in Hayes (1981)). In all proposals up till now, the direction of assignment is not dependent on the position of the element to which the structure must be assigned vis-à-vis the stem, but is specified extrinsically.

3.4 Remaining issues

3.4.1 *h*-deletion

After having presented our analysis of the Tonkawa Vowel Elision, Vowel Deletion and Vowel Truncation processes, we now turn to four issues in Tonkawa phonology which are more or less related to the phenomena discussed above.

The first one concerns the behaviour of *h*. Morpheme initial syllables beginning with *h* drop this *h* when a prefix syllable is added in front of them. This is shown in (30a-e) (Hoijer 1933: 40, 42, 80; 1949, Phelps 1973: 38-39; 1975: 151):[8]

(30) a.	hecno?	< he+cane+o?	'he falls down'
b.	ke:cno?	< ke+he+cane+o?	'I fall down'
c.	xe:cno?s	< xa+he+cane+o?s	'I fall down with force'
d.	heylapo?s	< he+yalapa+o?s	'I stand up'
e.	xe:ylapo?s	< xa+he+yalapa+o?s	'I stand up at a distance'

We see here that the *h* disappears in intervocalic position. Phelps (1973: 39, 1975: 151) has formulated the following rule for this process:

(31) *h-deletion*

$h \rightarrow \emptyset$ / [+segment] + ___

A possible explanation for this phenomenon in our framework is the following. There are two distributional facts about *h*. Firstly, like in many languages, *h* can only occur in syllable-initial position (Hoijer 1946: 292). We analyse this as the result of a general syllabic constraint: only the onset node is subcategorised for *h*, not the coda. We assume that this contraint holds at all levels. Secondly, in general, *h* can occur phonetically only in word-initial position (Phelps 1973: 38; 1975: 151).[9] As the reader will see shortly, we will analyse this second distributional fact not as a syllable structure constraint, but as the result of a fairly late rule, which applies at the word level.

A theoretical reason not to analyse the second distributional fact about *h* (the fact that it occurs in general only word-initially) as a constraint is that in lexical phonology, distributional constraints are often suspended at the postlexical level, and certainly not introduced at that level. A constraint against an *h* in any other onset position than that of the word-initial level could not be in force during the lexical part of phonology,

---

[8] The *?s* combination in (30c,d,e) is one of four clusters (the other ones being *l?, y?, s?*) that may end a syllable in Tonkawa (Hoijer 1946: 292). Whether these clusters have to be regarded as 'glottalised' consonants is not fully clear. On the behaviour of non-word-final 'glottalised' consonants, see the next subsection.

[9] Word-medial *h* appears only in nonderived words and may be analysed as an exception that does not delete as a result of Kiparsky's identity rule, in order to avoid an absolute neutralisation. An example is *?ahen* 'daughter' (Hoijer 1946: 291).

as it is not known at the time of the of the application of syllabification on a given cycle whether an element will ultimately be word-initial or not. (Note that on a given cycle, the morphemes added during the next cycle are invisible. Thus during the syllabification of *h* in (30b), it is not known whether this element is preceded by other material within the same word).

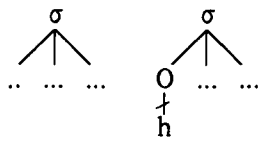
Apart from this theoretical reason, there is the factual reason that even at the word level, *h* must have been syllabified initially.

A closer look at the forms in (30b,c,e) reveals that wherever there is an intervocalic *h* underlyingly, this *h* is not realised, *and* the two vowels have been *contracted*, with a long vowel resulting from two short vowels. This contraction differs from the regular deletion of the leftmost vowel when two vowels are concatenated. In that case the remaining vowel keeps its vowel length, i.e., when it is short, it remains short. As we have seen in section 3.3, this latter deletion is a direct result of syllabification. Consider (30b). If *h* were not syllabified, the outcome would be [ke:cno?] but *[kecno?]. This is so because, if *h* did not trigger syllabification, at the first cycle, *h* would not trigger syllable structure imposition in /ke+he+cane+o?/. Syllabification would proceed as follows (cf. (33) below for the genuine syllabification of this form in our view):

(31) a. *first cycle* b. *second cycle*

In the first cycle, *h* would not trigger syllabification and only the syllable *no?* would be formed. On the second cycle, only *k* would trigger syllable structure imposition and as a result, after direction reversal (22a) the syllable *kec* would be formed. Recall that *h* cannot link to the coda position. The leftmost *e* would map to the nucleus because after direction reversal (22a) the direction of mapping is now left-to-right. Postlexically, nothing happens, because all consonants which trigger syllabification have been syllabified and the outcome would be wrongly predicted as *[kecno?] instead of the attested form [ke:cno?]. We propose the following deletion rule:

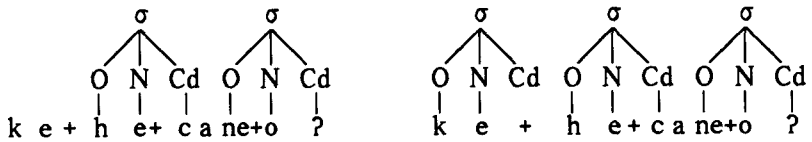
(32) *h*-delinking (word level)



This rule, applying at the word level, says that *h* is delinked from the onset node when the syllable of which this onset is part is preceded by a syllable at the word level. This deletion can become operative only at the word level, i.e., *after* the cyclic part of the phonology. This entails the syllabification of *h during* the cyclic part of the phonology,

as it is not known at the time of the of the application of syllabification on a given cycle whether an element will ultimately be word-initial or not. (Note that on a given cycle, the morphemes added on the next cycle are invisible. Thus during the syllabification of *h* in (30a,b), it is not known whether this element is preceded by other material within the same word). Therefore, during the phonological cycles, *h* functions as a normal consonant (with the proviso that it can be linked to the onset node only). We can envisage the following syllabification (we take (30b) as an example):

(33) a. *1st cycle* b. *2nd cycle*

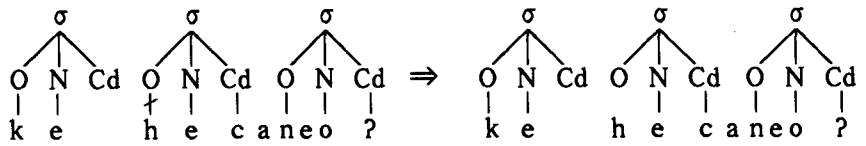


During the first cycle, the consonants in the morphemes bordering the stem trigger syllabification and need to be incorporated in the syllabic structure. Thus, *h* in the morpheme *+he+* and *?* in in the morpheme*+o?* trigger syllabification and are mapped to the coda position of the syllable whose imposition they have triggered. Then, it is attempted to syllabify the segments to their left. This attempt is successful as far as the rightmost syllable (the one with *?* of the morpheme *+o?* in tis coda) is concerned. Hence, *o* and *n* are linked to the nucleus and the onset of this syllable. In the case of the syllable with *h* in its coda, however, further syllabification is not possible, because there is no material to the left of this element at this level (note that the *ke+* morpheme is added only on the second cycle) Therefore, syllabification is reversed by virtue of (22b) and the syllable *hec* is formed (cf. the configuration in (33a), (above)).

Next, on the second cycle, syllable structure imposition is triggered by the consonant *k* in the leftmost prefix. There being no material on the left side, the direction of syllabification will again be reversed by virtue of (22b). The *e* of the prefix will now be linked to the nucleus. The result is (33b) (above).

At the postlexical level nothing happens because all elements that trigger syllable structure imposition have been syllabified. We are thus faced with the situation in (33b). Now *h*-delinking (32) comes into play:

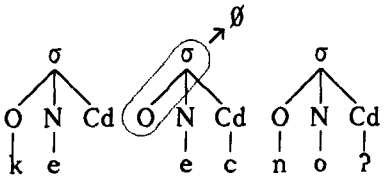
(33) c. *h-delinking* d. *after h-delinking*



We now see that the result of *h*-delinking is that the onset is of the second syllable is empty, forming an illicit syllable structure. A strategy to resolve this would be to destroy the entire syllable and to incorporate the segmental material in existing syllables.

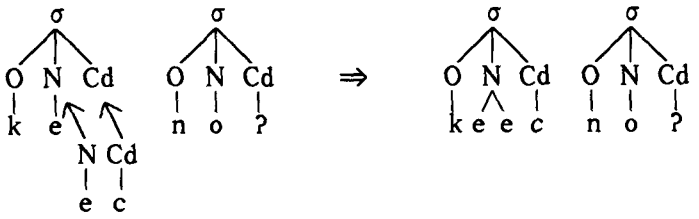
This is the case when an onset cannot be filled during regular syllabification. However, unlike normal syllabification (e.g., when a direction reversal takes place as a result of (22a)), the syllable structure has already been fully established, and has become illicit postlexically after the application of a delinking rule. Therefore, we think that only the structure as far as it is illicit destroyed. That is, the syllable node is destroyed. The onset, devoid of any content, is deleted. Also all segments unlinked to subsyllabic nodes are deleted by convention at the postlexical level ('Stray Erasure', proposed by McCarthy (1979a, 1981), Steriade (1982), J. Harris (1983), Itô (1986, 1989)) and hence are phonetically not realised. The filled nucleus and coda continue to exist. We thus get the following situation:

(33) e. *partial syllable structure deletion*



Now a fusion (or unification) with the preceding syllable is possible. Note that there is a tendency (reflected, among other things, in the mapping and dumping of the segments to the subsyllabic nodes) for syllable structure normally to be optimal, i.e., as fully filled as possible. This is precisely not the case with the first and second syllable in (33d). If the two syllables are fused, a full, permissible syllable is the result:

(33) f. *fusion* g. *outcome*

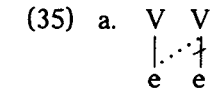


This produces the correct outcome [ke:cno?]. One issue should still be settled here. In this chapter, we have omitted skeletal slots. The sequence *e e* in (33g) is in fact an abbreviation of the configuration in (34).

(34) V V skeleton
| |
e e melodic (segmental) tier

This structure violated the Obligatory Contour Constraint (OCP), originally proposed by Goldsmith (1979) for tones, and subsequently extended for other areas of nonlinear phonology. The constraint prohibits identical adjacent elements on the tonal tier, and by extension on the melodic (or segmental) tier. As a result of this constraint, the link

between one of the melodic elements (*e*) and the skeletal element in question will be severed and spreading will take place from the melodic element to the now skeletal slot. This can happen either as in (35a) or as in (35b):

(35) a. 

b. 

In (35)a, the rightmost *e* is delinked, and the leftmost *e* spreads to the skeletal element to which it was linked. (35b) represents the mirror image of this. We would like to argue that the actual delinking and spreading takes place as in (35b). Thus is so because in (30c,e), repeated here as (36a,b), the vowels in the syllables that are fused actually differ in quality, and the resulting long vowel has the quality of the vowel of the rightmost syllable:

(36) a. xe:cno?s < xa+he+cane+o?s 'I fall down with force'
b. xe:ylapo?s < xa+he+yalapa+o? 'I stand up at a distance'

Thus, in (36a,b) when the syllables fuse, we have the following situation:

(37) 

Because *e* is linked to the first V, the vowel comes out as a long, and *a* is not realised.

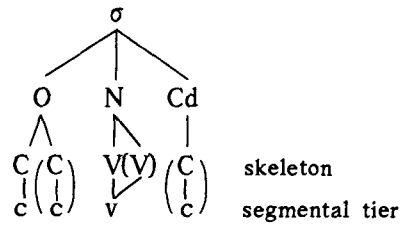
This concludes our analysis of *h*-deletion in Tonkawa. It is only tentative, because certain proposed mechanisms, like syllable fusion, have not been sufficiently independently motivated here. However, the principle of syllable fusion in order to avoid non-optimal syllable structure will also be used in chapter 6, section 6.6.3, in order to account for a phenomenon in French. In addition, we feel that the proposed syllabically related analysis fits into the present framework better than an analysis involving several adhoc segmental rules, which would otherwise be needed to explain *h*-deletion and the subsequent lengthening of the vowel, as well as its quality.

3.4.2 "Glottalised" consonants

Another phenomenon involves the occurence of biconsonantal onsets can occur in Tonkawa in certain cicumstances. Hoijer (1946: 292) writes that these clusters may only occur in syllable initial position and that the second member is always a glottal stop (but cf. note 3). The initial consonant of these clusters can be k^w, *c*, *m*, *n*, *s*, *x*, x^w, *l*, *y*, as well as *p*, *t*, *k* in slow speech. (This boils down to nearly the complete consonantal inventory of Tonkawa, given by Hoijer (1946: 290), excepting only *?* and *h*. This is not surprising, given the different character of these segments from other (genuine) consonants, and the special status of *h* outlined above). We thus have to

amend the syllable template given in (19) to:

(38) *Tonkawa syllable* (second version)

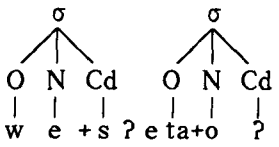


Phelps (1975: 158) mentions that in an environment comprised of a consonant followed by a glottal stop, the vowel does not elide in a situation where it would if preceded by only one consonant. An example is given in (39) (Hoijer 1946: 295).

(39) a. wes?eto? < we+s?eta+o? 'he cuts them'
b. key?oco? < ke+y?oco+o? 'he pinches me'

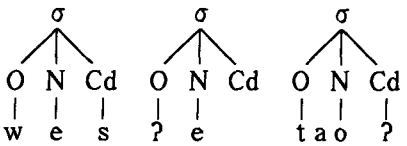
How can this be explained in our framework? Let us analyse how syllabification would proceed according to our theory:

(40) *first cycle*



We see here that in the first cycle, the *s* is linked to the coda of the first syllable. As mentioned by Hoijer (cf. above) a syllable cannot end in a combination of a consonant and a glottal stop, hence the glottal stop is left unsyllabified at this stage. Let us now look at the postcyclic syllabification:

(40') *postcyclic (postlexical) syllabification*



Here the direction of syllabification has been reversed, due to (22a). Hoijer (1933) and Kisseberth (1970a) take the position that a consonant followed by a glottal stop in fact constitute a single, glottalised, consonant. They do this precisely because of the fact that of all combinations of consonants, only this combination may begin a syllable. Therefore, it seems to behave like a single consonant. This assumption, however,

would not explain why the second vowel in (40) is not elided. Hoijer (1946) and Phelps (1973, 1975) reject the idea of analysing a combination of a consonant and a glottal stop as a single, glottalised, consonant, on several grounds, including phonetic ones. One of the reasons mentioned by Hoijer (1946) for analysing the combination of consonant plus glottal stop as two different segments in fact supports the analysis given above:

> It may also be noted that clusters of type two" [i.e. clusters of the type consonant plus *glottal stop*, R.N.], "when placed between vowels, become ambisyllabic just like the consonant combinations of type one [i.e., other combinations of consonants, which occur only in intervocalic position, R.N.].

Our theory is thus in line with the assumption that the consonant and the glottal stop are in fact two different segments, dominated by different skeletal nodes. The fact that shortening does not take place here is a direct result of our conception of syllabification in Tonkawa. While, as noted by Hoijer, a combination of a consonant and a glottal stop may begin a syllable, and may thus be in onset position, it may not end a syllable and thus may not be in coda position.

3.4.3 Long vowels in closed syllables

Consider the following forms given by Phelps (1973: 50, 1975: 153), adapted from Hoijer (1933: 4)

(41) so:pko? < soopaka+o? 'he swells up'

Here we see a long vowel in a closed syllable. The question can be asked: how can this form come into existence? Syllabification would proceed as follows:

(42) a. *first cycle* b. *postcyclic (postlexical) syllabification*

Here, only one *o* has been incorporated into syllabic structure.[10] Given the fact that V's do not have to be syllabified and that syllabification tries to achieve one-to-one relationships between subsyllabic nodes and segments (see (6) and subsequent discussion), the leftmost *o* will never be syllabified. In this very fact lies the answer why we do find the syllable *soop*. Given Kiparsky's identity rules, this syllable must in fact

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[10] In fact *oo* should of course be read as:

We use here *oo* as an abbreviation for this structure, purely for reasons of exposition.

show up here, because otherwise it would never show up. In fact, it must be assumed that there is a separate syllabification rule forcing CVVC sequences in underived environments to be exhaustively syllabified at the beginning of postcyclic phonology.

3.4.4 The vowel shortening phenomena

We turn now to the shortening process, for which Phelps has also formulated rule (14), repeated here as (43), in its expansion (15b). In this expansion, this rule should be read as (44).[11]

(43) (= 14) *Phelps' rule of Vowel Elision* (iterative, rightward)

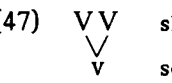
$$\begin{bmatrix} V \\ +stem \end{bmatrix} \rightarrow \emptyset \;/\; V\ C\ ((?)V)\ \_\_\_\ C\ \begin{bmatrix} V \\ -suffix \end{bmatrix}$$

(44) $$\begin{bmatrix} V \\ +stem \end{bmatrix} \rightarrow \emptyset \;/\; VCV\ \_\_\_\ C\ \begin{bmatrix} V \\ -suffix \end{bmatrix}$$

The analysis that follows is necessarily of a rather speculative and tentative character, since no independent evidence can be found to confirm it. Nevertheless, it is presented here in order to show that an analysis of vowel shortening is possible in our framework. Expansion (43) accounts for the shortening of the vowel in (45b, 46b,c):

(45)	a.	kaanano?	< kaana+n+o?	'he is throwing it away'
	b.	xakano?	< xa+kaana+o?	'he throws it far away'
	c.	neskaano?	< nes+kaana+o?	'he causes him to throw it away'
(46)	a.	naato?	< naate+o?	'he steps on it'
	b.	wenato?	< we+naate+o?	'he steps on them'
	c.	wenateno?	< we+naate+n+o?	'he is stepping on them'

In these forms, we see that a long stem vowel is shortened if it is preceded by a CVC sequence, but not if it is preceded by a CVCC sequence. Recall that we assume that a long vowel in Tonkawa has the form:

(47) 

As often noted in the literature, short vowels can disappear completely, in contrast to

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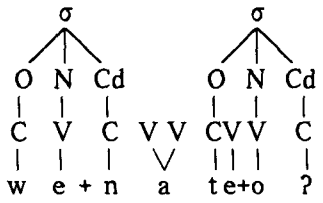
[11] Kisseberth, in contrast to Phelps, does not assume that a long vowel consists of a sequence VV. Therefore, Kisseberth's rule (6c) does not shorten long vowels (which would result an absolute neutralisation), but Phelps' rule (14/43) does. Kisseberth does not provide an account for the vowel shortening phenomena.

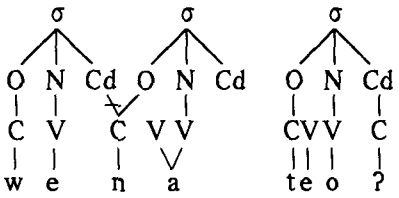
long vowels. Therefore, we will assume that at least one V of $\overset{V\ V}{\underset{V}{\vee}}$ has to be incorporated into syllabic structure. (A structural solution for this would be to actually analyse a long vowel as $\overset{V\ C}{\underset{V}{\vee}}$, a solution employed by Clements & Keyser (1983)). Let us consider what happens during the derivation of form (46c). First cycle syllabification will yield (this time with skeletal slots indicated):

(48) a. *First cycle*



We now come to the postlexical syllabification. The second V linked to the vowel (or in Clements and Keyser's framework: the C) will have to be syllabified.

(48) b. *Postcyclic syllabification*



In this case, the link between the first syllable and *n* is broken and *n* is incorporated into the newly formed syllable, by virtue of (22b). In this way, the shortening data are borne out. The V connected to the element on the segmental tier has not been connected to the syllabic tier, and this timing unit is therefore not realised. To fully understand this one should realise that (22b) is in fact an emergency measure. As mentioned above the emergency measures are – normally recessive – strategies of syllabification, available as an option to language, which for Tonkawa become operative if the dominant strategies fail. Because of the emergency character of these measures, they apply only when strictly necessary. Therefore, the leftmost V is not incorporated into syllabic structure, since there is no strict obligation to do so.

Apart from these examples, there is still one question concerning vowel shortening, which our theory in its present form (or for that matter, anybody's theory) cannot account for. The question concerns again the status of consonant + glottal stop sequences. Recall that in section 3.4.2 it was demonstrated that there are good reasons to believe that these sequences are genuine clusters and not a single, glottalised, consonant. There are cases however, where it does seem that these sequences behave like single segments. An example is given in (49) (taken from Kisseberth (1970a: 125);

the *s* + glottal stop sequences are rendered here as genuine clusters, Kisseberth himself presents them as single glottalised consonants, viz. *ṡ*).

(49) a. s?e:to? 'he cuts him'
b. kes?eto? 'he cuts me'

It is for the shortening in this environment that Phelps has formulated her rule (14, 43), repeated here as (50), in its expansion (15a). In this expansion, the rule should be read as (51):

(50) (= 14, 43) *Phelps' rule of Vowel Elision* (iterative, rightward)

$$\begin{bmatrix} V \\ +stem \end{bmatrix} \rightarrow \emptyset \;/\; V\ C\ ((?)V)\ \_\_\ C\ \begin{bmatrix} V \\ -suffix \end{bmatrix}$$

(51) $$\begin{bmatrix} V \\ +stem \end{bmatrix} \rightarrow \emptyset \;/\; VC?V\ \_\_\ C\ \begin{bmatrix} \\ -suffix \end{bmatrix}$$

This phenomenon cannot be seen as a result of syllabification and should therefore be seen as the result of the application a separate, specific, rule. For more details on this we refer the reader to Phelps (1973: 80-93, 1975: 158-169). It may very well be that the vowel shortening phenomena in Tonkawa must be seen as a metrical phenomenon, connected with the need to preserve a given foot structure. We will not go further into this matter here.

3.5 Conclusion

In this chapter, we have provided an explanation for the different phenomena of vowel deletion and vowel shortening taking place in Tonkawa. We have shown that it is possible to account for these phenomena by analysing them as a result of of the assignment of syllable structure. This assignment conforms to our syllable assignment algorithm (30) of chapter 1. The language specific parts of this assignment are the following: (a) syllabification is cyclic (in addition to being postcyclic); (b) the geometry of the canonical syllable of Tonkawa is trinodal; (c) syllable assigment is triggered by consonants only; (d) the dominant directionality of syllabification is right-to-left.

We have introduced in this chapter the notions of dominant and recessive directions of syllabification. There are good reasons to assume that the idea of a recessive direction of application is not limited to syllabification, but that every operation applying directionally can in principle apply in a recessive direction – the direction opposite to the normal one – when this is needed. In chapter 6, on French, we will show that the operation of dumping of skeletal slotes to subsyllabic nodes can take place in the recessive direction.

4 Syllabification in Yawelmani

4.1 Introduction

This chapter is devoted to Yawelmani, a dialect of Yokuts, spoken in the San Joaquin valley in South Central California. Yokuts has been classified as belonging to the Penutian family. Other dialects of Yokuts include Chawchila, Choynimni, Chukchansi, Gashowu, Wikchamni. The main source on Yokuts is Newman (1944). Other sources are Kroeber (1907), Newman (1946), Gamble (1978).

For phonologists, Yawelmani is a special language. More than any other language, apart from English, it has played an important role in discussion throughout the history of generative phonology. It has given rise to two theoretical dissertations (viz. Kisseberth (1969a), Archangeli (1984)), a monograph (Kuroda 1967) and numerous articles (e.g., Z. Harris (1944), Hockett (1967, 1973), Iverson (1975), Kisseberth (1969b, 1970b), Lapointe & Feinstein (1982), Archangeli (1983a,b, 1985a,b, 1989, 1991)). Apart from the discussions, Yawelmani has found uses in linguistics pedagogy:

> Data from Yawelmani, particularly on verbs, [were, R.N.] used repeatedly in courses designed to train apprentice linguists in the analytic techniques of descriptive linguistics [...]. A consequence of this iterated and widespread pedagogical use is that a journal article on Yawelmani (or Yokuts) will now catch the eyes of a few linguists in every part of the world, most of whom will leaf silently past an article on any other aboriginal language of North America.
> (Hockett 1973: 64)

Here, we will show that syllabification is the key to the understanding of the notorious conspiracies noted in Yawelmani. First, we will treat the early generative analyses by Kuroda and Kisseberth and the nonlinear analysis by Archangeli. In both cases, we will take a special look at the analysis of epenthesis.

4.2 Kuroda's and Kisseberth's accounts

In this section several rules proposed by Kuroda and Kisseberth will be given, which will be of interest to us later. These rules are the rules of Vowel Elision, Shortening, Verb-final Vowel Deletion, Epenthesis and Two Sided Open Syllable Deletion. The rules are given here in the formulation by Kuroda, except for the rule of Verb-final Vowel Deletion, which Kuroda does not give. Kisseberth's formulations are sometimes slightly different.

Kuroda (1967: 20) formulates the following rule of Vowel Elision which he terms "Truncation":

(1) *Vowel Elision*

$V \rightarrow \emptyset \; / \; \_\_V$

An example of this process is given in (2). *ɪ* is a short diffuse vowel, which later in the derivation is turned into *i*. In *hn* the vowel is epenthetic (Kuroda, 1967: 20).

(2) /pana:+ɪn+hn/ [paninhin] (*pana:*- 'arrive',
-ɪn-, mediopassive,
-hn, aorist)

The rule of Shortening is formulated by Kuroda (1967: 10) as:

(3) *Shortening*

$V \rightarrow [-long] \; / \; \_\_ C \left\{ \begin{matrix} \# \\ C \end{matrix} \right.$

An example of the functioning of this rule is given in (4).

(4) /panaa+t/ [panat] (*-t*, passive aorist)

We now come to the rule of Verb-final Vowel Deletion, which Kisseberth (1969a: 151, 1970b: 302) lists as:

(5) *Verb-final Vowel Deletion*

$V \rightarrow \emptyset \; / \; V + C \; \_\_ \#]_{Verb}$

It is important to note that this rule refers to morphological information, because it applies to verb endings only. An illustration is provided in (6).

(6) /taxa:+k'/ [taxak'] 'bring it' (*taxa:*, 'bring', *-k'a*, imperative)

This rule is needed to explain the alternation in the verb ending *-k'a* (Newman 1944: 118), *-mi* (consequent-gerundial, Newman (1944: 134)), *-xa* (precative, Newman (1944: 119)). They show up postconsonantally as *-k'a*, *-mi*, *-xa*, but postvocalically as *-k'*, *-m*, *-x* (our account of these alternations is given in section 4.4.6). A possible criticism to this rule is that another dialect of Yokuts than Yawelmani, viz. Chukchansi, where we also find the alternations *-k'a/-k'*, *-mi/-m* and *-xa/-x* has a verb ending of the form -CV which does not alternate with -C, viz. the narrative aorist *-ta* (Newman, 1944: 125).

We now come to the rules of Epenthesis and Two Sided Open Syllable Deletion, cf. (7,8). We will consider the interaction between these rules. (The rule of Epenthesis

given in (7) is formulated by Kuroda in a slightly different way from Kisseberth's version of the rule, presented by us in (1) of the Introduction).

(7) *Epenthesis* (Kuroda 1967: 23)

$\emptyset \rightarrow i \; / \; C\_\_C]$

(8) *Two Sided Open Syllable Deletion* (Kuroda 1967: 33)

$$\begin{bmatrix} V \\ -\text{long} \end{bmatrix} \rightarrow \emptyset \; / \; VC\_\_CV$$

An example of the application of the rule of "Two Sided Open Syllable Deletion" can be seen in (9) (Kuroda 1967: 21).

(9) xatnal (*xat-*, 'eat', *-in-*, mediopassive, *-al*, dubitative)

The rule of Epenthesis (7) is ordered before Two Sided Open Syllable Deletion (8). As the reader will notice, a vowel inserted by rule (7) will again be deleted by rule (8), whenever the environment happens to be followed by a vowel-initial suffix. As an illustration is given in the derivation in (10), an example mentioned by Kuroda (1967: 18).

(10) *paʔṭ*, 'fight'; *-hn*, aorist; *-t*, passive aorist

a.		b.	
paʔṭ+hn		paʔṭ+t	Underlying Representation
paʔiṭ+hin		paʔiṭ+it	Epenthesis (7)
n.a.		paʔṭ+it	Two Sided Open Syllable Deletion (8)
paʔiṭhin		paʔṭit	Surface Representation

In (10b), we see that an *i* is inserted and then deleted. Intuitively, it seems strange that a vowel is inserted by a phonological rule rule only to be deleted by a subsequent rule in a very large number of cases (unless there are very good reasons for this). It would seem preferable if one could devise a mechanism which would insert the *i* in only those places where it effectively surfaces. As noticed by Kisseberth (1969a: 37-38), the result of the interaction of the rules of Epenthesis and Two Sided Open Syllable Deletion is that the epenthetic vowel shows up on the surface *only* in those places where this is required by syllable structure conditions. Yawelmani allows three types of syllables, viz. CV, CVC, CV:. Epenthetic *i* only occurs in those places where otherwise a disallowed syllable structure would ensue. This state of affairs hints at a syllable related phenomenon, which early generative phonologists, because they ignored the syllable as a relevant phonological notion, were not able to capture formally.

As noted, the rule of "Two Sided Open Syllable Deletion" (8) is used in a very large number of cases just to undo the results of the Epenthesis rule in (7). This raises the question whether there are any grounds for assuming this rule at all. Also, the process is not noted by so observant a linguist as Newman, which seems strange. Furthermore, in Newman's (1944) monograph, one can find many examples of short vowels in the

environment stated in this rule.[1] Just in the short specimen of Yawelmani text at the end of the book alone, out of 32 different words containing three or more syllables, five have a short vowel in the environment VC CV.[2] Also, the short vowels in the affixes *-iyoo-*, priorative (Newman 1944: 115) and *-hanaa-*, passive verbal noun (Newman 1944: 149), do not delete when in an environment of a "two sided open syllable".

In spite of this, many authors have taken Kuroda's statements for granted and have at most reformulated his rule. This may be due to the "enormously cumbersome descriptive machinery" (Hockett 1973: 63) used by Newman, which does not make his monograph on Yawelmani very accessible. As we will see below, apart from being required to counterbalance the overinsertion caused by his formulation of the epenthesis process in Yawelmani, Kuroda posited rule (8) chiefly in order to explain the behaviour of one single affix: mediopassive *-in-* (see note 1 and below).

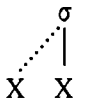
4.3 Archangeli's account

4.3.1 Syllabification, Epenthesis and Syncope

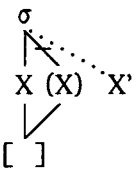
Let us look now at Archangeli's (1984) analysis. Assuming that syllabification is partially underlying, syllable heads (i.e., nuclei) being present in the underlying representation, she posits the following syllabification algorithm:

(11) *Core Syllabification* (Archangeli 1984: 181)

a. *Syllable Formation*



b. *Rime Formation/Shortening*



In (11b) *X'* stands for a skeletal slot which is not linked to syllabic structure. The process of shortening, formulated linearly by Kuroda as in (3), has been combined with

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[1] As we will see below in section 4.3.1, Archangeli (1984) treats the counter-examples as being the result of diacritical markings in the lexicon. The only real argument adduced in favour of the rule of "Two Sided Open Syllable Deletion" is the behaviour of the mediopassive morpheme *-in-*. Where *-in-* is preceded by a CVC verb stem and followed by a vowel, the *i* drops, because it is reanalysed as epenthetic. The assumption is corroborated by the fact that CVC+*in* behaves like a basic verb, which can assume all the possible template forms (cf. Newman 1944: 75-76). We will come back to this in section 4.3.3, when we discuss the template system of Yawelmani.

[2] In two of these five examples the environment VC__CV constitutes a derived environment, viz. the examples numbered 27, 50 (Newman 1944: 240-247).

the process of Rime Formation by Archangeli. For Epenthesis, Archangeli posits the rule (1984: 183):

(12) *Epenthesis*

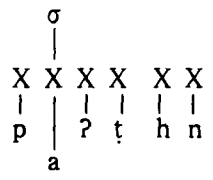
$$\emptyset \rightarrow \overset{\sigma}{\underset{|}{X}} \; / \; \_\_ X'$$

Before we go on and look at the workings of these rules, a word must be said about the fact that rules (11b) and (12) refer to an element's status of not being linked to higher syllabic structure (i.e., the use of *X'*). It is not at all clear that this type of reference is necessary in phonology, and it seems that by allowing for reference to an element's unlinked status enriches the power of phonological devices and thus impoverishes the explanatory power of the phonological theory. One can realise this fully if one tries to translate the notations in (11) into SPE notation. An $\overset{|}{X}$ (like the leftmost X in (11b)), a syllable, would be a V, i.e., a segment specified as [+syll]. An $\overset{/}{X}$ or an $\overset{\backslash}{X}$, i.e., elements belonging to a syllable, but non-heads (like the second X in (11b)), would be segments specified as [-syll]. The expression *X'*, as used in (11b) and (12) refers to a segment unspecified for [syllabic], i.e. [Ø syllabic]. Because reference is made to the state of being unlinked to syllabic structure, using expressions like *X'* in fact boils down to the introduction of a third feature value. The objections that must be raised against this are notorious since publication of Stanley's (1967) article on unspecified features and redundancy rules. What is more, it is precisely Archangeli (1984) who discusses the objections raised by Stanley and devises a (rather far-fetched and powerful, in our opinion) mechanism to escape them in her theory of underspecification. We have just seen that the same point – making reference to three feature values – crops up (thusfar unnoticed, as far as we know) in Archangeli's account of Yawelmani. We will come back to this point in chapter 5, section 5.4.2, when we discuss a rule very similar to (12), proposed for Epenthesis in German.

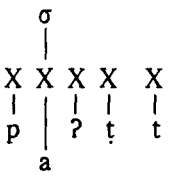
Let us now look at how Core Syllabification (11) and Epenthesis (12) operate on the forms in (10).[3]

underlying forms

(13) a.



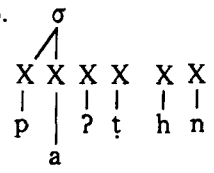
(14) a.



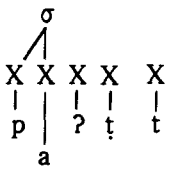
[3] The derivations given here are constructed in analogy to the derivations given by Archangeli (1984: 181-188).

Syllable Formation (11a)

(13) b.

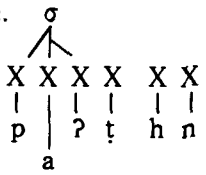


(14) b.

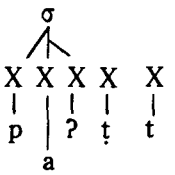


Rime Formation (11b)

(13) c.

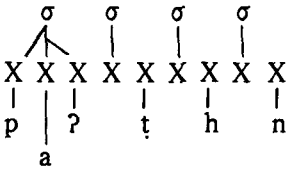


(14) c.

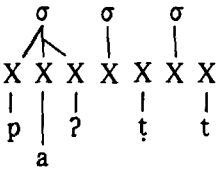


Epenthesis (12)

(13) d.



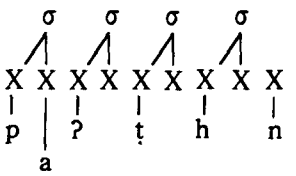
(14) d.



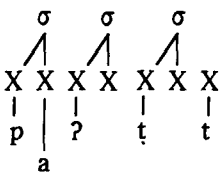
After the application of epenthesis, core syllabification reapplies automatically (Archangeli, 1984: 183, 185). In this example, the glottal stop is resyllabified into the second syllable because Syllable Formation (11a) also operates on slots that are already syllabified (Archangeli 1984: 183). Apparently, the existing link to the first syllable is then severed (although Archangeli does not mention this explicitly).

Syllable Formation (11a)

(13) e.

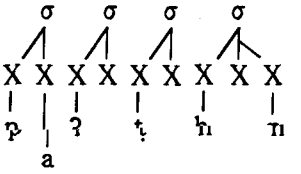


(14) e.

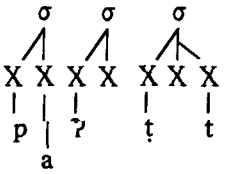


Rime Formation (11b)

(13) f.



(14) f.



The empty X's, (i.e. the X's not linked to a segmental slot) are in Archangeli's frame-

work automatically linked to default features, which produces the value *i*. In this way the intermediate forms *pa?iṭihin*, *pa?iṭit* are created.[4]

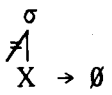
We now come to Archangeli's version of the rule of "Two Sided Open Syllable Deletion". Instead of positing a linear rule, Archangeli constructs a tree according to the following parameters (1984: 187).

(15) *Syncope*

i. Tree construction
   a. branching rimes must be heads
   b. bounded trees
   c. left dominant
   d. right to left

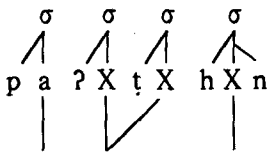
ii. resyllabify within the tree

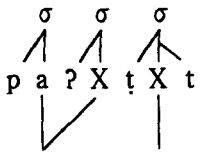
iii. Bare rime deletion



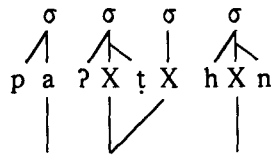
Let us now look at how these rules work on the forms in (13,14).[5]

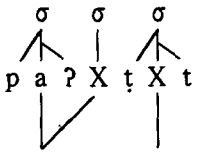
Tree construction (15i)

(13) g. 

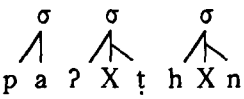
(14) g. 

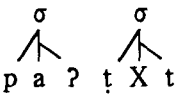
Resyllabification (15ii)

(13) h. 

(14) h. 

Bare Rime Deletion (15iii)

(13) i. 

(14) i. 

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[4] The default rules filling in the *i*'s in fact apply later in the grammar than the rules deleting the X's that are syllable heads (cf. below), but the form *pa?iṭihin* is given here to illustrate the gross overinsertion caused by Archangeli's "core syllabification".

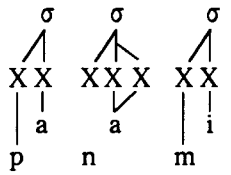
[5] Like Archangeli, we abbreviate the X's linked to elements on the segmental tiers as the elements on that tiers (i.e. lower case characters), while X's unlinked to the segmental tiers are represented as "X".

Syncope (15) is also used by Archangeli to account for those deletions, which Kisseberth accounted for with his rule of Verb-final Vowel Deletion (5). The example she gives (1984: 184) is presented here in (16) and involves the consequent-gerundial suffix *-mi.*

(16) /panaa + mi/ [panam] 'having arrived' (Newman, 1944: 135)

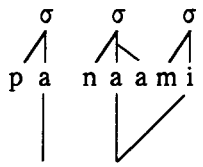
She then gives the result of Core Syllabification (11)

(17) a.



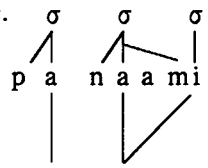
This form undergoes syncope tree formation (15i):

(17) b.



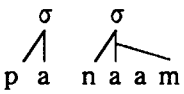
Resyllabification (15ii) applies:

(17) c.



And finally, Bare Rime Deletion (15iii):

(17) d.

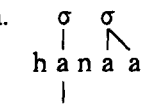


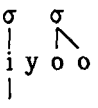
Having outlined Archangeli's account of Core Syllabification and Syncope, we will now treat some objections that can be raised against this proposal. First of all, note that Archangeli has to over-epenthesise even more than Kuroda. While Kuroda inserts and then deletes a vowel only in the underlying form *paʔṭ+t* (= (10b, 14)), Archangeli also inserts and subsequently deletes an epenthetic vowel (in her theory an $\overset{|}{\underset{}{X}}$ in the underlying form *paʔṭ+hn* (=(10a, 13)). Consider also the position of the glottal stop in the syllable structure in (14). In (14c) the glottal stop is linked to the first syllable. Then, in (14e), it is incorporated into the second syllable. Finally, in (14h), it is reincorporated into the first syllable. This appears a rather cumbersome way to achieve the

desired goal. It should also be mentioned that tree building in (15) only takes place for the sake of deletion. The trees thus built are otherwise completely unmotivated. Archangeli refers to tree-based accounts for syncope given by Selkirk (1978), Anderson (1982) and Withgott (1982) for French, Prince (1980) for Estonian quantity, as well as Rappaport (1984a, 1984b) on Tiberian Vowel Reduction. These accounts, however, are metrically based. Not so the account by Archangeli. On the contrary, Archangeli declares (1984: 190) that

> the trees necessary for stress are not the same as the trees necessary for syncope.

A second objection is that there appear to be a number of counter-examples to the proposal. Archangeli accounts for them by saying that the vowels which according to the proposal should be deleted but are not, are underlyingly the head of the trees of the type set up by (15i). She thus cites the affixes *-hanaa-*, passive noun, and *-iyoo-*, priorative (Archangeli 1984: 207-208). She assumes the underlying representation as in (18).

(18) a.


b.


The assumption of underlying syncope tree heads is a completely ad hoc solution for cases which Archangeli's theory in fact cannot handle. Apart from these suffixes, the case affixes, *-ni*, indirect objective, and the single vowel affixes *-i*, *-a*, object markers in certain paradigms, do not undergo Syncope either. This applies also to the already mentioned Chukchansi verbal affix *-ta*, narrative aorist (cf. the discussion of Kisseberth's rule of Verb-final Vowel Deletion (5)). Although Archangeli mentions these cases herself (except *-ta*), she has "nothing insightful to say about syllabification here" (1984: 209). One cannot but conclude that Archangeli's Syncope (15) creates more problems than it solves.

4.3.2 Cyclicity?

Somewhat later in her thesis than the account on which the above derivations are based (cf. note 3), Archangeli mentions that syllabification must be cyclic. She proposes this because the underlying form in (19) would otherwise produce the alleged wrong surface form (Archangeli, 1984: 192).

(19) pa?ṭ+mx+t (*pa?ṭ-* 'fight', *-mx-* comitative, *-t* passive aorist)

If syllabification is not cyclic, the resulting form would be *pa?ṭimxit*, instead of *pa?ṭitmixit*, supposedly the correct form. However, the form is listed only by Kuroda (1967: 20) who has himself constructed it, as Archangeli herself admits. But "the forms

correspond to that those described by Newman (1944), although examples are not found there" (Archangeli 1984: 192). If one does not wish to take this statement for granted, one has to look for the data in Newman's description of Yawelmani. We are then confronted here with the problem that, as Hockett (1973: 65) writes, "unfortunately Newman often fails to give the actual shape of a whole word just where the reader needs it". This raises the question of what exactly Newman is describing in this case. The only place where Newman writes about this is on page 72 of his 1944 monograph. After Newman has noted the influence of the syllable on the presence/absence of the epenthetic vowel (which he does not consider as such) and has mentioned that the situation he is describing occurs in all dialects of Yokuts, he goes on to say:

> if -mix-, comitative, is suffixed to a vowel ending-stem, the resulting theme (i.e., stem + nonfinal morpheme, R.N.) behaves in accordance with type IIAa (i.e., a verbal theme with an open penult ...VCVC-, mentioned by Newman on p. 71, R.N.), but the same affix added to a consonant-ending stem creates a theme of type IIAb (i.e. a verbal theme with a closed penult, CVCCVC-, R.N.): e.g., Gashowu laga·mix-, (...VCdC-) (see note 6, R.N.), 'stay over night with ...', composed of mix- with laga· [...] 'stay over night', pc (=preconsonantally, R.N.) laga·mix-, pv (=prevocalically, R.N.) laga[·]mx- (see note 7, R.N.), but Gashowu ʔepmix- (...CCdC-), 'swim with ...', composed of -mix- with ʔe[·]p-, preconsonantal reduced stem of ʔe·pi preconsonantally and prevocalically ʔepmix-.

In fact Newman does not mention an example of *-mix-* being attached to a stem the type of *paʔṭ*, which he would list as CVCdC, *paʔṭit*. This would be a case of one "dulled" vowel preceding another one. The only thing we can be sure of is that combined with *lagaa-*, the form is *lagaamxit*, because here *-mx-* stands in front of a vowel (in Newman's description *i* in *-it*, is a genuine vowel). This is in conflict with Archangeli's interpretation. If syllabification were cyclic, the form would have to be *laga:mix*, also prevocalically. As mentioned the passage above is the only one where Newman speaks about alternation in the affix *-mx-*. If Archangeli states that her interpretation of the facts corresponds to that described by Newman, she should indicate what passage in Newman's text allows for this statement. As shown, the only passage on *-mx-* to be found in Newman's text disproves the alleged cyclicity. We therefore are forced to conclude that Archangeli's (and Kuroda's) interpretation of the facts is false and that the correct surface form should be *paʔṭimxit*.

But even if we admit this form for the sake of argument, cyclicity does not seem to be the way to derive it, because this leads to other problems. To see this, let us look at

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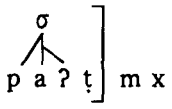
[6] By *d* in VCdV and CCdC Newman means the "dulled" vowel, which belongs to the class of "reduced vowel". These reduced vowels have been reanalysed as epenthetic by Kuroda and all linguists working on Yawelmani since. Newman indicated them, when using schemes, with lower case, while full vowels are written in upper case.

[7] Newman actually uses a raised full stop, "·", to indicate a long vowel. By "[·]" Newman means a shortened vowel. This process of shortening, which takes place before two consonants and before a single word final consonant, will be treated below.

the cyclic derivation Archangeli (1984: 193-195) gives of *paʔiṭmixit*. She assumes in accordance with the general assumptions in lexical phonology, that the first cycle starts in a derived environment, i.e., after the first morphological process.

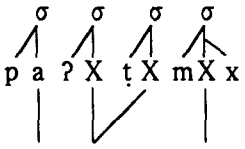
(20) a. *First Cycle*

underlying syllabification and core syllabification (11)

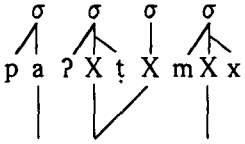


Epenthesis (12) and Core Syllabification (11)

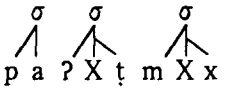
Syncope Trees (15i)



Resyllabification(15ii)



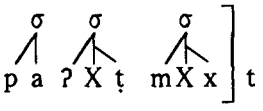
Bare rime deletion (15iii)



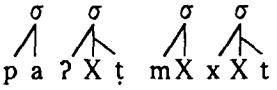
end of the first cycle: *paʔiṭmix*

(20) b. *Second Cycle*

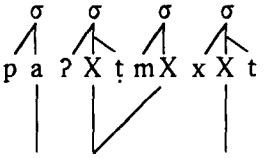
underlying syllabification and Core Syllabification (11)



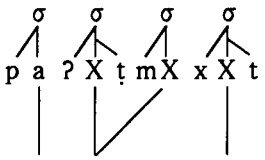
Epenthesis (12) and Core Syllabification (11)



Syncope Trees (15i)



Resyllabification(15ii)
and
Bare Rime Deletion (15iii)
(not applicable)



end of the second cycle: *paʔiṭmixit*

Notice that at the end of the first cycle, the syncope trees are erased. The reason for this is that (1984: 194)

> as noted in chapter 1, the trees are demolished at the end of the first cycle and structure is built anew. This is because the trees themselves have no phonetic correlates.

As we have seen above, the syncope trees have no independent motivation, which is of course the reason for (or is tautological to) having "no phonetic correlates". Moreover, Archangeli implicitly claims that the underlying tree heads in *hanaa* and *iyoo* do not delete. It is difficult to see why the underlying tree heads in these suffixes do not delete, because they also do not have phonetic correlates. The reason why underlying elements or structures are normally not affected by structure changing rules is because of Strict Cyclicity, but it is precisely this principle which does not seem to be operative for the syncope trees.

In conclusion, it can be said that Archangeli's Core Syllabification (11), Epenthesis (12) and Syncope (15) operate in a very complicated fashion, with even more overinsertion than in Kuroda's framework. On top of that, besides lacking any empirical basis, the alleged cyclicity is theoretically problematic, because one has to assume that the syncope trees erected by Syncope (15) do not obey the Strict Cycle Condition: they are deleted at the end of every cycle even in underived environments.

Below, in section 4.4.1, when we present our own proposals on Yawelmani syllabification, we will show that if one assumes that regular syllabification is only postcyclic, epenthesis can be analysed a *result* of this process. In this way, the fact noticed by Kisseberth (1969a: 37-38) (cf. also above), that the epenthetic vowel only shows up when it is required by syllable structure conditions, will find its natural explanation.

4.3.3 The template system

We now come to the template system of Yawelmani, as described by Archangeli (1983a, 1983b, 1984). In Yawelmani, the regular verb, which Newman refers to as the basic verb, consists of either two or three consonants. There are three possible consonant-vowel configurations, which are given here in (21).

(21)

A1	A2	B
CVC(C)	CVVC(C)	CVCVV(C)

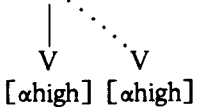
A1, A2 and B correspond to Newman's classification.[8] When combined with the majority of affixes, verbal stems take one of the forms listed above. Examples are given in (22).

(22)

	stem selected by the base[9]	*aorist (-hin)*[10]	*passive aorist (-t)*	*gloss*
IA1	caw	cawhin	cawit	'shout'
IA2	hiix	hexhin	heexit	'be fat'
IB	lagaa	lagaahin	lagat	'spend the night'
IIA1	luk̓l	luk̓ulhun	luk̓lut	'bury'
IIA2	wuu?y	woo?uyhun	wo?yut	'sleep'
IIB	biniit	binethin	bineetit	'ask'

In these forms the workings of several phonological processes in Yawelmani can be seen. A harmony process has taken place in the forms in IIA1 and IIA2. This process works directionally from left to right and rounds unrounded vowels if preceded by rounded vowels with the same specification for the feature [high]. The process has been formulated by Archangeli (1983b: 14, 1984: 33) as:

(23) *Vowel Harmony (VH)* [+round]



Also, we can see the workings of the epenthesis process, formulated by Kuroda and Kisseberth as in (1), in the passive aorist forms of the verbs given under IA1, IA2, IIA1, IIA2 and IIB. In the cases of IA1 and IIA2, the inserted *i*'s have turned into *u*'s by the subsequent workings of VH. An *i* has also been epenthesised in the aorist form of IIA2, and has also subsequently been turned into *u* by VH.

Another process to be noted is Lowering, which lowers long high vowels. It is given here, in Archangeli's (1984: 125) formulation, in (24).

(24) *Lowering* [αhigh] → [-high] / ___

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8 We have taken the vowel in aorist *-hin*, which Kuroda and Archangeli treat as epenthetic, as underlying, since it does not alternate with zero. In doing so, we can keep the derivations as transparent as possible.

9 These are intermediate forms, created by a morphological process according to one of the patterns given in (21).

10 Newman actually uses IA1, IA2, IB for biconsonantal verb roots and IIA1, IIA2, IIB for triconsonantal roots.

The workings of the process can be seen in the aorist and passive aorist forms of the verbs given as examples of types IA2 and IIA2. In the aorist form of the verb given as example of type IA2, the underlying *ii* has been changed to *ee* by Lowering. In the aorist form, *ee* has subsequently been turned to *e* due to the Shortening process given in (3). In the verb given as an example of type IIA2, the long *uu* has given rise to the harmony process, rounding high vowels in the following syllables, has then been lowered to *oo*, and is finally shortened to *o* in the passive aorist case.

There are, however, a number of affixes which select a different consonant-vowel configuration for the verb stem than the one which, so to speak, 'belongs' to the verb in question. Examples are given in (25).

(25)

stem selected by the base		*desiderative-aorist* -(h)atn+hin *selects:* CVC(C)	*reflexive/reciprocal adjunctive*[11] -wsiil- *selects:* CVCVV(C)
IA1	caw	cawhatinhin	cawiwseel-
IA2	hiix	hixhatinhin	hixewseel-
IB	lagaa	laghatinhin	lagawseel-
IIA1	luk̓l	luk̓latinhin	luk̓olwsel-
IIA2	wuu?y	wu?yatinhin	wu?oywseel-
IIB	biniit	bintatinhin	bineetiwseel-

Archangeli gives the following account of the alternations of the verb stems in Yawelmani. She posits the three rules given in (26) (Archangeli 1983b: 356).

(26) a. insert CVCC
b. insert CVVCC
c. insert CVCVVC

The affixes which select a verb stem of their own carry a diacritic which triggers one of the rules in (26). The other affixes, like the aorist in (22), do not carry such a diacritic. Furthermore, according to Archangeli, the verbs themselves carry a diacritic triggering one of the rules in (26). This diacritic comes into action only if there is no affix with a diacritic of its own, otherwise the diacritic of the affix takes precedence by means of the Elsewhere Condition. One can thus speak of a 'default template' supplied by the verb. The *h* in *-hatn-* is present when it is preceded by only one consonant and is absent when preceded by two. We will come back to this in section 4.4.6.

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[11] We have taken here the reflexive/reciprocal adjunctive affix *-wsiil-*, which is a non-final affix, to be in prevocalic position, or in a position followed by a consonant + vowel sequence. When in a position before a word-final consonant or before two consonants, the long *ee* is shortened to *e* due to the Shortening process for which Archangeli has formulated rule (11b).

In her 1984 dissertation, Archangeli has changed these rules to (27):

(27) a. insert CxCC
b. insert CxxCC
c. insert CxCxxC

In (27), C's represent in, fact, unsyllabified slots of the skeleton while the *x*'s are *X*'s which are underlyingly syllable heads. After insertion of these templates, association takes place. The form *caw-* is taken here as an example (Archangeli 1984: 277).[12]

(28) a. c w b. c w c. c w
C x C C + C x x C C + C x C x x C +
a a a a

In (28c), we see a second *a* attached to an x-position in the template. This is because Archangeli assumes a copying rule instead of a spreading rule. We will come back to this below, in section 4.4.4. Here the question is what happens to the final C in the template that is not linked to a segment. For this, Archangeli has to posit a specific rule of deleting this empty slot (1984: 278):

(29) *Slot Deletion* (X') → ∅

The circle around the *X'* indicates that the slot is not linked to an element on the segmental tier. Archangeli has to assume that this rule precedes syllabification. This seems rather strange since she assumes syllabification to be an automatic process, applying at all times. The *X'* is not erased, however, if an affix of the type of *-hatn-* is added. In that case, we have the following representation, after the concatenation of the affixes (cf. Archangeli 1984: 280).

(30) a. *biconsonantal root* b. *triconsonantal root*

affix & root:
c w (h) t n h n — l k̓ l (h) t n h n
x C C C C — x C C C C
a a — u a

template & associate:
c w h t n h n — l k̓ l (h) t n h n
C x C C x C C C C — C x C C x C C C C
a a — u a

It was for the alternation involving the *h* in *-hatn-* that Kisseberth formulated rule (2) in chapter 1, which we repeat here as (31).

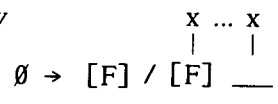
[12] In order to allow her rule of Vowel Harmony (23) to operate, Archangeli assumes that the vocalic and consonantal segments are on different tiers.

(31) C → Ø / CC+ ___

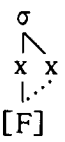
As mentioned, Kisseberth sees this rule as part of a conspiracy to avoid triconsonantal clusters. Given the fact that this restriction clearly has to do with syllable structure, it would be preferable to account for it in a syllable related way. However, this has not been done by Archangeli. In her theory it is merely accidental that the templates are all triconsonantal. This is in no way related in the theory with the fact that the verbs have either two or three consonantal segments. Slot Deletion (29) also seems ad hoc, given the fact that this deletion is at variance with the rest of Archangeli's analysis of the morphology and phonology of Yawelmani, in which empty slots are filled by association and spreading.

We must now look at how the V's in (26) (or the x's in (27)) are linked with elements on the segmental (or melodic) tier. According to Archangeli (1984: 121-132) this is done by the copying rule in (32) and the syllable internal spreading rule in (33).

(32) *Copy*



(33) *Syllable Internal Spread*



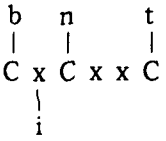
An example of the workings of these processes is given in (34), where the application of the rules in (27c) and the subsequent application of the rules of Copy (32), Syllable Internal Spread (33) and Lowering (24) are shown.

(34) a. *underlying form*

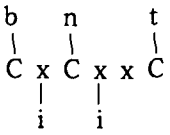
b n t consonantal tier

i vocalic tier

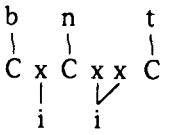
b. *Template Insertion (27c) and universal association*



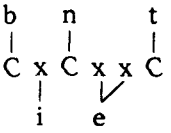
c. *Copy (32) and universal association*



d. *Syllable Internal Spread (33)*

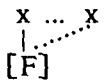


e. *Lowering (24)*



For the related dialect of Gashowu, Archangeli (1984: 133-134) assumes a spreading rule instead of the Copy rule (32), cf. (35):

(35) *Spread*



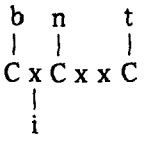
This she does to account for the fact that in Gashowu, in a form with the shape CVCVVC the first vowel is also lowered. This can be achieved in the simplest way if it is assumed that the x's (or V's) in such a form are linked to a single feature matrix. The derivation for (34) in Gashowu would thus be as in (36).

(36) a. *underlying form*

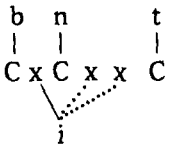
b n t consonantal tier

i vocalic tier

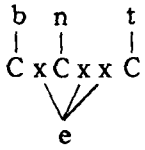
b. *Template Insertion (27c) and universal association*



c. *Spread (35)*



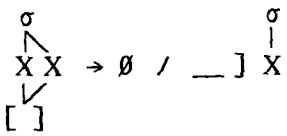
d. *Lowering (24)*



4.3.4 Vowel Elision

The rule of Vowel Elision which Kuroda has formulated as in (1), is reformulated by Archangeli as in (37) (1984: 196).

(37) *Vowel Elision*



Since according to Archangeli there are no morphemes which end in a short rhyme the rule need not be complicated to also delete short rhymes. Examples of the functioning of this rule can be seen in (38) (Archangeli 1984: 196-197).

(38) a. wilaldihni? < will + CXCxxC + d(aa) + ihnii
'one who is always preparing to depart (subj.)'

b. hoyinhin < hoyoo + in + hn
'was named'

Notice that Archangeli's rule (37) is far more complicated than Kuroda's rule (1). This complication is a result of the theory she uses, since she has to refer to the fact that the two X's that are to be deleted have to be linked to the same element on the (vocalic) segmental tier. Not referring to that tier would result in e.g., the first element of a long vowel being deleted. Of course, the deletion of vowels before other vowels can be seen in connection with the fact that Yawelmani allows neither hiatus nor diphthongs. In other words, this is directly connected to conditions on syllable structure. It is in fact part of the great "conspiracy" in Yawelmani. If we reverse the relationship between syllable structure and rules, and suppose that these rules are in fact the result of conditions on syllable structure, rules like the one in (37) would not be needed in this form in nonlinear phonology.

4.4 Syllabification in Yawelmani

4.4.1 The syllabification parameter settings and the processes of epenthesis, vowel elision and shortening

After having treated the proposals by Kuroda/Kisseberth and Archangeli, we now come to our own theory. We assume that syllabification in Yawelmani proceeds as follows:

(39) *syllabification parameter settings for Yawelmani*

a. geometry parameter setting: three places
b. obligatory incorporation parameter setting: C's and V's
c. directionality parameter: RL
d. cyclicity parameter: off

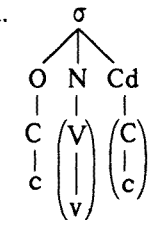
Comparing the above parameter settings with the ones of Tonkawa, we see that Yawelmani syllabification differs from Tonkawa syllabification on two points: the obligatory incorporation parameter, which is set to C's and V's, as well as the cyclicity parameter, which is set to 'off' here.

The fact that the geometry parameter is set to three places means that every time a syllable is projected onto the existing skeletal structure, three nodes are projected, regardless of the fact whether they can be connected with skeletal slots or not. The possible syllables of Yawelmani are given in (40).

(40) a. CV b. CVC c. CV: (CV_iV_i)

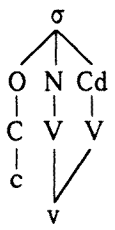
The expression of the possible syllable in Yawelmani is:

(41) *Yawelmani syllable*

a. 

b. 

We see here that the third position of the Yawelmani syllable, the coda, is subcategorised for consonants. The reasons why we analyse Yawelmani syllable structure in this way and do not allow for a structure like in (42) are several. In (42), the coda is not subcategorised for consonants.

(42) 

One reason is that diphthongs are not allowed in Yawelmani. This prohibition is difficult to express if structures like the one in (42) are allowed: it would be of an extreme specificity (the V dominated by the Coda node should be linked to the same element on the vocalic melodic tier as the V dominated by the nucleus), whereas otherwise the Coda would be very liberal as to the choice of segments it may contain. It does not matter whether the element is a C or a V. If it were a C, there would be no restriction on the nature of the element on the consonantal tier which the C dominates. A further argument against (42) is that a CVVC syllable does occur in Yawelmani in some exceptional cases. A final reason is that the syllabically conditioned alternations to be treated in section 4.4.6 below cannot be explained in a syllabic framework if it is assumed that the third position of the syllable may contain a V. (Cf. the *-hnil-* case in (90), below).

Although according to (41), the nucleus may be empty, a nucleus filling epenthesis rule which fills empty nuclei is operative in Yawelmani.

(43) *Yawelmani Epenthesis*

$$\emptyset \rightarrow \underset{|}{V} \; / \; \underset{|}{N} \; \_\_$$

Recall that the term Nucleus is used here only as an abbreviation for a geometrical position in the syllable, which is subcategorised for vowels. In (43), *N* thus means an

empty second position in the syllable. As with the German glottal stop insertion rule (15) of chapter 1, which inserts a glottal stop in an empty onset, this rule need in fact not be stated as an specific rule. It need only be stated that the V dominating *i* is the default value for the nucleus in Yawelmani.[13]

Let us now look at how the rule of Epenthesis works in conjunction with the syllabification mechanism. For this, we take the underlying forms for the two examples given in (13), (14). (In contrast to Archangeli, we assume that the underlying forms have no syllabic structure at all).

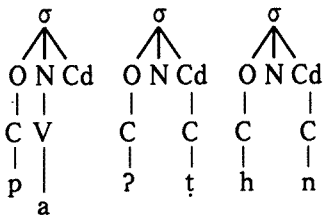
underlying forms

(44) a. C V C C C C
p a ʔ ṭ h n

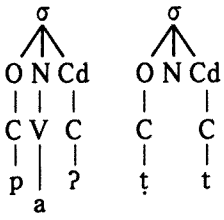
(45) a. C V C C C
p a ʔ ṭ t

syllabification (39)

(44) b.



(45) b.



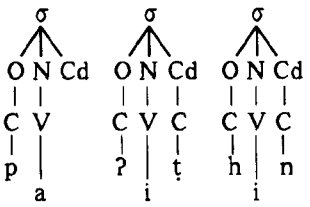
Here, the nodes Coda, Rhyme, Onset are projected from right to left onto the skeleton. Because of the conjecture mentioned in chapter 1 (cf. (30) and (31) in chapter 1 and subsequent discussion) that the linking conventions of autosegmental phonology apply, the subsyllabic nodes are linked to skeletal slots wherever possible (viz. wherever permitted by the templates in (41), which are in fact positive output constraints for syllabification). The empty subsyllabic nodes in (44b, 45b) are the result of the fact that the nucleus (or, more correctly in geometric terms, the second position in the syllable) cannot be linked to a consonant, and that the coda (or third position) cannot be linked to a single vowel. After syllabification, Epenthesis (43) takes effect, and the following form is produced:

---

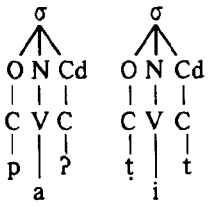
13 We may go one step further and say that V is the default value for the nucleus (in fact the only possible value) and *i* the default value for V. In this way, the filling of an empty nucleus is analysed as the result of two successive local level processes, one filling a nucleus with V and a second one filling a V with *i*. These default value assignments should be late processes. *Unsyllabified* empty V's which, as we will see in section 4.4.5 (see (101b) and note 22, below), may result from certain processes in Yawelmani, have already been deleted by the convention of stray deletion before default value assignment applies. See chapter 5, section 5.6 for a similar two-step default assignment to empty nuclei in German, where the default value of V is *ə*.

Epenthesis (43)

(44) c.



(45) c.



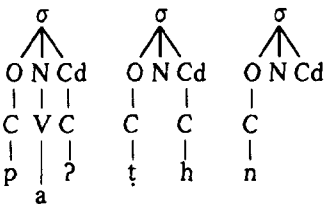
phonetic outcome

(44) d. paʔiṭhin

(45) d. paʔṭit

We thus see that our very general rule of epenthesis, which refers exclusively to a subsyllabic node, can predict the exact epenthesis sites, without over-insertion. Recall that Kuroda's analysis over-epenthesises (and subsequently deletes the superfluous vowel in the form in (44) (cf. (10) of chapter 1) and that in Archangeli's analysis there is over-epenthesis and deletion in both (44) and (45) (cf. (13,14)). If syllabification were to take place from left to right, the ensuing syllabic structure for (44) would be:

(44) e.



phonetic outcome, after epenthesis (43): (46) *paʔṭihni

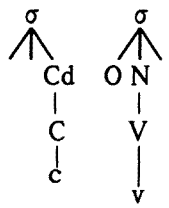
We thus see that because of the RL directionality, the correct epenthesis sites are produced.[14] Another, theoretical reason for the RL directionality is that the reverse direction, LR, would give rise to complications. If the mechanism applied from left to right, and encountered a postvocal C, it could not be determined to which syllabic node this element should be connected. For this, it would have to be known whether

---

[14] Archangeli (1984: 186, fn. 32), referring to Noske (1985), rejects our analysis of directionality of syllabification as an explanation for Yawelmani Epenthesis. However, in later papers (1989: 3-4, 1991: 235, 245), Archangeli has adopted this position, this time without reference to our 1985 analysis: "Syllabification (...): map from right to left" (1989: 3). "... in Yawelmani syllabification is from right to left" (1991: 235). "The effect of epenthesis in Yawelmani is to allow syllabification of consonants which cannot otherwise syllabify, a straightforward prosodic function. As such epenthesis is best represented as a result of syllabification itself" (1989: 4). "... [Yawelmani] epenthesis is not the result of a separate rule, but rather is intrinsic to the general syllabification process in the language" (1991: 245). Unfortunately, in these papers, she uses Hayes' moraic model of syllable structure, which, as demonstrated in chapter 2, is flawed.

the element following the C was a C, or a V. In the first case, the C would be assigned to the coda (of the former syllable), in the second case to the onset (of the latter syllable). This means that the mechanism would have to look ahead. Application from right to left, however, yields no such problems. In that case, the mechanism will project an onset and link it with C, if the last projected node was a nucleus, and it will project a right coda and link it with C, if the last projected node was an onset. Recall from (41) that the first node of the syllable, (for mnemonical reasons referred to as onset) cannot be empty, hence the situation in (47) cannot occur.

(47) *



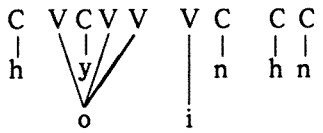
The third reason for the RL directionality is the vowel elision phenomena in Yawelmani, for which Kuroda has formulated the rule in (1), and Archangeli the rule in (37). In our theory this elision can be explained in a principled way. Let us consider what happens when a vowel is preceded by another vowel. When the rightmost vowel has been syllabified, i.e. the nucleus node has been linked with the V, the onset is projected. However, there is no C to which this node can be linked, which the templates in (41) require. We propose that in this case an emergency measure of the same category as the ones proposed for Tonkawa (cf. (21) of chapter 3) be taken. As in Tonkawa, these measures consist of an operation that is normally not available to the language, but which is an option in Universal Grammar. In situations where otherwise no solution is available these recessive operations become available to a particular language for which they are normally unavailable. We propose that here the emergency measure consists of the skipping of V's, by the syllabification mechanism:

(48) *measure taken when syllabification fails*

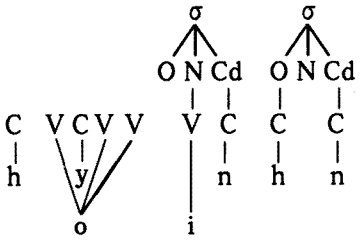
> If the right-to-left applying mapping mechanism which establishes one-to-one links between the subsyllabic nodes and the skeletal elements reaches an onset node (on the subsyllabic node level) and a V (on the level of the skeleton), and as a result the linking is blocked by the syllable structure conditions expressed in the templates in (41), then it should ignore the V and try to link the next skeletal element to the left.

This is normally not allowed in Yawelmani, but it is permitted in Tonkawa as we have seen in chapter 2, because in that language, V's are not syllabification triggering elements. Let us see how this exceptional skipping of V's takes place. For this we take the example in mentioned above in (38b), [hoyinhin] < /hoyoo+in+hn/.

(49) a. *underlying form of (38b)*

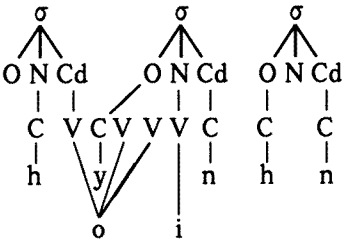


b. *syllabification (39)*



The structure in (49b) shows the stage of the syllabification process when the onset of the second syllable from the right should be linked with a C. It is at this point that emergency measure (48) comes into play. By virtue of (48), the two V's are skipped.

(49) c. *emergency measure (48) and syllabification (39)*



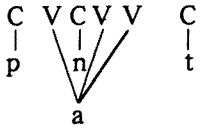
d. *phonetic outcome, after epenthesis (43):* hoyinhin

In (49c), the coda is not linked to a skeletal slot, because there is no suitable element available (which are either a C or the rightmost V of a long vowel). In contrast to the onset node, the coda node may be empty according to the templates in (41). Because the two rightmost V's of the stem were skipped by the syllabification, they are not phonetically realised.

Note that we cannot simply state that in Yawelmani the vowels are not triggers of syllabification. In contrast to Tonkawa, word final vowels preceded by VC are not deleted, which they otherwise would be.

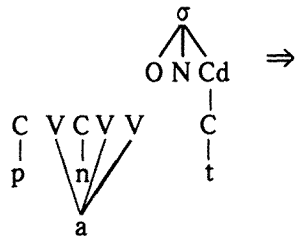
The same explanation as was given for vowel elision can be given for the shortening phenomena, for which Kuroda has given the rule in (3), and which Archangeli has integrated into her Rime Formation/Shortening (11b) by means of the delinking of the syllable node and the second V. We show here the functioning of our syllabification (39) in conjunction with emergency measure (48) employing the example used by Kuroda, given in (4) and repeated here as (50).

(50) a. *underlying form*



⇒

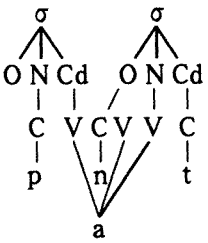
b. *syllabification (39)*



⇒

c. *emergency measure (46) and syllabification (39)*

⇒



⇒

d. *phonetic outcome*

panat

In (50b), after the rightmost V has been linked to the nucleus node, syllabification comes to a standstill because the onset cannot be linked to the second V. Then, emergency measure (48) takes effect, the second V is skipped and the onset node is linked to the following C.

We thus see that by positing emergency measure (48) we have been able to capture two apparently disparate phenomena of vowel alternation in Yawelmani, and to relate them to syllabification.

4.4.2 Excursus on the syllabic processes in Tigrinya

We have seen above that in Yawelmani the direction of syllabification determines the exact epenthesis site in a sequence of consonants (i.e. C $\{\overset{C}{\#}\}$). It also determines which vowel out of two adjacent vowels is deleted. Because of the RL directionality, it is the leftmost vowel that is deleted. As we have seen in chapter 3, this latter argument also pertains to the vowel deletion phenomena in Tonkawa. With the general assumption that syllabification takes place directionally (see section 1.5 of chapter 1), the setting of the directionality parameter will determine in which direction syllabification actually takes place. Below we will show that there is a language not unlike Yawelmani in the relevant respects, in which syllabification indeed takes place in the LR direction. Tigrinya, a South Semitic language of northern Ethiopia, possesses an epenthesis process which can operate word-internally as well as word-finally. Pam (1973) mentions two different rules, which he later combines. The first rule is given in

(51) (1973: 116):

(51) Ø → ɨ / CC__(C)#

The functioning of this rule can be seen in (52) (1973: 114):

(52) a. /kalb+n/ [kʌlbɨn] 'dog' + suffixed conjunction
b. /kalb/ [kʌlbi:] 'dog'

In (52b) the ɨ has been lengthened by a rule given in (53) (1973: 115):

(53) ɨ → i: / __#

The second epenthesis rule is given in (54) (1973: 111):

(54) Ø → ɨ / #C__C

An example of the functioning of this rule can be seen in (55):

(55) /sbar/ [sɨbʌr] 'break'

Pam combines these two rules as in (56) (1973: 117):

(56) Ø → ɨ / [-syll] [-syll] ___ [-syll]

Pam thus has to resort to the feature specification [-syll], i.e. he has to treat word boundaries on a par with consonants. He thus has to specify these elements negatively with regard to their syllabicity. This is not very satisfying, for in fact word boundaries and consonants have nothing in common. Word boundaries refer to the way segments are organised, while consonants are segments themselves. In modern phonological theory, the organisational aspect is expressed in hierarchical structure. The only thing that 'boundaries' and consonants have in common is, as we will see, that they can have a similar impact on syllabification. Their 'similarity' is thus one of function, not one of substance. This is the reason why phonologists have stopped referring to word boundaries as [-syll] (In fact, this feature has been abolished altogether, because its specification expresses whether or not an element is the peak of the syllable, something which is expressed precisely by hierarchical syllabic structure).

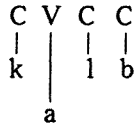
One can now ask the question whether in Tigrinya, as in Yawelmani, the epenthesis process can be analysed as the result of the process of syllabification. For this, it is necessary to know what the maximal syllable in Tigrinya is, and whether epenthesis takes place only if the process of syllabification is confronted by an otherwise unsyllabifiable sequence.

The answers to both questions are straightforward: the syllable structure of Tigrinya is CV(V)(C), the maximal syllable thus being CVVC, and Epenthesis operates only in those structures where otherwise a more complex consonantal syllabic structure than CVVC would ensue.

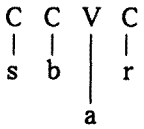
We can now see that the rules in (51) and (54) can be dispensed with if we assume a *left-to-right* syllabification, in the same way as the right-to-left syllabification in Yawelmani we proposed above: if during syllabification a nucleus is projected and then a C is encountered by the syllabification mechanism, the nucleus V is left empty, and later filled by the neutral vowel (in the case of Tigrinya an $\overset{V}{|}$). Cf. the derivations (57) and (58) for the forms in (51) and (55) respectively:[15]

underlying forms

(57) a.

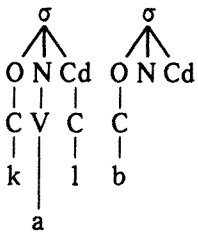


(58) a.

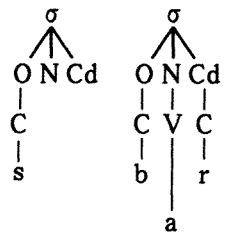


left to right syllabification

(57) b.



(58) b.



(An explanation will be given shortly for the fact that the coda of the first syllable in (58b) is left empty, and that C dominating *b* is linked to the onset of the second syllable.) If we adopt such an analysis of Tigrinya epenthesis as a result of syllabification, we can express this major process in a unitary way, without having to resort to references to [-syll]. The only difference from the Yawelmani case is that the directionality of syllabification is reversed.

Not only does the epenthesis process provide motivation for the directionality of the syllabification process, but this is also the case with a process of vowel deletion, operating in an opposite fashion to Yawelmani and Tonkawa. This is formulated by Pam (1973: 76) as in (59).

(59) *Vowel Elision* (Pam 1973: 76)

$$V \rightarrow \emptyset \; / \begin{bmatrix} V \\ +long \end{bmatrix} \; \_\_$$

---

[15] Like in Yawelmani, we have represented the vowel and consonant melodies on different tiers here. We have done so in analogy to the similar representation used by McCarthy (1979b, 1981), bearing in mind the pervasiveness of the morphological 'binyam' system (which McCarthy analyses) througout the Semitic languages. The configuration, however, is not crucial to the point we are making here.

The structural description of this rule is the mirror image Archangeli's rule (37) for Yawelmani (if we reformulate it in a linear way) and the near mirror image of Kuroda's rule (1) for Yawelmani (the only difference being its requirement that the vowel be long, which follows from the fact that Tigrinya allows two V's in a closed syllable (the two V's represent a long vowel or a diphthong)). An example of the application of rule (59) is given in (60) (Pam 1973: 77):

(60)

Base	r ɨ ʔs	
a+-prefixation	a+	
Infixation	a:	
Vowel Elision	Ø	
Output	a+ra:ʔs	'heads'

This form surfaces as [ʔara:ʔɨs]. (The place where the epenthesis takes place seems to contradict rule (51), as well as our reanalysis of it. However, Pam (1973: 17-18) points out that the epenthesis site is exceptional and is restricted to the class of words to which the form in (60) belongs, thus there seems to be a morphological conditioning here.)

We will come back to the fact that C dominating *b* in (58) is linked to the onset of the second syllable and in conjunction with this, we will make a final point concerning the directionality here. Given the presence of directionality in the syllabification mechanism, one would expect it to be right-to-left rather than left-to-right because of the fact that in the latter case, the mechanism has to look ahead. To see this, it is necessary to consider what happens if when going from left to right a third position (coda) in the syllable is imposed, this C will be linked to this node. However, if like in Yawelmani the onset must be obligatorily filled, the mechanism has to 'know' whether the C is followed by a C or a V. In this latter case it would leave the coda empty, and link the C with the following onset that will be projected. This is the situation in (58). The mechanism has to look ahead in its direction of application (i.e., rightward). Syllabification in the reverse direction, however, yields no such problems, and the mechanism can be kept as simple as possible. The right-to-left directionality thus constitutes the unmarked case. In fact the so-called maximal onset principle (which has been shown to be very general but not universal, see e.g. Kiparsky (1979), for counterexamples from Finnish) could be related to this markedness principle.

This conjecture seems indeed to be confirmed by the facts. There are many CVC languages where $\_\_\{^{\#}_{C}$ is the environment for syllable repair. A situation such as the one in Tigrinya, however, where the environment for syllable repair could be formulated as $^{\#}_{C}\}\_\_$, seems to be very rare, and must be assumed to be the marked case. This conjecture is confirmed if we look at the situation in languages closely related to Tigrinya, e.g., Tigre. In Tigre, the equivalent of (52b) is as in (61):

(61) [kʌlɨb]

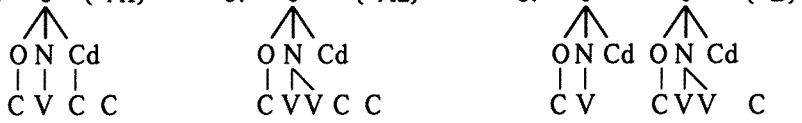
This form is also found in other related languages. Hence it must be concluded that in Tigre, syllabification takes place from right to left, in the unmarked direction, and that Tigrinya is exceptional in its left-to-right syllabification. We will come back to the question of the markedness of the direction of syllabification in chapter 6, section 6.7, when we treat syllabification in French.

4.4.3 Verb stem morphology

4.4.3.1 Mora insertion and translation

We now come back to the morphological alternations of the verb stem. We gave a summary Archangeli's analysis of these alternations in section 4.3.3. Recall (see (26)) that Archangeli posits three templates for Yawelmani verbs, viz. CVCC, CVVCC and CVCVVC. If we take a closer look at the different templates, it seems that it is the syllable structure that is different for the templates. Using the same trinodal syllable type as the one which shows up postlexically, we can distinguish three syllabic patterns, (cf. 62).

(62) a. σ (=A1) b. σ (=A2) c. σ σ (=B)



(The final C's have not been incorporated, because they cannot be not incorporated in the syllabic structure, cf. the conditions on syllable structure in (41)). However, as we have shown in the syllabification parameter settings (39), regular syllable structure is assigned only postlexically, while the morphological alternation of the verb stem must be a lexical process since it is determined by the affixes with which the verb stem is combined. Therefore, we should assume that the syllable structures as depicted in (62) are not yet present at the time of the working of the process determining the stem alternation. They are merely the (postlexical) *result* of it.

What, then, is the exact nature of this alternation process? If we take a close look at (62), we see that these forms differ in the *quantity of the vowels*. More correctly, we can say that they differ in the quantity of realisation of the *single* vowel value, as this the two V's in (62b) and the three V's in (62c) should be linked to the same vowel (see section 4.3.3). Hence it seems that we are faced here with a lexical process of specification of quantity.

Therefore, it is our conjecture that this morphological process does not involve templates on the CV-tier (as Archangeli (1984) does), but the specification of quantity in some prosodic form. This is in line with the proposals in Kaye & Lowenstamm (1986) and McCarthy & Prince (1986), where morphological processes involving bin-

yanim and reduplication (on reduplication, see section 1.4 of chapter 1) are viewed as the insertion of specific syllable types. It was shown in chapter 2 that quantity can be expressed in moras (although, as also demonstrated in that chapter, moras cannot directly be a building stone of syllable structure, but can be translated into it).

The three patterns CV(C), CVV(C) and CVCVV(C) can clearly be characterised as mono-, bi- and trimoraic forms respectively, where only V's but not C's can count as moras. This represents one of the options for mora counting languages, the other being that both V's and C's can count as moras (see e.g., Hayes 1989). The root type A1, CV(C), is a verb root consisting of a light syllable (one mora), root type IA2, CVV(C), is a verb root consisting of a heavy syllable (two moras) and root type B, CVCVV(C), is a verb root consisting of a light syllable followed by a heavy syllable (one mora plus two moras). Specifying full syllable types instead of moras would seem to introduce a redundancy, because if the quantity specification is known, the specific syllable type can be predicted, on the grounds of the regularities in syllable structures stated in the grammar. Hence, it can be concluded that only the number of moras must be specified.

However, recall from chapter 2 that the direct representation of moras into syllabic structure leads to fundamental problems with respect to the nature of representations. More specifically, it was shown in section 2.3.1, that the inclusion of moras into the syllable makes the model unrestrictive and unspecified in the number of dimensions. Therefore, we have to reject the idea that the moras specified in the morphology of the Yawelmani verb are themselves included in the syllable structure at some stage in the derivation. Instead, a mechanism should be operative, translating moras into syllable structure. This is the logical counterpart of the interpretative mechanism which should exist translating syllable structure into metrical quantitative structure, the necessity of which was demonstated in chapter 2.

Our specific proposal is the following. The inserted templates in Yawelmani are assumed to be quantity specifications of one, two and the moras respectively. The A1, A2 and B templates can be assumed to look as follows (μ = mora):

(63) a. assign μ (A1)
b. assign μ μ (A2)
c. assign μ μ μ (B)

The morphological rules in (63) express that diacritics of the affixes (or, by default, the ones of the roots) either supply a light syllable, or a heavy syllable with a long vowel, or a combination of these two syllable types in light-heavy pattern.

Since only V's count for quantity, and V's in Yawelmani are always dominated by the nucleus, we can conceive of the quantity assignment in Yawelmani assignment of nucleus nodes. We assume the following two rules, which translate moras into nuclear structure:

(64) a. *Heavy Nucleus Assignment* b. *Light Nucleus Assignment*

These rules are intrinsically ordered. The structural description of (64a) properly includes the one of (64b) and is therefore more specific. Therefore, the Elsewhere Condition, a principle first proposed by Kiparsky (1973) that gives priority in application to the more specific rule if we are faced with with two rules competing to apply to a form, will decide which rule applies. Because the SD of Heavy Nucleus Assignment (64a) is more complex, this rule will apply if its SD is met (i.e., if there are two moras), and Light Nucleus Assignment (64b) will not be able to apply because structure has already been erected.

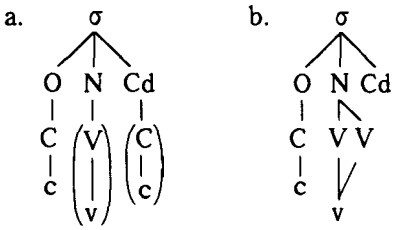
Like all prosodic structure assignment, this morphological (partial) syllable structure creation algorithm applies directionally. We posit that it applies from right to left. Hence in a specification of three moras, because two moras are found first a heavy nucleus is created by virtue of Heavy Nucleus Creation (64a). Then, only one mora has not yet been 'translated' into a nucleus structure and only Light Nucleus Assignment (64b) can apply. This produces the light-heavy pattern. In the case of the three possible configurations, the following partial syllable structures are formed for μ, μμ, and μμμ stems respectively.

(65) a. *A1* (= μ) b. *A2* (= μμ c. *B* (= μμμ

4.4.3.2 Unification with syllable structure

Let us now consider how these partial structures can be mapped into full structures, using the syllabification conditions of Yawelmani. Recall that the syllable structure conditions are expressed through the template in (41). We repeat them here as (66).

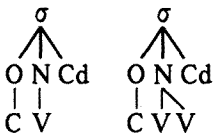
(66) *Yawelmani syllable*



Let us assume that if the morphological partial syllable structures as in (65) have been assigned, these syllable structure conditions are applicable. (We thus make the simplest assumption possible, i.e., that the syllable structure conditions applicable on the syllables formed by morphology are identical to the ones formed in the postlexical part of phonology.) Notice that the nucleus structures in (64) are partial syllable structures. They do not violate the syllable structure conditions, they are just incomplete. Minimal full structures corresponding to (65a,b,c), are respectively (abstracting away from the melody):

(67) a. 

b. 

c. 

Because of the conditions in (66), the structures in (65) should be supplemented by a higher structure including the syllable node, and material in the onset.

We will assume here that there is a unification mechanism in grammar which combines partial structures with independently stated requirements on syllable structure (the syllable structure conditions). We call this mechanism *unification*. The notion as we use it here has been inspired by a branch of computational syntax, i.e., unification grammar (Shieber 1986 and Carlson & Linden 1987).[16] There are two logically necessary formal properties to unification which are important here. First, all information contained in the parts which are combined are retained (no information is deleted or lost; otherwise unification would not be a simple mechanism or process). This is called the *monotonic* character of unification. Second, the result of the unification should be the same no matter from which of the two items to be combined unification starts (otherwise unification would not be a simple combination but a specific structure creation). This property is called *commutativity*.[17]

The syllable structures in (65) resulting from the Heavy and Light Nucleus Assignments (64) are *unified* with the independently motivated regularities. The result is the creation of the structures in (67). This unification is possible because, as mentioned, the structures in (65) *do not contradict* the syllable structure conditions in (67). They only display a partial syllable structure. Hence structure creation through unification can take place, because it is monotonic.

Once this has happened, unification takes place again: it combines the underlying verb root and the syllable structures in (67). We take two verb roots in (22), a biconsonantal one and a triconsonantal one, as examples. We assume that segments are linked to skeletal slots underlyingly. In this way, in contrast to Archangeli's analysis, we do not have to treat the vowel stems and the affixes in a fundamentally different way.

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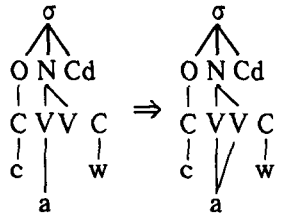
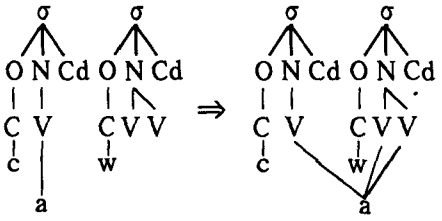
[16] See Wiese (1990) for an application of unification grammar to phonology.

[17] For a discussion of the requirement of commutativity, see Carlson & Linden (1987: 113).

(70) a. *Spreading in (69b)*

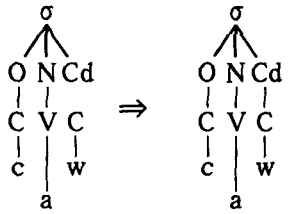


b. *Spreading in (69c)*



In the case of (69a), another association convention applies than the spreading as shown in (70), and it applies between different tiers. Here, the C will map to the empty third position of the syllable, labelled coda, and the IA verb stem *caw* is the outcome:

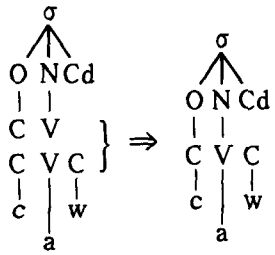
(71) *Mapping between the skeleton and coda in (69a):*



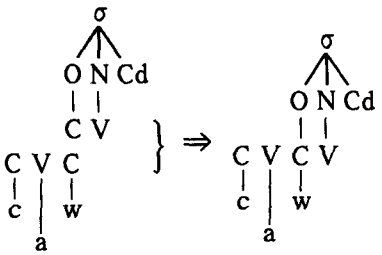
In (70a), mapping of C to coda position cannot take place because the syllable structure condition expressed in (41b) (repeated in (66b)) would otherwise be violated.

If unification is from right to left, the outcome can be totally different. There are two possibilities here: the unification could start with the rightmost V's if one started from the skeleton in the syllable structures in (67) or with the rightmost C if one starts from the skeleton in the verb roots in (68):

(72) a. *right to left unification of (67a) and (68a), starting with the skeletal elements in the syllable structure*



b. *right to left unification of (67a) and (68a), starting with the skeletal elements in the verb root.*



(68) *underlying verb root forms*

a. C V C 'shout'
c | w
a

b. C V C C 'ask'
b | n t
i

The forms in (68) have to be unified with the structures in (67). In contrast to mapping as part of regular syllabification, here elements should be unified (fused), and not associated, because the skeleton is present in both the underlying forms (68) and the syllable structures in (67). This fusion can takes place again through the principle of unification. Thus, a C in (68a,b) fuses with a C in (67a,b,c) if the structures which they are part of are unified with each other.

Again the question of directional application should be raised here. In principle the application of the fusion could go in either direction, from left to right or from right to left. We will demonstrate here that the actual direction of application is from left to right. We show what happens if unification takes place from left to right, and when it takes place from right to left. We start with the biconsonantal verb root in (68a).

4.4.3.3 Biconsonantal verb roots

(69) *Left to right unification of (68a) and (67a,b,c)*

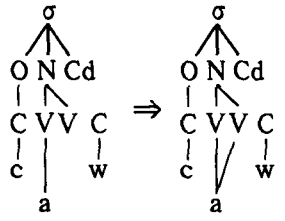
a. σ
O N Cd
C V
C V C
c | w
a
⇒ σ
O N Cd
C V C
c | w
a

b. σ
O N Cd
C V V
C V C
c | w
a
⇒ σ
O N Cd
C V V C
c | w
a

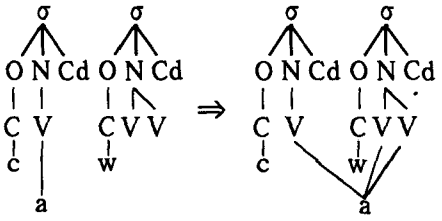
c. σ σ
O N Cd O N Cd
C V C V V
C V C
c | w
a
⇒ σ σ
O N Cd O N Cd
C V C V V
c | w
a

Then, spreading from the melody to the skeleton takes place in (69b,c) linking *a* to the V's unlinked to the melody. This produces the IB and II verb stems, viz. *caaw* and *cawaa* repectively.

(70) a. *Spreading in (69b)*

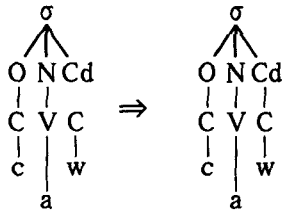


b. *Spreading in (69c)*



In the case of (69a), another association convention applies than the spreading as shown in (70), and it applies between different tiers. Here, the C will map to the empty third position of the syllable, labelled coda, and the IA verb stem *caw* is the outcome:

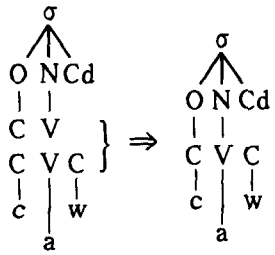
(71) *Mapping between the skeleton and coda in (69a):*



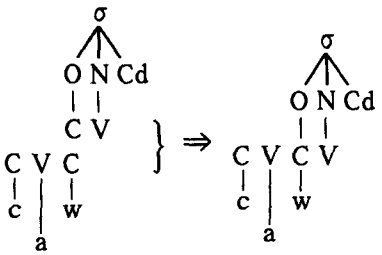
In (70a), mapping of C to coda position cannot take place because the syllable structure condition expressed in (41b) (repeated in (66b)) would otherwise be violated.

If unification is from right to left, the outcome can be totally different. There are two possibilities here: the unification could start with the rightmost V's if one started from the skeleton in the syllable structures in (67) or with the rightmost C if one starts from the skeleton in the verb roots in (68):

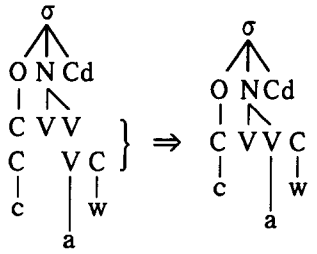
(72) a. *right to left unification of (67a) and (68a), starting with the skeletal elements in the syllable structure*



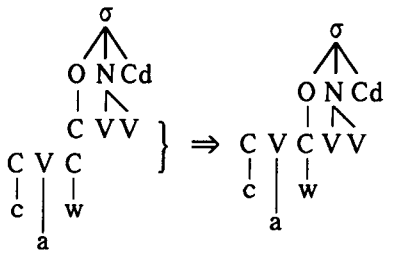
b. *right to left unification of (67a) and (68a), starting with the skeletal elements in the verb root.*



(73) a. *right to left unification of (67b) and (68a), starting with the skeletal elements in the syllable structure*



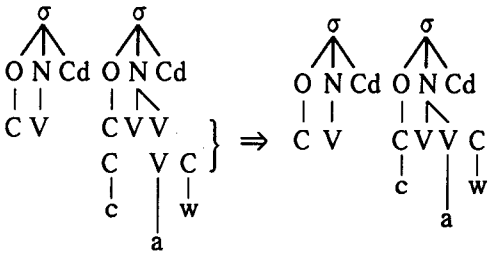
b. *right to left unification of (67b) and (68a), starting with the skeletal elements in the verb root.*



We see here that RL unification starting from the verb roots (which have a C at their right edge) produces the wrong result, but not unification starting from the syllable structures in (67) (which have a V at their right edge). In that case, the outcome (after spreading and mapping between the skeleton and the coda, shown in (70) and (71)), would be the same as after unification from left to right. Note that, in this case, it was necessary to specify from which structure – the verb root or the syllable structure – unification starts. We will come back to this below.

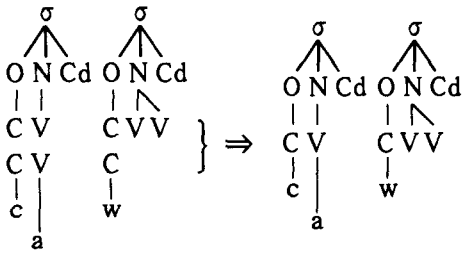
Consider now right to left unification of the trimoraic sylable structure in (67c) and the biconsonantal verb root in (68a).

(74) a. *right to left unification of (67c) and (68a), starting with the skeletal elements in the syllable structure*



Here, right to left unification would not link the first leftmost C of the syllable structure (67c) to the first C of the verb root (68a). The outcome would be (after spreading of both *a* and *c* (recall that vowels and consonants are on different planes, so both can spread) and mapping to the coda node) **cacaaw*. The real outcome is *cawaa*.

(74) b. *right to left unification of (67c) and (68a), starting with the skeletal elements in the verb root*



This would produce, after spreading of the *a* in the melody the the two V positions on the skeleton, the correct form *cawaa.*

If we now look at right to left unification for the mono-, bi- and trimoraic syllable structures in (67a,b,c) respectively, we see that the correct form is produced if unification starts from the syllable structures in the case of mono- and bimoraic syllable structures (hence with the V's, because these syllable structures have a V at their right edge on the level of the skeleton), cf. (72), (73). In the case of trimoraic structures however, the correct form is produced if unification starts from the verb root (and hence starts with unifying the rightmost C's, because the rightmost skeletal element of the verb root is a C).

This shows that it is not possible, if one assumes right to left unification, to stipulate from which structure unification should start. Apart from this, such a stipulation would go against the requirement of commutativity, which was mentioned above in section 4.4.3.2. Right-to-left unification would not be *commutative*, i.e., the result would depend on the order of combination.[18]

4.4.3.4. Triconsonantal verb roots

We will now briefly show that for the triconsonantal verb roots in (68b), left to right unification with the mono-, bi- and trimoraic syllable structures in (67) is also the only possible solution.

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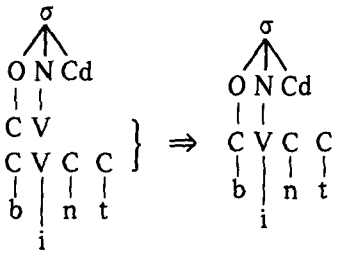
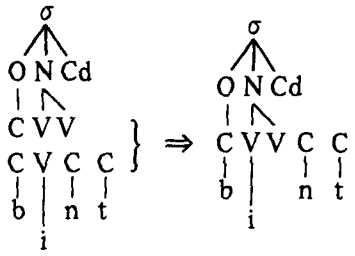
[18] The direction of unification is not the same as the order of combination of two structures. Rather, its specification is part of the specification of the nature of the combination (unification) itself. Hence specification of the direction does not constitute a violation of the requirement of commutativity.

(75) a. *left to right unification of (67a) and (68b)*

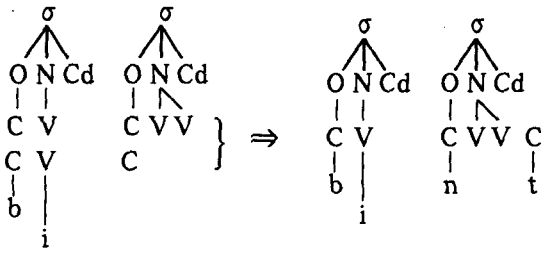


b. *left to right unification of (67b) and (68b)*



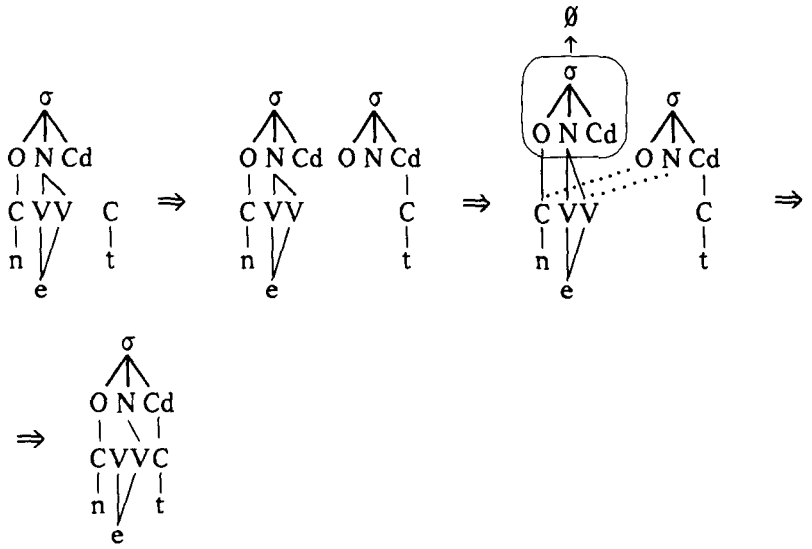
After spreading and mapping to the coda position this results in the forms *bin(t)* and *biin(t)* respectively. The *t* has been put between parentheses to indicate that it is not incorporated in syllable structure. (*biin(t)* will change into *been(t)* as a result of Lowering, cf. section 4.3.3) Unification of the trimoraic syllable structure in (67c) and the triconsonantal verb root (68c) yields:

(75) c. *left to right unification of (67c) and (68b)*



After spreading of *i* to the two V's this produces the form *binii(t)* (*binee(t)* after Lowering). Note that the rightmost C (the one that is linked to *t*) cannot map to the coda position, as this is prohibited by the syllable structure conditions in (41) (repeated in (66)). Later, during regular syllabification, which as demonstrated in section 6.3.2, is only postlexical, this C will have to be syllabified. If it cannot be incorporated into the onset of the syllable to the right, as is it can in *binethin* (*-hin*, aorist)), a new syllable will be imposed. Because this syllable cannot be minimally satisfied by mapping to unlinked C in the normal way (the onset cannot be filled, although this is required by the syllable structures in (41) (or (66))), the existing syllable structure above *nii* (*nee* after Lowering) will be delinked and deleted. Thus a new syllable is created, according to the pattern in (41a) ((66a)). The material which belonged to the deleted syllable structure is newly syllabified, effectively shortening this vowel:

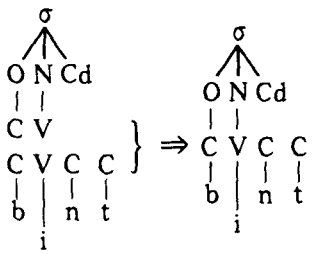
(76)



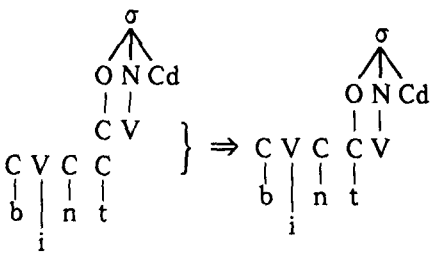
Note that the delinking of the original syllable is in line with the general assumptions of lexical phonology, as proposed by Kiparsky (1982a,b). Postlexically, rules and processes are not necessarily structure preserving.

If unification takes place from right to left, we should again distinguish between the case in which unification starts from the skeletal elements that are part of the mono- bi- and trimoraic syllable structures in (67a,b,c) or originates from the skeletal elements in the verb root. In the first case, the unification starts by uniting the rightmost V's, in the second case unification starts by uniting the rightmost C's:

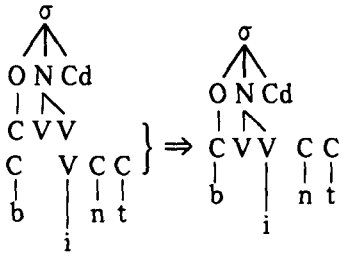
(77) a. *right to left unification of (67a) and (68b), starting with the skeletal elements in the syllable structure*



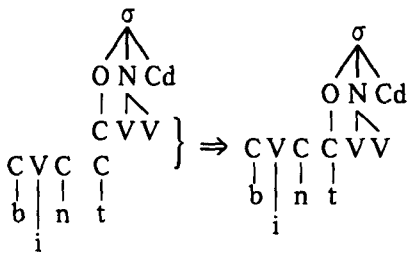
b. *left to right unification of (67a) and (68b), starting with the skeletal elements in the verb root*



(78) a. *right to left unification of (67b) and (68b), starting with the skeletal elements in the syllable structure*



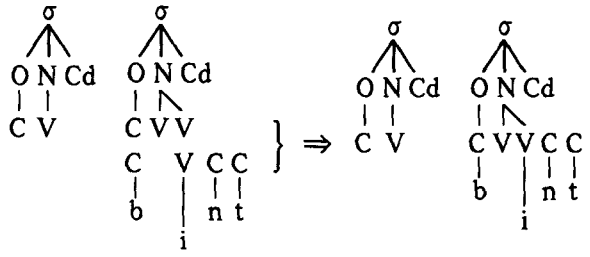
b. *right to left unification of (67b) and (68b), starting with the skeletal elements in the verb root*



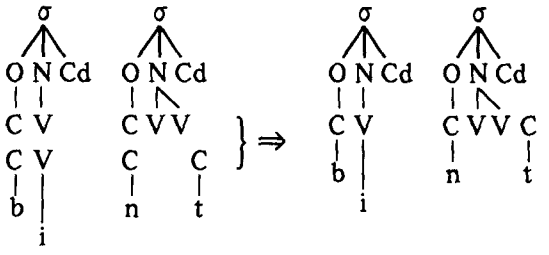
As in the case of the biconsonantal verb roots in (72) and (73), the unification starting from the skeletal elements in the mono- and bimoraic syllable structure produces the correct results (after spreading and mapping to the coda position) viz. *bin(t)* and *bii(nt)* (*bee(nt)* after Lowering). Right-to-left unification starting from the verb root produces incorrect, even bizarre results: **(bin)tii* in both cases (after spreading, **(bin)tee* after lowering).

The picture is again reversed in the case of a trimoraic syllable structure:

(79) a. *right to left unification of (67c) and (68b) starting with the skeletal elements of the syllable structure*



(79) b. *right to left unification of (67c) and (68b) starting with the skeletal elements of the verb root*



Here, unification starting from the skeletal elements in the syllable structure in (79a) produces the wrong results **bi(nt)*, after spreading and lowering **bibee(nt)*, whereas

it should be *binee(t)*. We see again that right-to-left unification does not produce consistent results for the mono-, bi- and trimoraic syllable structures, and therefore would violate the requirement of commutativity, as explained above.

4.4.3.5 Theoretical implications

We have demonstrated the workings of the mechanism of morphological quantity specification in verb roots. Through a translation mechanism and unification with the syllable structure conditions it produces a syllable structure for the verb roots. Hence, this syllable structure erection is the result of the specification of quantity.

This does not constitute a refutation of our claim in sections 4.3.2 and 4.4.1, i.e, that general syllabification in Yawelmani is only postcyclic (and postlexical). One should bear in mind that *only* the verb stems receive a syllable structure through quantity specification (by the rules in (63), (64) and unification with the syllable structure conditions in (66)), even though additional affixes are available. Recall from section 4.3.3 that the morphological template insertion rules (26) (or (27)) proposed by Archangeli can only work if the stage in the lexical morphology has been reached at which the suffixes have already been added. This is so because it is in many cases the suffixes which bear the diacritic determining which template is inserted (if there is no suffix bearing such a diacritic, the diacritic of the verb root itself determines which template is inserted). Because our mora assignment rules (61) replace Archangeli's template insertion rules (26) (or (27)), but are conditioned in the same way, this reasoning is equally true for our mora insertion rules.

This means that even though the suffixes are present during the syllable structure erection on the verb stems as a result of the application of the mora assignment rules in (63), the rules translating the quantity into nucleus structure (64) and of subsequent unification with the syllable structure conditions, these suffixes are not yet syllabified. This is also true for the third consonant of the triconsonantal roots. This consonant, as we have just seen (cf. (76)), is also syllabified only during regular, postlexical syllabification. The reason for this is that it is not required as part of minimal syllable structure (cf. (67)).

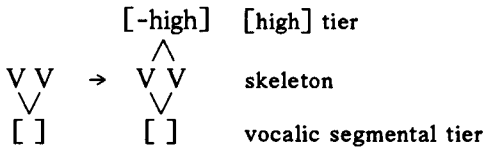
We conclude that the 'template system' as Archangeli terms it, is the result of a very simple rule system given in (63), assigning one, two or three moras. The statement that only V's in Yawelmani count for weight, plus the right to left mora-to-nucleus translation result in the creation of that three weight structures, those given in (65), comprising of a light nucleus, heavy nucleus and a light nucleus followed by a heavy nucleus. Through unification with the syllable structure conditions given in (41) ((66)), these are transformed into full syllable structures. Finally, left to right unification with verb roots, the only direction of application which does not violate the requirement of commutativity, produces the observed verb stems.

The advantage of our account over Archangeli's templates is that general quantity categories are used, which mostly by general principles (unification, the Elsewhere Condition) and independently motivated statements (such as the syllable structure conditions) produce the verb stems. An added advantage of our approach is that Archangeli's rule of Slot Deletion (29) is no longer necessary. In Archangeli's approach where the skeletal templates CVCC, CVVCC, and CVCVVC are inserted, the final C has to be deleted in the case of a biconsonantal verb root.

4.4.4 Lowering

We assume the following lowering rule:

(80) *Lowering*



This rule differs from the one given by Archangeli (cf. (24)), in that a feature value is assigned to a separate tier, which we have called the [high] tier. It is a feature adding rather than a feature changing rule. Because the feature specification assigned by the Lowering rule is on a specific tier, it is assumed that for phonetic interpretation, this specification overrides the more general specification on the vocalic segmental tier.[19]

The advantage of this analysis is that it is not necessary to posit a copy rule, which Archangeli does for Yawelmani, in order to prevent the first vowel of a CVCVVC template to lower also. As pointed out in section 4.3.3, this first vowel does lower in Gashowu, which is why Archangeli assumes spreading for that closely related dialect. To us it seems strange that a copying rule applies to one dialect and a spreading rule to another. Spreading is a fairly general process (although for Yawelmani we have to limit it to stems), but copying although fairly common in reduplication analyses is much more specific. Also it must operate concomitant with the rules in (63b,c) (or Archan-

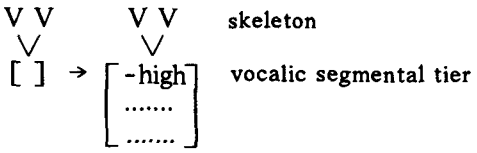
---

[19] If one assumes Archangeli's theory that the default value is [+high]; there is no overriding of a feature, because the default feature has not yet been assigned (it is assigned only later in the derivation. (We do not go into Archangeli's underspecification theory here, because it falls outside the scope of this dissertation.) Also, if one assumes underspecification the Gashowu Lowering (cf. below) is genuinely feature adding. If one assumes, on the other hand, that the feature specification of the segment on the vocalic segmental tier contains a specification for [high], this feature specification is replaced by [-high]. In that case, the Gashowu Lowering rule is actually feature changing.

A slightly different solution would be that for both dialects, Yawelmani and Gashowu, the feature [-high] is assigned on separate tier, but that the domain for the application of this is the syllable for Yawelmani and the foot, (or, perhaps, the phonological word), for Gashowu (Norval Smith, personal communication).

geli's rules (27b,c)), which makes the whole operation very specific. To account for the difference between Yawelmani and Gashowu, we propose that the tier on which the lowering rule (80) operates is different for Yawelmani and Gashowu. In Gashowu the rule is:

(81) *Gashowu Lowering*



Here, the feature [-high] is added to the vocalic segmental replacing the existing feature specification (but cf. note 15). Because the element on the vocalic segmental tier can also be linked to a single V on the skeletal tier in a preceding syllable (in the case of application of (63c), leading to a light-heavy syllable sequence (CVCVV), that vowel will also be lowered.

4.4.5 The segmental tier association rule

We now come to another feature of Yawelmani, alluded to shortly during our discussion of the forms in (25), which we repeat here as (82):

(82) desiderative-aorist *-(h)atn+hin*

caw hatin hin
hix hatin hin
lag hatin hin
luḵ'l atin hin
wu?y atin hin
bint atin hin

The *h* in *-hatn-* is present when it is preceded by only one consonant and is absent when preceded by two consonants. Note that this process works so as to avoid CCC clusters. This alternation process also seems to be connected to syllable structure. It is by no means the only affix in which a segment may be absent, although this presence/absence relationship of segments depending on syllable structure applies only to certain segments in certain affixes with a given structure, not to all. The alternation can be found in the following affixes (with the alternating segment between parentheses, where the affix has not been attested for Yawelmani, but for another dialect of Yokuts, this is indicated):

(83) *affixes with alternating segments*

		Newman (1944: page)	(dialects)
a. -(h)atn-	*desiderative*	114	
b. -(h)ne:l-	*passive consequent gerundial*	166	
-(ʔ)haṇa:-	*passive verbal noun*	149	(Wikchamni)
-(l)sa:-	*causative-repetitive*	94	
-ʔ(h)iy-	*consequent adjunctive*	162	(Wikchamni, Gashowu, Choynimni)
c. -k̓(a)	*imperative*	118	
-m(i)	*consequent gerundial*	134	
-x(a)	*precative*	119	
d. -(a)l	*dubitative*[20]	120	
-(a)ṁ	*aorist*	123	(Chawchila)

The parenthesised segments in the affixes listed under (83b) are present if the affix is preceded by V, but absent if preceded by C. This means that the consonants in question are only absent if an illicit syllable structure would otherwise ensue, involving three intervocalic consonants (if this structure comes into being in other situations, an epenthetic vowel is eventually linked to the then empty nucleus, cf. our account of epenthesis in section 4.4.1). As with the alternation in *-(h)atn-*, the alternations in these affixes work so as to avoid CCC clusters. Note here the place of the alternating segment in the consequent adjunctive affix *-ʔ(h)iy-*. It is not at the edge of the affix, as in the case of the other affixes, but is preceded by a non-alternating glottal stop.

The parenthesised vowels in the word final suffixes under (83c) are present if the affix is preceded by a consonant, but are absent if the affix is preceded by a vowel. The alternating vowel is only present if otherwise an illicit syllable structure would ensue. Note the difference with the affix under (83a) where the alternating segments are only absent if a disallowed structure would ensue.

Finally, the alternating segments in the affixes under (83d) are present if preceded by a consonant, but absent if preceded by a vowel. Here the disappearance of the vowel of the affix takes precedence over the deletion of the vowel in the stem which would normally take place (cf. our account of vowel elision in section 4.4.1).

We will propose a rule that accounts for the *-hatn-/-atn-* and *-hne:l-/-ne:l-* alternations (type a,b), where consonants constitute the alternating elements, as well as for the type c alternations (*-k̓a/-k̓*, etc.) and the type c alternation (*-al/-l*), where the vowels alternate. We assume the form in (84) as the underlying form for *-hatn-*.

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[20] In the Wikchamni dialect, the form of the dubitative morpheme is *-a(d)*. It displays exactly the same alternation as the *-a(l)* morpheme in Yawelmani.

(84) C V C C
h | t n
a

As we will see, a rule, the Segmental Tier Association Rule (STAR), will link the unlinked *h* to C under certain conditions. The reason why we have not preferred an underlying representation with only three skeletal slots, together with a rule that projects a skeletal slot for an element on a melodic tier, will be given below when we treat the type b alternation (*-k'a/-k'* etc.). We now come to STAR itself, which consists of two parts:

(85) *Segmental Tier Association Rule* (STAR)

a. associate an unlinked element on a melodic tier to an unlinked skeletal slot

b. condition: association may apply only if the resyllabified output contains fewer empty syllabic nodes than the input

By assuming STAR, we have replaced the automatic association by a conditioned rule. It is assumed that in language normally the melodic tiers are underlyingly linked and that the (exceptional) unlinked melodic elements are linked to the skeleton by rule. Note that condition (85b) is connected to our assumption, mentioned in chapter 2, that a one-to-one relationship between skeletal and segmental tiers constitutes the unmarked case, which is one of the principles of syllabification. In its turn, this principle of syllabification follows from the general association conventions. It is thus that the relationship of the alternation types *-(h)atn-*, *-(h)ne:l-*, and *-k'(a)* and *-(a)l* will become clear.

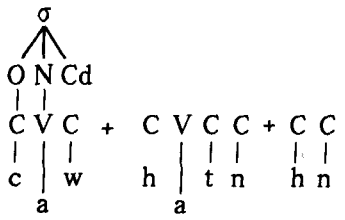
We will now show some cases which illustrate the working of STAR. The first case concerns the *-(h)atn-* type. Consider (86a,b) which are the underlying forms for *cawhatinhin* and *luk'latinhin* (previously cited in (25)).

(86) a. C V C + C V C C + C C
c | w h | t n h n
a a

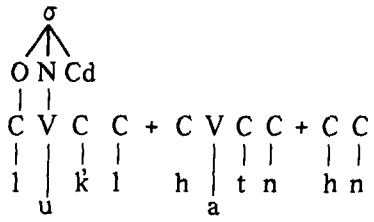
b. C V C C + C V C C + C C
l | k' l h | t n h n
u a

The *-hatn-* morpheme will now trigger morphological rule (63a), inserting one mora. After application of Light Nucleus Assignment (64b) and unification (cf. section 4.4.3.2) with the syllable structure conditions expressed in the templates in (41) (repeated in (66)), this amounts to the following structure:

(87) a.

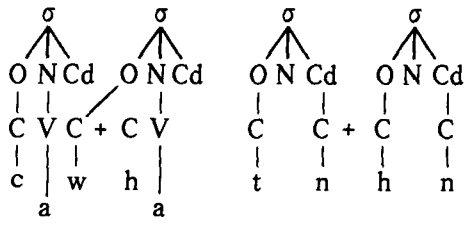


b.

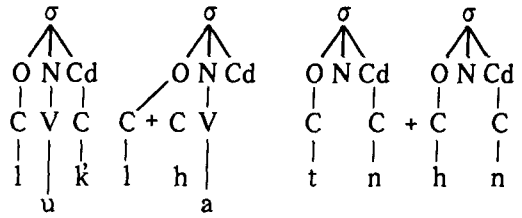


The regular postlexical syllabification process (see section 4.4.1) will now produce the following syllabic structures:

(88) a.

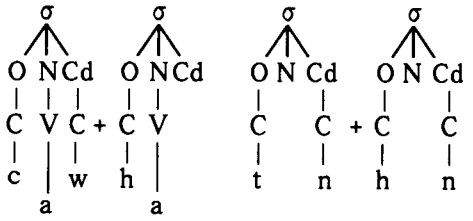


b.

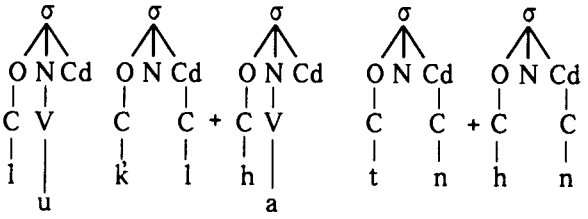


Note that in (88a,b) the *C* which is situated above *h* but is not linked to it has not been incorporated into syllabic structure, because the syllable structure conditions in (41) ((66)) do not allow for skeletal slots that are not linked to a melodic tier to be syllabified (although the conditions *do* allow for empty *subsyllabic* nodes). Note also that (88a) contains three empty subsyllabic nodes and (88b) two. If we now link the *C* to the *h* below it, the results are (after the unsyllabified segments have triggered syllable structure imposition and the subsequent application of the association conventions):

(89) a.



b.



We see that in (89a), the number of empty syllabic nodes has decreased by 1, but that in (89b), it has increased by 2. Therefore, STAR in conjunction with the condition on its application (83b) will link *h* to *C* in (89a), producing the correct result *cawhatinhin*, but will not link *h* to *C* in (89b), because the number of empty nodes would then increase instead of decrease. The correct form *luk'latinhin* is thus produced, instead of **luk'ulhatinhin* (the form which would eventually result from (89b) (after epenthesis and vowel harmony)).

We now come to the (83b) type of alternation, for which we first take the example involving the passive consequent gerundial *-(h)ne:l-*, which because of lowering, can be analysed as having the underlying form *-(h)niil-* (Archangeli (1984) also assumes this). What is interesting is that this suffix triggers morphological rule (63c), after Heavy and Light Nucleus Assignments (64) and unification with the syllable structure condition in (41) (repeated in (66)), producing a CVCVV(C) stem (in Newman's terms: it takes a strong stem, in Archangeli's: it selects a CVCVVC template). An example is given in (90) (from Newman 1944: 166).

(90) a. ṭ'ikehne[·]l-ni < *ṭ'iki 'tie, imprison', -ni, indirect objective
b. ʔamalnil < *ʔa·mal 'aid' + *zero morpheme*, subjective[21]

Underlyingly, these forms are (the morphemes following *-hniil-* are omitted):

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[21] The expected form for (90b) is *ʔamalnel* and not *ʔamalnil*. This is so because the lowering rule in (80) normally applies independently of whether the V's linked to the vowel are linked to the syllabic structure or not. The linear accounts by Kuroda and Kisseberth have expressed this by assuming that (the segmental version of) Lowering stands in a counterbleeding relationship to the shortening rule they postulate (cf. (3)). The non-lowering of the vowel in the underlying suffix *-hniil-* seems to be of an isolated character, and no other examples of this are found in Newman (1944).

(91) a. C V C + C C VV C b. C V C C + C C VV C
t' i k h n i l ? a m l h n i l

The *-(h)niil-* morpheme will now trigger morphological rule (63c), inserting three moras. This produces, after Heavy and Light Nucleus Assignments (64) and unification with the syllable structure conditions (41) ((66)):

(92) a. σ σ
ONCd ONCd
CV CVV + C C VV C
t' i k h n i l

b. σ σ
ONCd ONCd
CV CVV C + C C VV C
? a m l h n i l

Then spreading takes place from the stem vowel to the skeletal V-positions inserted as a result of Heavy Nucleus Assignment (64a):

(93) a. σ σ
ONCd ONCd
CV CVV + C C VV C
t' k i h n i l

b. σ σ
ONCd ONCd
CV CVV C + C C VV C
? m a l h n i l

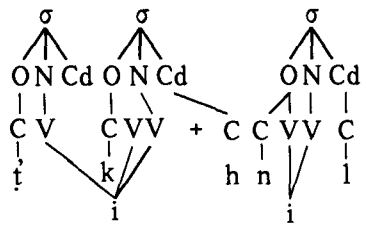
Postlexically, regular syllabification will produce the forms in (94a,b). Note that in (94b), the second syllable has been resyllabified, due to the as yet unsyllabified *l*, belonging to the stem. (This was explained in section 4.3.3, see (76).) Because we are here in the postlexical part of the phonological derivation, we have omitted the indication of the morpheme boundary, as this information is not available anymore postlexically.

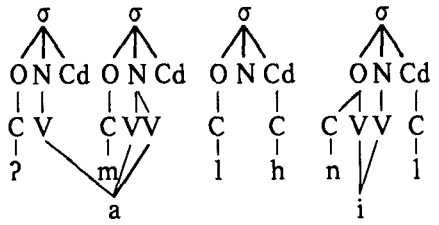
(94) a. * σ σ σ
ONCd ONCd ONCd
CV CVV + C C VV C
t' k i h n i l

b. σ σ σ
ONCd ONCd ONCd
CV CVVC + C C VV C
? m a l h n i l

Inspection of these syllabified forms reveals that (94a) (the form with the biconsonantal verb root) contains two empty subsyllabic positions, while the form with the triconsonantal verb root (94b) contains one such position. If we now link the *C* above the *h*

below it, the results are (after the unsyllabified segments have triggered syllable structure imposition and the subsequent application of the association conventions):

(95) a. 

b. * 

We see, as in (89), that in the form incorporating the biconsonantal root (94a), the result of the linking is that the number of empty subsyllabic nodes decreases by 1, while in the case of a triconsonantal root it increases by 2. Therefore, again, STAR in conjunction with the condition on its application (85b) will link *h* to *C* in (93a), producing the correct result *ṭ'ikehnil-* (for the height of the third vowel, cf. note 21), but will not link *h* to *C* in (93b), because the number of empty nodes would then increase instead of decrease. The correct form *ʔamalnel-* is thus produced, instead of **ʔamaalihnel-* (the form which would eventually come out of (95b) (after epenthesis).

Another instance of the alternation type (83b) is represented by the consequent adjunctive morpheme *-ʔ(h)iy-*. What is interesting here is that it is not the first, but the second segment of the morpheme that alternates with zero. The representation of the morpheme must thus be assumed to be as in (96):

(96) C C V C
| | | |
ʔ h i y

Examples of the alternations (from Gashowu) are given in (97) (Newman 1944: 163-164).

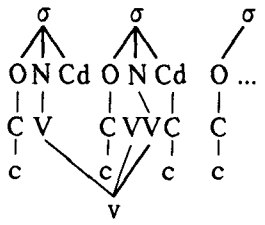
(97) a. češ[·]-ʔhiy-a nim ʔoṭsuʔ '(he) stole my knive', -a *objective*,
< *čiši 'cut with the knive' (the root form postulated by Newman)

b. hoyčus na k'ana[·]w-ʔiy-a 'I want a bed', -a objective,
< *k'anaw 'fall asleep'

The alternation in (97) is similar to the one in (90). In both cases, we find a suffix which triggers morphological rule (61c) inserting three moras, effectively creating, through Heavy and Light Syllable Assignments (64) and unification with the syllable structure conditions (41) (repeated in (66)), a CVCVV verb stem in the case of a biconsonantal verb root and a CVCVVC stem in the case of a triconsonantal root. Hence, there is a resulting sequence of two C's on the border of the stem and the suffix in the first case, and one of three C's in the second case. It is not difficult to see now that

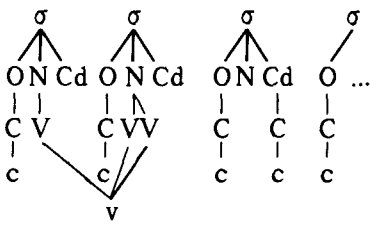
STAR will apply in the former case, but not in the latter. In the case of a biconsonantal verb stem, the C's starting with the suffix will fill the coda of the second syllable of the verb stem, creating a syllable structure as in (98) (which also entails shortening (cf. (50), above)).

(98)



In this case, linking the unlinked node to the melodic tier is beneficial in achieving the optimal filling of subsyllabic nodes. If the unlinked C is indeed linked, the syllabification as in (98) is produced, and onset and coda have been filled. On the other hand, if the same suffixes are combined with a triconsonantal verb root, rule (63c) will create, again through Heavy and Light Syllable Assignments (64) and unification with the syllable structure conditions (41) ((66)), a CVCVVC verb stem. Then, incorporating both C's starting the suffix will produce the syllabic structure in (99).

(99)



Here we see that two additional empty subsyllabic nodes are created, viz. an empty coda and an empty nucleus. Therefore, in this case, application of STAR is detrimental for the achievement of optimal syllable structure, and will therefore fail to apply.

We can go one step further in generalising and establish that the alternation type (83a) in fact is a parallel case. As we have seen, the *-(h)atn-* morpheme triggers rule (63a), which inserts one mora, through the now well-known mechanisms, effectively producing a CVC verb stem in the case of biconsonantal verb root, and a CVCC verb stem in the case of a triconsonantal verb root. The exact parallelism lies in the fact that if the unlinked C is realised, in the former case we have a sequence of two consonants, and in the latter case a sequence of three consonants.

We now come to the alternation displayed by the morphemes in (83c,d). These differ from the ones treated above in that in these suffixes, the alternating segments are vowels. The conditioning of the alternations displayed by the morphemes in (83c) and those in (83d) is essentially identical: if the verb stem preceding them ends in a vowel, the vowel of the alternating morphemes is not realised, if the verb stem ends in a con-

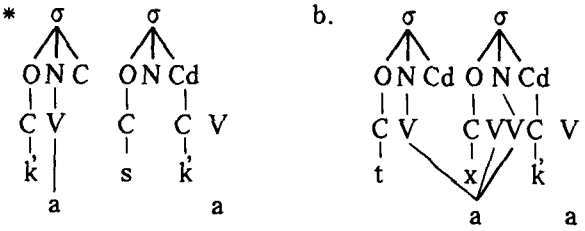
sonant the vowel is realised. Let us first consider the alternation type (83c), involving the morphemes *-m(i), -(x)a, -k'a*. An example is given in (100) (taken from Newman 1944: 29):

(100) a. k'as-k'a 'pierce (it)' b. taxa[·]k' 'bring (it)'

The *-k' a)* morpheme, (like, incidentally, *-m(i)* and *-x(a)*, the other two morphemes of this alternation type) does not not select one of the morphological mora insertion rules in (63). Therefore, the verb root itself triggers one of these rules, depending on what type of diacritic it carries (note that this is exactly parallel to Archangeli's analysis (cf. section 4.3.3), the only difference being that the diacritic carried by the verb root itself triggers one of the mora insertion rules in (61) instead of one of the skeletal template insertion rules in (26) or (27). It is for this reason that in (100a) we can find a CVC verb stem (in Newman's terms: a IA1 'primary base') and in (100b) a CVCVV verb stem (a IB 'primary base'). If we compare the syllabic structures resulting from the potential application of STAR to those of its non-application, it becomes clear why the rule applies in the case of (100a), but not in the case of (100b):

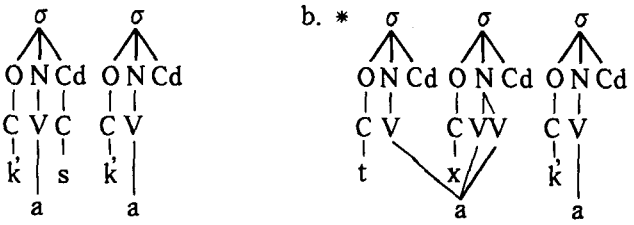
nonapplication

(101) a. * b.



application

(101)' a. b. *



It is clear that in the case of (101a), application of STAR reduces the number of empty subsyllabic nodes, whereas in (101b) the working of STAR would increase the number of subsyllabic nodes. For this reason, STAR applies in (101a), but does not apply in (101b).[22] Let us now look how STAR works in the case of the affixes in (83d). Consider the following example (Newman 1944: 120):

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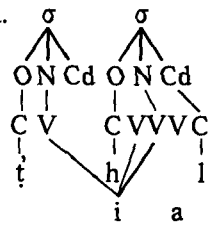
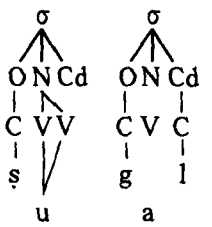
[22] The unlinked V in (101b) will be deleted by the general convention deleting stray elements (proposed by McCarthy (1979b, 1981), Steriade (1982), J. Harris (1983), Itô (1986, 1989)) and as a result will not be spelled out as the default vowel *i*. (See also note 13, above).

(102) a. ṭehe[·]-l <*ṭihe· 'get skinny, get lean'[23]
b. ṣo·g-al < *ṣo·gu 'pull out an unfastened object'

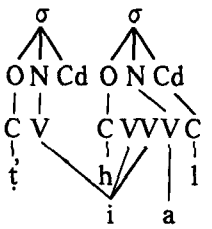
If we compare again the syllabified forms before and after the potential application of STAR, we see why that the vowel shows up in (102a), but not in (102b):

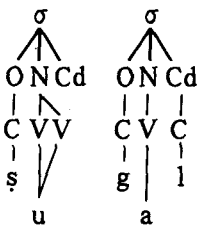
nonapplication

(102) a. 

b. 

application

(103)' a. 

b. 

In (103'a), the number of empty subsyllabic nodes has not changed. The condition on the application of STAR (85b) says that STAR only applies if the number of empty subsyllabic nodes actually decreases and therefore (103'a) is a structure which will not arise. In (103'b) however, we see that the number of empty subsyllabic nodes has indeed decreased, and therefore STAR will apply and the form shows up as *ṣoogal* (after the application of Lowering) and not as *ṣoogul* (as the form in (103b) would eventually surface without the application of STAR, but after Lowering, Epenthesis and Vowel Harmony).

4.5 Conclusion

This concludes our analysis of the segmental alternation in Yawelmani. The upshot of our analysis compared to those of Kuroda, Kisseberth and Archangeli is that it treats

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[23] The form *tehe[·]-l* is listed by Newman as a Yawelmani form. As pointed out in section 4.4.4 however, normally in Yawelmani, in contrast to Gashowu, the first vowel of a CVCVVC verb stem does not lower. It seems that Newman's data are inconsistent on this point and that in this form Yawelmani has behaves like Gashowu with respect to Lowering.

seemingly syllable related alternations as being conditioned by syllable structure, and not as processes independent from syllable structure. In a letter (of 5 April 1984) written to us shortly before his death, Newman, commenting on a version of our 1985 article of Yawelmani, acknowledges that the processes in question must be syllabically conditioned. By positing our theory, we have been able to express this insight in a formal way.

5 Schwa in German

5.1 Introduction: the existence of schwa/zero alternation on both sides of the river Rhine[1]

After having treated in the two preceding chapters two well-documented Amerindian languages we will show in this and the next chapter that a well-known alternation type in two European languages, i.e., German and French, can be analysed as a direct result of syllabification. In both languages the alternations in question take place between schwa and zero. Although there is an extensive literature on these alternations, their relationship with syllable structure has, however, seldom been noted.

Because our analysis of French is conceptually more complicated than the German one, we will start here with the latter language, and treat the French case in the next chapter.

For German, an analysis of schwa/zero alternations as being closely related to or as a result of syllabification has not been proposed hitherto.[2] Only Wiese (1986, 1988) (and to some extent also Giegerich (1985, 1986, 1987)) proposes an analysis which is related to syllable structure. In Wiese's case the analysis is related rather to the absence of syllable structure: he proposes a schwa insertion rule the structural description of which crucially contains a non-syllabified segment (see section 5.4.3, below). We will show that an analysis of these alternations as being directly related to syllabification is viable and provides us with an insight as to why the process takes place.

Before we go on, we should recall a point that was made earlier. As we have seen in chapter 1 (section 1.6.2), German has three place syllables. We have also shown there that in German the third subsyllabic node can be linked to a vowel (the same one as is linked to the nucleus (in fact the shortening case in colloquial speech mentioned in section 1.6.2, is the result of the delinking of this position, hence the subsequent intervocalic consonant becomes ambisyllabic)). In this German contrasts with, e.g., Yawelmani where, as shown in the previous chapter, the coda is subcategorised for being linked to consonants only.

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[1] We wish to thank Richard Wiese, Tracy Hall (who both adopt positions on German schwa different from ours and from each other's, see Wiese (1988) (and section 5.4.1, below) and Hall (1992)), Ursula Kleinhenz, Albert Ortmann and Karl-Heinz Ramers for discussions about this analysis of German. We have benefitted greatly from Wiese (1986, 1988) for compiling an outline of the data.

[2] Within the framework of generative phonology, there exist a number of purely linear accounts of schwa-zero alternation in German, which do not take into account prosodic categories like the syllable: Wurzel 1970, Kloeke 1982, Strauss 1982. We will come back to these analyses below in section 5.4.

5.2 German postlexical schwa/zero alternation

In German, there are two types of schwa/zero alternation, which we will analyse as lexical and postlexical respectively.[3] Although our main aim is to show that the lexical alternation is governed by syllabification, we will first focus our attention briefly on the postlexical one, because its effects interfere with those of the lexical alternation.

The postlexical alternation takes place between a schwa followed by a lateral or nasal and a syllabic lateral or nasal respectively (i.e., between *əS* and *S̩* (where *S* stands for a liquid or nasal)). It is a free, exceptionless alternation, independent of any morphological process.[4] Because of its exceptionless character, and the fact that it does not seem to be conditioned by morphology, this alternation can be analysed as being the result of very late processes in the phonology of German. Therefore, in terms of Kiparsky's (1982a,b) lexical phonology, the processes in question can be analysed as postlexical.

The answer to the question in what environment this free alternation can be found is complicated. There appears to be quite a degree of variation, and the choice between the alternants is highly dependent on the speech rate and style. This in itself is a further indication that the alternation can be analysed as taking place in the postlexical part of the phonology. There is also a considerable regional and idiolectal variation. Abstracting way from this variation for the moment, we give here an overview of the cases in which syllabic sonorants normally occur. Benware (1986: 70), basing himself on *der Große Duden* pronunciation dictionary (Mangold et al. 1962) reports the following situation for "usual pronunciation":

> Schwa is deleted before /m/ after fricatives, before /n/ after obstruents, and before /l/ after all consonants when the sonorants occur word-finally or are themselves followed by another consonant. Schwa before /r/ in this environment is always deleted [...].

Benware then gives the following deletion rule (1986: 71):

(1)

$$/ə/ \rightarrow \emptyset \;/\; \begin{bmatrix} -son \\ +cont \end{bmatrix} \_\_ m \quad \begin{bmatrix} -son \\ +cons \end{bmatrix} \_\_ n, l, r \quad \begin{Bmatrix} \# \\ C \end{Bmatrix}$$

---

[3] Wiese (1986, 1988) first introduced the idea of a postlexical schwa-zero alternation. In his view, it is the result of a deletion rule (cf. (5), below).

[4] Prinz (1991: 84-85) shows that the personal pronoun object clitic [n̩] (< ihn) and the article clitics [dn̩], [dm̩], (< *den*, *dem*) are exceptions. The nasals in these clitics are always syllabic cannot alternate with ə + nasal.

Examples where this "deletion" has taken place are given in (2) (Benware 1986: 70).[5] Note that the sonorants in question have become syllabic. In (2), also the effects of an optional process of progressive place of articulation assimilation are shown.

(2) *m*:

a.	großem	[gʀo:sm̩]	'big' (dative singular masculine and neuter ending)
b.	losem	[lo:zm̩]	'loose' (dative singular masculine and neuter ending)
	n:		
c.	haben	[ha:bn̩]	'to have'
		([ha:bm̩])	(after assimilation)
d.	Faden	[fa:dn̩]	'thread'
e.	legen	[le:gn̩]	'to lay'
		([le:gŋ̩])	(after assimilation)
f.	großen	[gʀo:sn̩]	'big' (adjectival ending of several categories)
g.	lachendes	[laxn̩dəs]	'laughing' (nominative and accusative singular neuter ending)
	l:		
h.	Hebel	[he:bl̩]	'lever'
i.	Mittel	[mɪtl̩]	'means'
j.	wickeln	[vɪkl̩n]	'to wrap'
k.	Geisel	[gaɪ̯zl̩]	'hostage'
l.	Kacheln	[kʰaxl̩n]	'to tile'
m.	Tunnels	[tʰʊnl̩s]	'tunnel' (genitive)
n.	Engel	[ɛŋl̩]	'angel'

In all these cases, there is an alternative pronunciation involving a schwa followed by the sonorant in question. The liquid consonant *r* is a special case. In descriptions of German (e.g. Moulton 1962, Krech et al. 1982 (reported in Wiese 1988: 149), Benware 1986), we find that a *r* except in onset position is transcribed as [ɐ], [ʌ] or [ɒ]. Hence, it is analysed as having undergone a vocalisation process. Examples are given in (3) (Wiese 1988: 149) and (4) (Benware 1986: 70).

(3) a. Leiter [laɪ̯tʌ] 'ladder'
b. mehr [me:ʌ] 'more'

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[5] Structuralists consider a schwa-sonorant sequence and a corresponding syllabic sonorant as one and the same thing. Thus Moulton (1962: 67) writes about schwa: "before /m n ŋ l r/ .... it may either show this same allophone or an allophone which can best be described as 'syllabicity of the following consonant'. " We will come back to this point of view in section 5.6.

(4) a. Wetter [vɛtɐ] 'weather'
b. wieder [vi:dɐ] 'again'
c. Becher [bɛçɐ] 'cup'
d. Weser [ve:zɐ] (name of a river)
e. Eimer [aɪ̯mɐ] 'bucket'
f. Keller [kɛlɐ] 'cellar'
g. Bauer [baʊ̯ɐ] 'farmer'

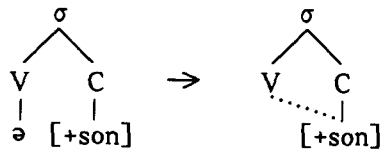
As mentioned by many authors the ideolectical and dialectical variation regarding the vocalisation of *r* is vast. In the standard dialect the vocalisation is obligatory, except if the *r* is preceded by a short vowel. In that case the vocalisation is optional (see Hall 1992: 56-57 and the references cited there; see also Vennemann 1982: 266ff, Benware 1986: 70 Wiese 1988: 169): By contrast, in certain southern dialects and southern variants of the standard language *r* is apical and is not vocalised. This illustrates the wide variation in the pronunciation of r-sounds in German. However, in nearly all cases a schwa + *r* sequence is at least obigatorily turned into a syllabic sound (i.e. either a vowel or [ɐ̯]). The pronunciation of schwa followed by tautosyllabic *r* as [əʀ] is very emphatic (basically, the older *Bühnenaussprache* (stage pronunciation)). We report it below, because forms with a schwa followed by tautosyllabic *r* have been analysed by others (especially Wiese 1988), and provisionally by us (in section 5.5, to be revised in 5.6) as occurring in this form in the lexical part of the phonological grammar. We render these pronunciations with the marking 'emph.'. We come back to this issue in section 5.6.

Here, we will follow Wiese (1988: 149) in not transcribing the postvocalic *r* as a vowel. Instead of using a vowel symbol ([ɐ], [ʌ] or [ɒ]) , we will use [ʀ]. Wiese uses [ʁ] for the uvular trill. We have changed [ʁ] to [ʀ], which is the current IPA symbol for this sound. For present purposes, the consistent use of [ʀ] is gives a more transparent transcription than one showing the effects of a (variable) vocalisation. The use of vowel symbols for surface representation would not invalidate our analysis, it would only make the data more opaque. When vocalisation does take place, it is a late postvocalic process (Hall 1992: 56-58) and does not interfere with the phenomena discussed here.

We now come back to the question of schwa/zero alternation itself. The statement of facts as given in (1) and (2) is only an approximation. Schwa-sonorant sequences in other positions other than the ones indicated in (1) and (2) also frequently alternate with syllabic sonorants, e.g., a schwa-nasal sequence in a position after a nasal or after a liquid.

To account for this free postlexical alternation, Wiese (1988: 169) has proposed the following rule, which he terms *postlexikalische Schwa-Tilgung* ('postlexical schwa deletion'). Wiese uses the framework of Clements & Keyser's (1983) CV-phonology:

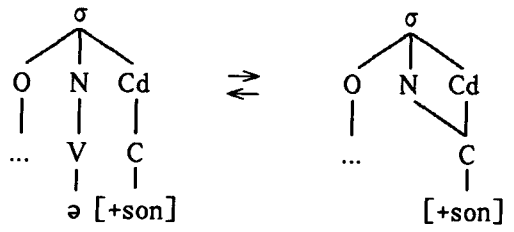
(5) *Wiese's postlexical schwa deletion*



We will discuss this rule in section 5.6. Under Wiese's analysis, all schwas are epenthetic and are inserted on the lexical level (cf. our sections 5.4.3 and 5.4.4, below, which treat Wiese's analysis of *lexical* schwa/zero alternation). Therefore, he can account for the postlexical variation by positing rule (5) only as a deletion rule.

As the reader will see below, we have good reason to believe that on the lexical level, liquids, but not nasals, should be able to be syllabic. On the surface, however, we see a free alternation between ə+L and L̩ as well as between ə+N and N̩ (where *L* and *N* stand for liquid and nasal respectively). If we were to adopt a rule-based analysis for this variational process, we would need a rule like Wiese's rule (5), but it would apply bidirectionally. Making Wiese's rule (5) bidirectional and adapting it to the constituent model of the syllable which is part of our framework, we get the rule in (6):

(6) *postlexical variation rule* (to be revised in section 5.6)



This rule is fairly complex. In fact it contains several rules. Later, in section 5.6, we will put forth a profound revision of this rule. For the moment, we also abstract away from the fact that ʀ is obligatorily syllabic in these cases. It will be shown that the rule in fact contains duplications of processes that have to be stated elsewhere in the phonological grammar. The rule will then be supplanted by one very simple delinking rule. Here, however, the rule will serve its purpose as a preliminary statement of the variation occurring between schwa-sonorant sequences and syllabic sonorants. In the next part of this chapter, on lexical schwa/zero alternation, between parentheses we will give the alternative phonetic forms emanating from the working of the 'postlexical variation rule' (6).

5.3 Lexical schwa-zero alternation in German: the facts

We now come to the main theme of this chapter, that of lexical schwa/zero alternation in German. In German, the schwa/zero alternation takes place in certain inflectional paradigms. Other schwas not appearing in these inflectional paradigms but in the same segmental environment do not alternate with zero. This fact is illustrated by the forms in (7) and (8):

(7) laufen [laʊ̯fən] (~ [laʊ̯fn̩]) 'to walk'
but not: *[laʊ̯fn]

(8) a. sichern emph.[zɪçərn] (~ [zɪçr̩n]) 'to protect'
but not: *[zɪçərn̩], *[zɪçr̩n̩], *[zɪçrn̩], *[ziçrn]

b. sicheren emph.[zɪçərən] 'certain', 'safe' adj.
(~ [zɪçrən] ~ [zɪçrn̩] ~ [zɪçr̩ən]
~ [zɪçr̩n̩] ~ emph.[zɪçərn̩])
but not: *[zɪçərn], *[zɪçr̩n]
(masc. acc. sing., dat. plur. endings and when preceded by an inflected determiner)

There is an alternation between the infinitival verb ending in (7) (where the *n* should be preceded by schwa or, by virtue of the postlexical alternation of section 5.2, should be syllabic) and the one in (8a) (where the *n* cannot be preceded by schwa or be syllabic). This type of schwa (or this type of syllabic liquid) behaves differently from the one in (8b), where the *n* of the adjectival ending should always be preceded by schwa (or be syllabic). The question where the alternation occurs and where it does not is an interesting one. In order to provide an answer, the data should be looked at more closely. We will now give a short systematic overview of the basic facts, followed by an overview of some previous analyses.

5.3.1 Verb forms in *-n* and *-ən*

In verbs we see the following pattern:

(i) The infinitive and present tense plural forms of verbs whose stems end in a liquid get only a (non-syllabic) *-n*. The form with syllabic liquids resulting from the postlexical alternation treated in section 5.2 is again given between parentheses).

(9) a. zittern emph.[tˢɪtərn] (~ [tˢɪtr̩n]) 'to tremble'
b. betteln [bɛtəln] (~ [bɛtl̩n]) 'to beg'

The forms in (9) cannot occur with two schwas, nor can the *n* be syllabic:

(9') a. *[tˢitərən] (*[tˢɪtərn̩], *[tˢɪtr̩n̩])
b. *[bɛtələn] (*[bɛtəln̩, *[bɛtl̩n̩])

In this respect, Standard German is markedly different from another West-Germanic dialect, i.e., Standard Dutch, where the equivalent of the forms in (9) are:

(10) a. sidderen [sɪdəʀən] ~ [sɪdəʀə]
b. bedelen [be:dələn] ~ [be:dələ]

We see that there is a schwa here both before the stem final liquid (as can be the case in German) *as well as* before the inflectional *n*. If there is any alternation, it is the final *n* that may be dropped. We will come back to this difference in behaviour between German and Dutch below, in section 5.7.

(ii) The infinitive and present tense plural forms of verbs whose stems end in consonants other than liquids get *-ən* (subject of course to the postlexical alternation with a syllabic *n*).

(11) a. atmen [atmən] (~ [atmn̩]) 'to breath'
b. regnen [ʀegnən] (~ [ʀegnn̩]) 'to rain'
c. geben [ge:bən] (~ [ge:bn̩]) 'to give'
d. retten [ʀɛtən] (~ [ʀɛtn̩]) 'to rescue'
e. sagen [za:gən] (~ [za:gn̩]) 'to say'

Again, forms with two schwas are excluded in Standard German:

(11') a. *[atəmən]
b. *[ʀegənən]

And again, the behaviour of Dutch is systematically different here:

(12) a. ademen [a:dəmən] ~ [a:dəmə]
b. regenen [ʀe:χənən] ~ [ʀe:χənə]

Two verbs in German are lexical exceptions in that their infinitives do not contain a schwa, viz. *tun* ('do' and *sein* ('be'). We will discuss these in section 5.5.1.

The difference in behaviour between verbs with liquid final stems and those with stems ending in other consonants is also found in verb forms other than infinitives, e.g. in the third person present tense, whose suffix has the form *+t*. Compare the forms in (13):

(13) a. (er) zittert emph.[tˢɪtəʀt] (~ [tˢɪtʀ̩t]) '(he) trembles'
b. (er) atmet [atmət] '(he) breathes'

It should be noted that in forms like (13b), a schwa is inserted between the stem final consonant (here *m*) and the consonant belonging to inflection (here *t*). This insertion takes place although *mt* is a possible syllable ending in German, at least word finally. If schwa were inserted only to produce a permissible syllable structure, then we would at first sight think that the insertion site would be the same for verbs, *zittern* and

atmen. So in the third person present tense, we would find either [tˢɪtəʀt] and *[atəmt], or *[tˢɪtʀət] and [atmət]. Again, Dutch behaves in a systematically different way. The equivalents for (13) in Dutch are given in (14):

(14) a. (hij) siddert [sɪdəʀt]
b. (hij) ademt [a:dəmt]

5.3.2 Adjectives

German adjectives ending in a liquid display the following alternation:

(15) a. dunkel [dʊŋkəl] (~ [dʊŋk̩]) 'dark'
b. dunklen [dʊŋklən] (~ [dʊŋkl̩n]) id. (adj. + case suffix)
c. dunkle [dʊŋklə] id. (adj. + case suffix)

The forms in (15b,c) with two schwas are again impossible:

(15') b. *[dʊŋkələn]
c. *[dʊŋkələ]

The Dutch equivalent for (15b) does not occur, because there is no adjective case suffix ending in *n*. The equivalent for (15c) does exist, and, as we now have come to expect, it contains two schwas:[6]

(16) donkere [dɔŋkəʀə]

A first look at the German situation concerning adjectives (abstracting away from the final schwa in (15c) for the moment) may now lead to the hypothesis that schwas show up only where they are needed for correct syllabification (the forms in (13) and (15) without schwa simply do not have possible word-final syllable endings in German). As we will show below, this idea is basically correct, but it seems to be disproved by forms like:

(17) trockeneren [tʀɔkənəʀən] 'drier' (adj.+comparative+case)

The forms *[tʀɔkənʀən], *[tʀɔkənəʀn] and ?[tʀɔknəʀən] are also syllabically well-formed, but are nevertheless ungrammatical, or at least questionable.

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[6] The Dutch equivalent of *dunkle* happens to have a stem final *ɤ* instead of a *l*. However, the same distribution of ə's (and hence the same contrast between Dutch and German) exists with *l*-final adjectives stems, e.g., in Du. *Wankele* [ʋɑŋkələ] 'unstable'.

5.3.3 Nouns

Nouns and nominalised adjectives can also have a case marker ending in *-ən/-n*. But here, the behaviour of schwa is different from the one with adjectives and parallel to the one with nouns. Let us consider the nominalised adjective in (18).

(18) a. (im) Dunkeln [dʊŋkəln] (~ dʊŋkl̩n]) '(in the) dark' (nominalised adj. + case)

We see here that the schwa is present *to the left of the liquid* (or the liquid is itself syllabic), whereas in (15b), there is a schwa *to the right of the liquid* (or the subsequent nasal is syllabic). This concludes our short presentation of the essential facts of lexical schwa/zero alternation.

5.4 Lexical Schwa/zero alternation: previous analyses

5.4.1 Linear generative phonology

We will now treat some previous analyses. First the purely linear accounts of Wurzel (1970), Kloeke (1982) and Strauss (1982) should be briefly mentioned here. These are plainly unsatisfactory. As pointed out by Wiese (1988: 141), Wurzel's and Kloeke's analyses have the undesirable characteristic that they analyse the alternation "through a battery of epenthesis and deletion rules" (our translation, as well as for the quotations to follow). Also,

> the rule systems became so complex, that for this reason alone they have little plausibility. Apart from that, these analyses have the undesirable consequence that a sound is first inserted and than again deleted, without having any perceivable role in the derivation. (Ibid.).

Strauss' analysis consists of

> positing an underlying schwa in all positions where it might conceivably be found and then deleting many of these specimens by way of a deletion rule. (Ibid.).

These analyses have the drawback of assuming either a suspiciously rich rule system, containing rules which are each other's opposites (Wurzel, Kloeke), or of positing overly rich underlying forms (Strauss).

5.4.2 Issatschenko (1974)

In nongenerative phonology, an interesting contribution was made by Issatschenko (1974). The fact that certain schwas alternate with zero (like the schwas in the infini-

tival and nominal endings) and others do not alternate with zero (like the schwas in the adjectival ending and in the comparative morpheme) has lead him to set up a distinction between two morphophonemes, *schwa constans* and *schwa mobile*. Wiese (1986: 698, 1988: 141) criticises this view:

> Apart from the dubious status of the morphophoneme in general, the problem with the morphomorphemic solution is that there is no systematic relationship between schwa mobile and schwa constans. It is quite accidental that they both surface as schwa. (1986: 698)

We will show below that in order to account for the observed difference in behaviour of the schwas in the endings of (7) and (8a) on the one hand and the one in (8b) on the other, it can be assumed that there are underlying schwas (the *constantia*), and epenthetic ones (the *mobilia*). By reformulating Issatschenko's insight in this way, it is not necessary to have recourse to the notion of 'morphophoneme'.

We feel that Wiese's second objection is not valid: it is not uncommon in phonology (or for that matter, syntax, or, *mutatis mutandis*, other sciences) that identical forms can stem from several distinct sources. We will now give a summary of the analysis by Wiese (1986, 1988), and show that the assumption of a single source for the schwas constantia and mobilia leads to serious problems.

5.4.3 Wiese (1986, 1988)

Wiese (1986: 704, 1988: 144), working in the framework of Clements & Keyser's (1983) theory of CV Phonology, assumes the following schwa insertion rule (we quote here the rule as given in Wiese (1988), translated into English, the 1986 version of the rule is slightly different):

(19) *Schwa Epenthesis* (Wiese 1988)

a. $\emptyset \rightarrow V / \_\_ X]_{word}$

b. Associate an empty V with schwa

By using *X*, Wiese indicates a skeletal position that is not specified for syllabicity. This permits him to indicate a skeletal position not associated with a syllable node, as a directly contextual condition. By an "empty V" is meant a skeletal node that is not associated with any segmental material (but which is incorporated into syllable structure). As an example we give here Wiese's (1988: 145) derivation of *Atem* [a:təm] 'breath'.[7]

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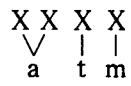
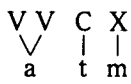
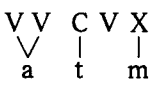
[7] Wiese uses the *rule approach* for syllabification (see chapter 2, section 2.5). For the technicalities of Wiese's conception of syllabification, see Wiese (1988: 85-89).

(20) a. 

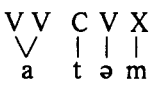
underlying

b. 

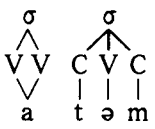
syllabification (partial)

c. 

Schwa Epenthesis (34a)

d. 

Schwa Epenthesis (34b)

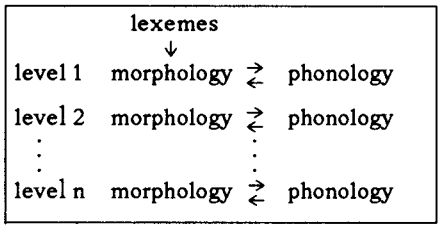
e. 

Syllabification

Wiese analyses *all* occurences of schwa as the result of the application of Schwa Epenthesis (19), and thus does not need to account for any difference between *constantia* and *mobilia*. In order to make this analysis work, however, Wiese has to make a number of nonstraightforward assumptions, which we will treat here.

Wiese works within the framework of lexical phonology. In chapter 3, section 3.3, we gave a concise summary of the basic idea of lexical phonology. Recall that in lexical phonology the lexicon is seen as a system of interconnected levels. On these levels, morphological processes like derivation, inflection and compound formation (specified for the level in question) take place, as well as phonological processes. Diagram (20) in chapter 3, repeated here as (21), illustrates the model:

(21)



As mentioned, Kiparsky (1985) claims that in English, there are two levels. On the first level class I derivation takes place. Class I derivation involves affixes which affect main word stress, as well as those which belong to irregular inflection types. On level 2, all other morphological operations, i.e., derivation of class II, compound formation and inflection take place.

Wiese (1986: 707-708, 1988: 150-151) argues that in German there should be three lexical levels. He argues that plural formation must take place on level 1 in German, because it is generally unpredictable (apart from the *-s* plurals used especially in loan words). Furthermore, the plurals of the unpredictable type are found in compounds,

like in (22) while *-s* plurals never occur in compounds, cf. (23).

(22) a. Vätersitte 'father habit' (sing.: Vater, plur.: Väter)
b. Häuserkampf 'house fight' (sing.: Haus, plur.: Häuser)
c. Schweinebraten 'pork' (sing.: Schwein, plur.: Schweine)

(23) a. Parkordnung 'park regulation' (sing.: Park, plur.: Parks)
b. Kinosterben 'disappearance of cinemas' (sing:. Kino, plur.: Kinos)
c. Barbesucher 'bar visitor' (sing.: Bar, plur.: Bars)

Because we do not find *-s* plurals in the first members of compounds, the regular plural formation (the one involving *-s*) should follow compound formation. Wiese then shows that class II derivation interacts freely with compounding. In *[[Förderungs][angelegenheit]]*[8] 'development matter', two words carrying class II affixes (*-ung* and *-heit*) are compounded, in *[[[[Disziplin]los]ig]keit]* 'lack of disciplin' three class II affixes are attached, and in *[[[ober][lehrer]]haft]* 'typical of secondary school teachers' a compound is modified by a class II affix (*+haft*). Because of this free interaction, Wiese assumes that level 2 subsumes both class II derivation and compounding.

We now come back to the issue of schwa insertion. Wiese assumes that the level on which his rule of Schwa Epenthesis (19) applies is specified in a fairly complicated way for grammatical word categories and the nature of the consonant ending the stem. Let us first take the two most simple specifications, i.e., those based on grammatical categories alone. For nouns, Schwa Epenthesis (19) should apply **before** inflection (which is regular and therefore should apply at level 3), but for adjectives, it should apply **after** inflection (also regular and at level 3). Therefore, Schwa Epenthesis is specified to apply on level 2 for nouns, but on level 3 for adjectives. To illustrate this, we reproduce here Wiese's derivations (1988: 153) of *Dunkeln* (noun) and *dunklen* (adjective) (cf. (18) and (15b), above).[9]

(24)		dʊŋkl	dʊŋkl	adjectival stem
	level 1	—	—	
	level 2	$dʊŋkl_N$	—	A → N
		$dʊŋkəl_N$	—	Schwa Epenthesis (19)
	level 3	$dʊŋkəl_N$+n	dʊŋkl+n	inflection
			dʊŋklən	Schwa Epenthesis (19)

---

[8] As for the 'binding morpheme' *-s* in *Förderungsangelegenheit*, Wiese (1988: 152) assumes that it is the result of a reanalysis of a genitive or plural *-s* belonging to level 3. Under this assumption, it is reanalysed as a level 2 element, applied to cases to which it was previously not applicable and has become completely devoid of meaning.

[9] We give here the forms in IPA, where Wiese uses normal orthography (where *ə* is rendered as *e*). We have rendered [ŋ] as an underlyingly velar nasal. The point of articulation can also be analysed as the result of an assimilation process to the following velar plosive, (as done by e.g., Hall 1989a,b, 1992: chapter 4). The question is immaterial to the present issue.

The third specification for the domain of application of Schwa Deletion concerns the adjective stems which end in a nasal. There is a systematic difference between this type of adjective and the type ending in a liquid. Cf. (25):

(25) a. dunklen 'dark' adjective + inflection
b. üblen 'evil' adjective + inflection
c. trockenen 'dry' adjective + inflection
d. ebenen 'level' adjective + inflection

The adjective stems ending in a liquid do not get an epenthetic schwa before their final element (25a,b), but adjective stem ending in a nasal do (25c,d). In order to account for this, Wiese assumes that in addition to the general specification of the application of Schwa-Epenthesis for level 3 for adjectives, there is a more specific specification for level 2, for nasal final adjective stems.

The fourth and fifth specifications for Schwa Epenthesis concern verbs. In order to account for the contrast between liquid-final and nasal-final verb stems (i.e., the difference between *zittern* and *atmen* (see (9) and (11), above), Wiese assumes that Schwa Epenthesis applies before inflection for liquid-final verb stems, but after inflection for nasal-final verb stems. This is illustrated by the derivations of *zittern* 'to tremble' and *widmen* 'to dedicate' in (26) (Wiese 1986: 112, 1988: 156).[10]

(26) a. tˢɪtʀ stem
tˢɪtəʀ epenthesis
tˢɪtəʀ+n affixation

b. vɪtm stem
vɪtm+n affixation
vɪtmən epenthesis

The verb stems ending in a liquid always show up with a schwa, independently of the derivational ending. For instance, in words containing the *+ʊŋ (-ung)* morpheme, the schwa is always present like in *Förderung* 'advancement', *Umsegelung* 'sailing around', as opposed to *Atmung* 'respiration' and *Ordnung* 'order'. Because the *+ʊŋ* morpheme is placed on level 2, Wiese assumes that Schwa-Epenthesis is specified to apply on level 1 for liquid final verb stems, whereas it is specified to apply on level 3 for nasal final verb stems (for more details, see Wiese 1986: 712-713, 1988: 156-157).

There are two more specifications for the level of application of Schwa-Epenthesis in Wiese's framework. They both concern *ʀ*. Before a suffix of the form *-ʀ*, Schwa-Epenthesis should always take place. The two suffixes of this form are the comparative and nominalising (often: agentive) suffix. Of the two suffixes, the nominalising suffix belongs to level 2 and the comparative suffix to level 3 (Wiese 1988: 165). Therefore, Schwa Epenthesis has to be specified to forms containing an *ʀ*, both on levels 2 and 3.

Wiese thus has to have recourse to no less than seven specifications for the level of application of Schwa-Epenthesis, cf. the overview given in (27) (Wiese 1988: 165).

---

[10] Again, we have changed Wiese's orthographic notation to one with phonetic characters.

(27)

level	word structures
1	Verb[... [liquid]]
2	Noun[ ], Adj[... [nasal]], |ʁ|
3	Verb[... [nasal]], Adj[ ], |ʁ|

For occurences of word-final schwa, Wiese assumes that they are the result of epenthesis applying before an empty X-position. In cases where schwa occurs superficially as an inflection marker, it is in fact an empty X that is adjoined to the verbal stem. Cf. the derivation of *(ich) lebe* '(I) live' in (28) (Wiese 1988: 160).

(28)

leb	stem
leb + X	affixation
lebəX	Schwa-Epenthesis
[le:bə]	surface form

Wiese also has to assume that the verbal prefixes *bə+* and *gə+* are underlyingly *bX+* and *gX+*.[11]

This concludes our short survey of Wiese's analysis. It is necessarily incomplete, but does present the basics of the proposal.

5.4.4 *Criticism of Wiese's analysis*

Wiese's proposal has the clear advantage of positing a single epenthesis process and the charm of assuming a single source for schwa. However, a high price has to be paid for this. We have seen that the specification of the domains of application for Epenthesis (19) is a very complicated one. In the specification (cf. (27)), we see that reference is made to grammatical categories as well as to categories of segments. Although the model of lexical phonology allows for a specification of the domain of lexical phonological rules in terms of grammatical categories, it cannot be an aim in itself to do so. The extreme specificity of the stipulations in (27) (which do not even suffice, see note 11), show that (27) contains a great number of idiosyncrasies. If, by adopting another model, we were able to reduce the high number of idiosyncrasies, this would seem a good path to follow. We will show below that this is indeed possible and that part of the idiosyncrasies contained in (27) in fact follow from general phonological principles and tendencies.

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[11] The reader will notice that diagram (27) does not contain information as to what level Schwa Epenthesis (19) should apply to for cases like *(ich) lebe* and the prefixes *bə+* and *gə+*. This is also true for verbs ending in consonants other than liquids and nasals. Hence the specifications for the domains of application of Schwa Epenthesis (19) should in fact be even more complicated.

First, however, we will have to tackle another feature of Wiese's proposal, viz. that *all* occurences of schwa are the result of epenthesis. It was mentioned above, that in order to maintain this thesis, Wiese has to analyse the -ə affixations as being the result of the presence of an X unlinked to segmental structure. The occurrence of *X* is an artefact of Wiese's theory and is otherwise not necessary in the phonology of German. It has to be realised that this symbol, which Wiese uses along with *C* and *V*, represents an element that is not linked to syllabic structure (cf. the derivation of *Atem* in (20), above). As already mentioned in chapter 4, section 4.3.1, the fact that reference has to be made to an element's status of not being linked to syllabic structure constitutes a fairly powerful requirement, the necessity of which is at least debatable. This point of criticism is not confined to Wiese's theory, but to the formulation of syllable structure related epenthesis in the rule approach to syllabification in general. An example is Archangeli's rule of epenthesis in Yawelmani, given in (12) in chapter 4, repeated here as (29).

(29) *Archangeli's Yawelmani Epenthesis*

$$\emptyset \rightarrow \overset{\sigma}{\underset{|}{X}} \; / \quad \_X'$$

The expression *X'* refers to an unlinked element (recall from chapter 4 that Archangeli uses X to refer to a position on the skeleton in general; she just uses one type of symbol (X), while Wiese uses three (C,V,X); the distinction here, however, is only notational: *X* in Wiese's notation equals *X'* in Archangeli's). In chapter 4, section 4.3.1, we have discussed why Archangeli's making reference to *X'* is very questionable indeed: if the rule is translated into terms of linear phonology, a third feature value is introduced. (Wiese's notations *C, V, X* correspond to "[- syll]", "[+ syll]", "[Ø syll]" respectively.) This shows that the power of a grammar refering to these three possibilities in the linked status of a skeletal slot is as great as one refering to three feature values, all other things being equal.[12]

Another feature of Wiese's analysis must also looked at with a critical eye. Schwa Epenthesis should be specified to apply for levels 2 and 3 before *R*. This is so because a schwa should always be inserted before an unsyllabified *R*. Because the two morphemes *+R* happen to be introduced on two separate levels, the element *R* has to be

---

[12] In radical underspecification theories, like the one by Archangeli (1984), it is possible to have an unspecified feature value. As soon as a feature is referred to, however, its value automatically filled in as '+' or '-' by redundancy rules. Hence, in that framework it is also not possible to use ternary features like [+ syll], [-syll], [Ø syll], as Wiese in fact does.

mentioned twice.[13] This means that the fact that epenthesis takes place immediately when a morpheme with the phonetic shape *R* is added by the morphology is completely obscured. One of the two *R*'s could have had another phonetic substance, and the rule would not have been more complicated. Clearly, a generalisation has been missed. In the next section, when we come to our own proposal concerning schwa insertion in German, this problem simply will not arise.

5.5 Lexical schwa/zero alternation as a result of syllabification

In this section, we will show that the schwa/zero alternation in German can be analysed as being a result of syllabification. For this, first a word must be said about the status of schwa. Unlike Wiese, we will claim that schwa can be structurally underlying in German. As schwa is the neutral vowel in German, we will assume it to be only a skeletal slot (V), which postlexically (or later in a possible phonetic component) receives its phonetic content by default value assignment; we will come back to default value assignment on the skeletal level in section 5.6. For morphemes which show up only as schwa (like in (28), *ich lebe*), one does not have to posit anymore an abstract underlying X-slot (which does not receive a phonetic interpretation) before which the schwa is epenthesised, as in Wiese's analysis. Instead, we will assume that certain morphemes can contain an empty V while others do not. This empty V-slot is not abstract, because it is postlexically filled in by the value of the neutral vowel, schwa.[14] In this it differs from the X-slot Wiese uses, because this latter element never shows up on the surface.

In line with our general syllabification theory presented in chapter 1, we assume that directionality is a universal property of syllabification. As in the analyses of Yawelmani and Tonkawa in chapters 3 and 4 respectively, the directionality is vital for the understanding of the syllable related alternation processes in German. As German, like most other languages, maximises onsets, we can assume that syllabification, like in Tonkawa and Yawelmani (but unlike in Tigrinya, cf. section 4.4.2 of chapter 4), takes place from right to left.

---

[13] Wiese (personal communication) also needs Schwa Epenthesis to apply on level 1 in words like *Bücherei* [byçəˈʀaɪ̯] 'library', because of the word accent. This accent is assigned at level 1 and because it is on the *-ei* morpheme, this morpheme should be added at this same level. Note that Schwa Epenthesis could not apply later in the derivation because then *R* would not be unsyllabified anymore because it would be in the onset of the next syllable, and hence the structural description of the rule would not be met.

[14] Giegerich (1987: 467) assumes, like us, that schwa is in fact an empty skeletal slot that is only postlexically specified. Giegerich's analysis is otherwise very different from ours, because he works in a metrical framework (in which the skeletal slots are dominated by S(trong)- and W(eak)-nodes).

As already argued in section 1.6.2 of chapter 1, the syllable in German is trinodal. As we have seen in chapters 1, 3 and 4, it shares this property with Navaho, Wiyot, Dutch, Tonkawa and Yawelmani. (In chapter 6, it will be shown that, in contrast to these languages, French is binodal.) Apart from these already established facts, two assumptions should be made about the parameter settings of German syllabification.

First, we take German syllabification to be lexical. Recall from our analysis of Tonkawa in chapter 3, section 3.3, that the same parameter setting applies for that language. In that section, it was argued that syllabification was cyclic, and that its first application was after the first morphological operation. For German, however, we assume that syllabification is *not* cyclic, but nevertheless lexical.

This kind of lexicality has been proposed by Booij & Rubach (1987). They propose a postcyclic, but nevertheless lexical level. They do so because they assume that certain processes (like, e.g., final devoicing in many languages) should take place at the level of the word, and not at the level of the sentence. The word level is the lexical level par excellence.

The processes of syllabification we will discuss in this section also take place on the level of the word. This reason in itself suffices for us to assume that syllabification in German is lexical. However, the idea of a lexical postcyclic syllabification is also adopted because, as the reader will see, there should be two levels in German, which differ from each other with respect to the syllabic constraints that are in force. Certain syllabic constraints operative on the first level have been suspended at the second level. In the theory of lexical phonology, this is characteristic for the distinction between the lexical part and the postlexical part of the phonological derivation.

It should be stressed that the postulation of a postcyclic lexical syllabification does not work out as an enrichment of the theory with respect to syllabification. In fact, the assumption that syllabification is only postcyclic in German is more restrictive than an assumption that syllabification applies cyclically.

Our second assumption about syllabification in German is that during lexical syllabification, liquids can be linked to the nucleus node. This is not a far-fetched supposition. Often in language, certain categories of segments, like high vowels, liquids and nasals, are not restricted in the choice to which subsyllabic node they can be linked. That is, they can be linked either to the nucleus (and hence be syllabic), or to one of the peripheral nodes onset and coda (and hence be nonsyllabic). In the case of German lexical syllabification, we assume that liquids can be either syllabic or nonsyllabic. (Giegerich (1987: 456-457), though working in a different framework, makes a similar assumption.) In contrast to this, we assume that nasals cannot be lexically syllabic in German. The idea that nasals cannot be syllabic but liquids can is not unnatural, given the place the latter category of segments occupies in the sonority hierarchy: liquids are closer to vowels than nasals. Consider the generally assumed hierarchy displayed in (30) (we have taken here the sonority hierarchy as given by Clements (1990: 296); the specific form of this hierarchy varies slightly among authors, and sometimes among the proposals for different languages by a single author).

(30) *Sonority Hierarchy*

V G L N O

← more sonorous less sonorous →

We now come back to our first assumption about German syllabification (concerning the existence of two levels of syllabification, a lexical postcyclic one and a postlexical one), comes into play. The theory of lexical phonology encompasses the idea that certain structural restrictions that are in force lexically no longer apply postlexically. For German, we assume that it is the restriction against syllabic nasals has been suspended at the postlexical level. Hence on this level, liquids as well as nasals can be syllabic.

In fact, the distinction between two levels of syllabification with different syllabic constraints is not new, and not confined to the framework of lexical phonology. In previous (nongenerative) phonological frameworks, a distinction was postulated between the *phonological* and the (sc. systematic) *phonetic* syllable (or between the *morphological* and *phonological* syllable) (cf. Rosetti (1963) and the references cited there). In the framework of lexical phonology, this fits neatly in the distinction between lexical and postlexical phonology.

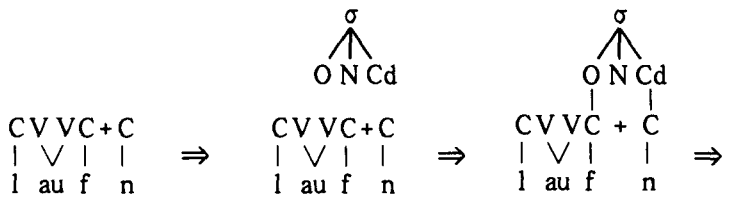
5.5.1 Verbs

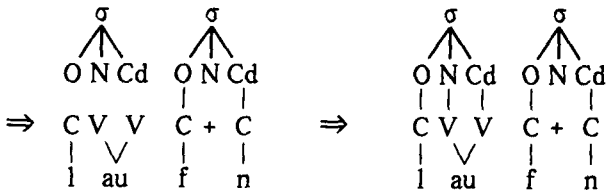
We will now give instances of the application of syllabification in German in all of the instances of schwa/zero alternation outlined in section 5.3. Let us first look at the example given in (7), repeated here as (31):

(31) laufen [laʊ̯fən] (~ [laʊ̯fn̩]) 'to walk'

The syllabification of this form, which for the moment we will assume to contain a schwa at the end of the lexical derivation (the form with a syllabic nasal is the result of the postlexical variation rule presented in section 5.2) takes place as follows:

(32)

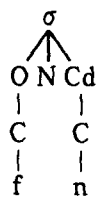




(The diphthong *au* in (32) has a monophonematic status, i.e., the material on the segmental tier is tied together as a single (complex) segment).[15] The diphthong is linked to two skeletal slots, as for long vowels.)

As the reader will have noticed, the infinitive morpheme is taken to be of the form *+n*. We see here that a trinodal syllable structure is imposed on the form. Because syllabification should be maximal (a result of the application of the association conventions, which as we have seen in chapter 2, section 2.5, play a crucial role in our syllable assignment theory), the elements to the left of the *n* are incorporated as much as possible in the syllabic structure. Hence the syllable in (33) is formed.

(33)



The nucleus is left empty because application of one-to-one association in either direction cannot link a segment to the nucleus node. Given that one-to-one association takes place from right to left, *n* is linked to the coda node. Then, *f* cannot be linked to the nucleus node, because this element cannot be syllabic in German (apart from one or two interjections like *pfft*, which are however not part of regular phonology). Therefore, the nucleus is skipped and *f* is linked to the node to the left of the nucleus node, i.e., the onset. We assume for the moment that, then, the nucleus node will be filled with the value of the neutral vowel (in German: schwa) by *Default Value Assignment*. We will come back to this in section 5.6.

Let us now take the form in (9a), repeated here as (34).

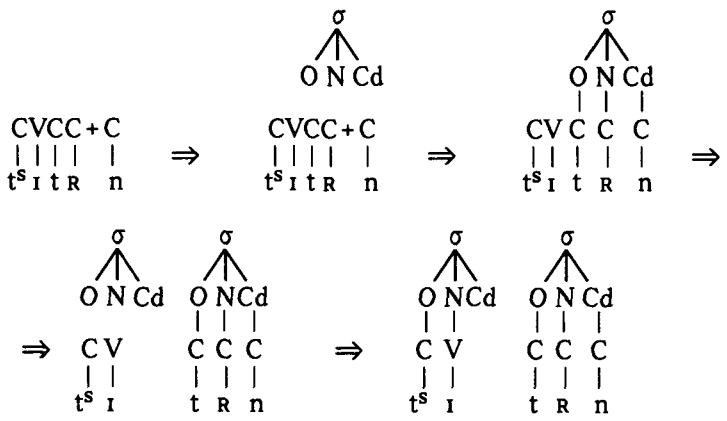
(34) zittern $^{\text{emph.}}$[tˢɪtəʀn] (~ [tˢɪtn̩]) 'to tremble'

---

[15] An alternative way of representing a diphthong is V V, where the segmental elements are
a u
each linked to a skeletal slot, and where the fact diphthongal character is expressed by the arc. In this representation, the fact that a diphthong is always heavy in German is expressed. It also expresses the general restriction (observed by, e.g., Kaye and Lowenstamm (1984)) that the elements of a diphthong cannot separately undergo phonological rules, e.g., deletion rules, or be syllabified in two different syllables.

Here, we assume that syllabification takes place in the way displayed in (35).

(35)

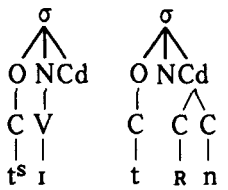


With syllabification applying from right to left, the *n* is the element which first triggers the imposition of a syllable. Then, association takes place and the *n* is linked to the coda node. Finally, according to the association principles, one-to-one association *takes place, because there are still two empty subsyllabic nodes (nucleus and onset).* These will now be linked to the nucleus, because, as we have just stipulated, liquids can be syllabic in German on the lexical level.

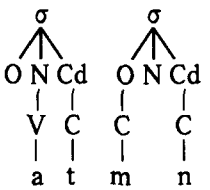
Postlexically, the variation rule (6) can change the syllabic liquid into a schwa-liquid sequence. We will come back to this in section 5.6. (In (35), we have not indicated how the right coda node of the second syllable is filled. In fact, spreading takes place from the right (linking the vowel to the coda) or from the left (linking *t* to the coda). These alternatives produce the possible pronunciations $^{emph.}$[tˢɪtəʀn] (~ [tˢɪtʀ̩n]) and $^{emph.}$[tˢi:təʀn] (~[tˢi:tʀ̩n]) respectively. The *t* in the first form is nevertheless not long on the surface, because an automatic degemination process applies later (parallel to the Dutch case treated in chapter 1, section 1.6.1).

The fact that we do not find the forms *[tˢɪtʀən] and *[tˢɪtʀ̩n] is explained by the lexical syllabicity of the liquid. (by rule (6), ʀ̩ can change into əʀ, but not into ʀə). In this, the form *zittern* contrasts with *atmen*, which can be pronounced as [atmən] and [atmn̩], see (11a). One could argue that the difference between the two forms is due to conditions on syllable structure: whereas *r* can be followed by *n* in the coda, *m* cannot. Suppose that syllabification produced the following lexical syllabifications for *zittern* and *atmen* respectively:

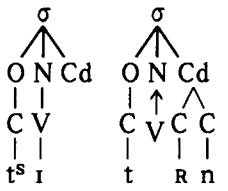
(36) a.

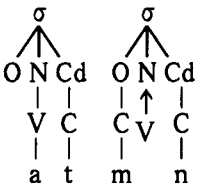


b.



The empy nucleus nodes would be filled by default assignment of a skeletal slot, as in (37). This skeletal slot would then eventually be filled by the default value for V, schwa.

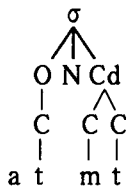
(37) a. 

b. 

This would be a nice explanation, were it not that for another inflected category it would systematically give the wrong predictions. This is the case in the forms given in (13), repeated here as (38).

(38) a. (er) zittert [tˢɪtəʀt] ~ [tˢɪtʀ̩t] '(he) trembles' (*[tˢɪtʀət])
b. (er) atmet [atmət] '(he) breathes' (*[atəmt], *[atm̩t])

The explanation outlined above would incorrectly predict the forms *[atəmt], *[atm̩t] for (38b). The underlying form is /atm+t/. Lexical syllabification would produce the following structure:

(39) 

Here, fully parallel to (37), either a default V (later to be filled by the value ə) would be inserted into the nucleus, or the C dominating *m* would spread to the nucleus position. The difference between *er zittert* and *er atmet* is systematic, we find always the schwa *before* a stem final liquid (or, alternatively, the liquid is syllabic), but we find the schwa always *after* a stem final nasal (if the element following the stem final nasal is a sonorant consonant (liquid or nasal) that the sequence schwa liquid alternates with the syllabic counterpart of the liquid). Hence the contrast between *zittern* and *atmen*, which in the case of the infinitive could be justified by syllabic structure constraints, is also found between *(er) zittert* and *(er) atmet*, where, as already indicated in section 5.3.1, it cannot be accounted for by invoking syllabic constraints (nasal + *t* is a permis-

sible syllable ending in German, e.g., *(er) kommt* [kɔmt] '(he) comes').[16]

It is for this reason that we have invoked the assumption that liquids are lexically syllabic in German.

In this subsection, we have assumed that the form of the infinitival suffix is *+n*. This, together with the assumption that liquids are syllabic in German, accounts for the difference in behaviour between liquid-final verb stems and those ending in other consonants, including nasals.

As for verb stems ending in vowels, there is an interfering metrical process. Because of an apparently metrical condition, most verb stems ending in a vowel get schwa, as shown by the forms in (40):

(40) a. gehen [ge:ən] (~ [ge:n̩]) 'to go'
b. bauen [baʊ̯ən] (~ [baʊ̯n̩]) 'to build'
c. nähen [nɛ:ən] (~ [nɛ:n̩]) 'to sew'

In the opinion of Wiese (1988: 157), the presence of schwa in these forms is the result of a condition implying that all verbs should be at least bisyllabic. He points out that Schwa Epenthesis also takes place in verbs like (40), although this is "neither required by the syllabic structure, nor by the infinitival ending" (cf. verbs like *zittern, betteln*). He then mentions that the presence of schwa must be due to a condition on the stress pattern for a delimited class of words. This condition is given here in (41) (Wiese 1988: 157).[17]

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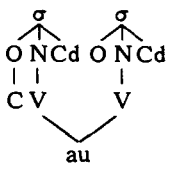
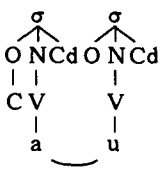
[16] In the deverbal nouns on *-ung* ([ʊŋ]), like *Förderung, Umsegelung, Atmung, Ordnung* (already mentioned in section 5.4.3), the same pattern is found: a schwa is present before a liquid (or the liquid is syllabic), but is not present before a nasal. For the liquid-final verb stems (like in *Förderung, Umsegelung*), the presence of schwa is not necessitated by syllable structure. Therefore, one could think that here, the schwa has been inserted before the *-ung* morpheme was added. This would be one of the rare cases in which cyclic schwa insertion, and hence cyclic syllabification, would be necessary. However, if that were true, we would find *[a:təmʊŋ], *[ɔʀdənʊŋ] as well. On top of that, *Fördrung* and *Umseglung* (even in this very orthography) are possible as well, and in certain liquid final deverbal nouns on *-ung* schwa cannot be present, like in *Entwicklung* 'development'. Hence the data are quite fluid here. We assume that word formation here is influenced by analogy with the infinitives. Irregularities as displayed in the discrepancy between *Umsegelung* and *Entwicklung* are typically the result of the working of analogy.

[17] Seeing the form in (40b) (*bauen*) and the metrical condition on verbs (41), one could think of another possibility to make (40b) bisyllabic, viz., as syllabification as:



, or as:



(see note 15). This would give rise to the phonetic form [ba.un] (with "." indicating a syllable boundary). However, this syllabification would violate the general restriction (already mentioned in note 15) that difparts of material in one diphthong may not be syllabified in two different syllables. For the same reason, a word like *Baum* [baʊ̯m] 'tree' may cannot be pronounced as [ba.um].

(41) Foot

Plural nouns, except those ending in *-s*, are also subject to this condition. (We will come back to this in section 5.5.3, on schwa in nominal inflection). An interesting point is that despite this intervening condition, which means that vowel-final verb stems normally get an infinitival ending containing a schwa, there are two vowel-final verbs stems that get only *-n* in their infinitives. These verbs are listed in (42a) and (43a).

(42)	a.	tun	[tʰʊ:n]	'to do'
	b.	(er) tut	[tʰʊ:t]	'(he) does'
	c.	(du) tust	[tʰʊ:st]	'(you (sing.)) do'
	d.	(ihr) tut	[tʰʊ:t]	'(you (plur.)) do'
	e.	(wir, sie) tun	[tʰʊ:n]	'(we, they) do'
(43)	a.	sein	[zaɪ̯n]	'to be'
	b.	(ihr) seid	[zaɪ̯t]	'(you (plur.)) are'
	c.	sei	[zaɪ̯t]	'be' (1st and 3rd pers. sing. conjunctive

By looking at the forms in (42b,c,d) and (43b,c) we can see that the verb stems of *tun* and *sein* indeed end in a vowel.[18] These verbs are exceptional in that they are not subject to condition (41). We will come back to this point in the next section.

5.5.2 Adjectives

Adjectives seem to behave differently from verbs. As shown in our overview in section 5.3 (more specifically, the subsection on adjectives, 5.3.2), schwa is found in a different place from verbal forms which are otherwise parallel to verbs like *zittern*, in relevant structure. Cf. the forms in (15), repeated here as (44).

(44) a.	dunkel	[dʊŋkəl] ~ [dʊŋk̩]	'dark'
b.	dunklen	[dʊŋklən] ~ [dʊŋkl̩n]	idem (adj. + case suffix)
c.	dunkle	[dʊŋklə]	idem (adj. + case suffix)

The fact that in (44b), we find the schwa to the right of the liquid, whereas in infinitives like *zittern* and *betteln* it is found to the left of the liquid, can be accounted for by the straightforward assumption that the adjectival marker is underlyingly *+ən*

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[18] The orthographic *d* in (43b) is always realised as *t* and must be assumed to be identical to the *t* ending in the corresponding form (42d). In (43c) we have listed a conjunctive form because the indicative present tense forms of *sein* corresponding to (42b,c,e) *(bist, ist, sind)* have another source and are provided by suppletion.

(possibly *+ə+n*, see below), instead of *+n*, as assumed by Wiese (1986, 1988).[19] This would also explain why the schwa in the adjectival case suffix *-ən* in forms like (44b) does not alternate with zero, in contrast to the infinitival *-(ə)n* ending, where as we have just seen in section 5.5.1, schwa is present only when it is brought about by syllabification. As mentioned in our comment on Wiese's criticism of Issatschenko (1974) (section 5.4.2), we think it does not come as an extension of the underlying segment inventory to posit two different underlying forms for infinitival markers and adjectival case markers which are mostly superficially identical.

Because of the fact that the attributive adjectival endings always contain a schwa (they can have the form *-ə*, *-ən*, *-əs*, *-əʀ*, *-əm*), it seems reasonable to consider schwa here as a separate attributive adjectival class morpheme (only present when the adjective is in attributive position), and to posit as morphemes *+n*, *+s*, *+ʀ*, *+m* (for respectively: (*+n*:) masculine singular accusative, dative plural, when preceded by an article in certain cases, (*+s*:) neuter singular nominative and accusative, masculine and neuter genetive, (*+ʀ*:) masculine singular nominative, feminine singular genitive, dative, plural genitive, (*+m*:) masculine and neuter singular dative). In this way, the inflection of the article and the adjective can be analysed as being constructed of largely the same case morphemes. Also the dative plural of nouns which end in *-n* can be considered as having the same case morpheme. In predicative position and in a non-head position in compounds, the adjectival class morpheme *-ə* does not show up, and the adjectives display their base form as in (44a), [dʊŋkəl] ~ [dʊŋk̩].

An additional motivation for the assumption that the adjectival inflection has a schwa underlyingly is given by forms where, without insertion of a schwa in another place (like in the adjective-noun pair *dunklen vs. Dunkeln*), the omission of the schwa would also produce a syllabically well-formed word. This is the case with the form in (45).

(45) schnelles [ʃnɛləs] *[ʃnɛls] 'fast' neuter nom. & acc. sing.

The form *[ʃnɛls] is *syllabically* well-formed. Another confirmation of the presence of schwa as a morpheme for adjectives is that even if an adjective ends in a vowel or glide, a schwa is found after this vowel, cf. (46).

(46) a. genauen [gənaʊ̯ən] (~ [gənaʊ̯n̩]) (*[gənaʊ̯n]) 'precise' (+ə+n, adj. + case)

b. hohen [ho:ən] (~ [ho:n̩]) (*[ho:n]) 'high' (+ə+n, adj. + case)

In contrast to the verbal infinitives (cf. section 5.5.1) there are no exceptions to this. The exceptionless presence of schwa in the adjectival paradigm in this case fits well

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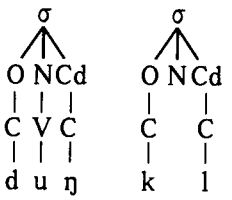
[19] We use here an abbreviatory linear notation, which in fact stands for a hierarchical structure involving skeletal and melodic elements. *ə* stands here for an empty V, later to be spelled out as *ə*. We will also use *ə* in this way below (when we mention underlying forms. When we refer to an "underlying schwa", this is also to be understood as meaning an underlying empty V.

into the assumption that it is an integral part of the adjectival inflection. The schwa in the case of infinitives, on the other hand, is epenthetic. It is a consequence of the obligatory presence of the two syllabic nodes by virtue of the metrical condition (41). If a verb is of the form CV:, this leads to an empty nucleus.[20] This empty nucleus is filled by the neutral vowel ə by default value assignment. The exceptional monosyllabicity of the infinitives *tun* and *sein* is the result of an idiosyncratic suspension of condition (41). If schwa, however, is part of inflection, like we propose for adjectives, its potential idiosyncratic absence would be much more difficult to account for. This is the desired result, because there are no adjectives like this. If it were indeed absent in some cases (this would mean that there would be monosyllabic inflected adjectives like *[ho:n] (cf. 46b)), and schwa is intrinsic in normal adjectival inflection, it would be very costly to account for this idiosyncratic absence of schwa: one would have to assume that the adjectival ending in these cases would be added at a lexical level preceeding the level of regular adjectival inflection (where the adjectival *+ə+* is added). This would mean that these endings would, for each case, have to be specifically stated in the grammar, including their form (they would have to be isomorphic to *+n, +r, +s, +m* for the relevant cases; for each of these endings, the isomorphism would be a complete coincidence). Hence, given these potential costs, and because schwa in adjectives is intrinsic, instead of epenthetic, we do not find forms like this.

It should still be explained what is the source of the schwa in the uninflected form in (44a), (*dunkel* [dʊŋkəl] ~ [dʊŋk̩] 'dark'). Here the schwa is epenthetic. Parallel to the infinitival form in (32) *(laufen)*, syllabification produces a syllable containing an empty nucleus:

(47)



(The velar nasal is represented as velar underlyingly. The point of articulation can also be analysed as the result of an assimilation process to the following velar plosive. On this see footnote 9). The empty nucleus is filled by a V on the skeletal level by default value assignment. Eventually this V is spelled out as schwa (but cf. our section on postlexical schwa/zero alternation 5.6).

A special case among the adjectives is the comparative morpheme, which always shows up as *-əR*. The question must be raised whether this morpheme contains an

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[20] As demonstrated in chapter 1, section 1.6.2, there are no short stressed open syllables in German. For the sake of a transparent exposition, we present underlying monosyllabic vowel final verb stems in German as containing a long vowel, because underlying short vowels in this position (which is usually stressed) would be lengthened anyway.

underlying schwa. To answer this question, we should look at the form (17), repeated here as (48):

(48) trockeneren [tʀɔkənəʀən] 'drier' (adj.+comparative+case)

The underlying shape of this the root of this form must be assumed to contain a schwa, because unlike in the adjective *dunkel*, this schwa turns up normally in normal adjectival inflection without the comparative morpheme:

(49) trockenen [tʀɔkənən] (~ [tʀɔkənn̩] ~ [tʀɔkn̩ən] ~ [tʀɔkn̩n̩])
(?[tʀɔknən], ?[tʀɔkn̩n̩]) 'dry' (adj. + case)

Given this underlying shape, the following form for the comparative without a schwa would be *syllabically* well-formed.

(50) *[tʀɔkənʀən]

The fact that this form is syllabically well-formed, but is nevertheless ungrammatical indicates that the comparative morpheme must also assumed to contain schwa. Hence it has the form *+əʀ*.

Two remarks should be made in order to counter arguments in favour of cyclic syllabification, which one could raise here. The first one concerns verbs derived from nasal final adjectives. The verb derived from *trocken* is given in (51):

(51) trocknen [tʀɔknən] ~ [tʀɔknn̩] 'to dry',
(*[tʀɔkənən], *[tʀɔkn̩n̩], *[tʀɔkənn̩], *[tʀɔkn̩ən])

The fact that there is no schwa to the left of the leftmost *n* (or: that this *n* cannot be syllabic) is not what our analysis would predict and this fact seems to be systematic because it also occurs with respect to comparable verbs. For this case, we assume that there must be a morphologically conditioned schwa deletion deleting a schwa in the environment: VC __ NV. A syncope rule like this is needed in German for some more cases, like for the adjectival form *offenes/offnes* [ɔfənəs] ~ [ɔfnəs] 'open' (see Wiese (1988: 172); Wiese assumes that for these forms Schwa-Epenthesis simply does not take place, although "the conditions for its application are fulfilled"). For this case of verbs, we believe that the obligatoriness of the rule is morphologically conditioned. Apart from this rather isolated case, our analysis shows that it is possible to analyse German schwa/zero alternation without morphologically conditioned phonological rule application. This instance cannot by itself be adduced as a case in point for cyclic syllabification, as this would produce the syllabified stem [tʀɔkən], from a stem of the form /tʀɔkn/, for both adjectives and verbs. As an additional specification to syllabification, one would have to state that it does not apply to lexical level 1 for verbs, but that for this category, syllabification would start at the level at which the infinitival morpheme has been added, /tʀɔkn+n/, producing [tʀɔknən] ~ [tʀɔknn̩]). Syllabification would, however, apply normally at level 1 for adjectives, producing [tʀɔkən].

This would boil down to making a category specific statement restricting the application of syllabification, which would deprive cyclic syllabification of its motivation here. Note that if one assumes a category specific condition on an otherwise independently motivated syncope rule (as we have indicated above), one only needs this statement without cyclic syllabification, whereas if one would like to assume cyclic syllabification in order to explain the lack of a schwa to the left of the leftmost *n* in the verb [tʀɔknən], one would need a category specific statement **as well as** cyclicity in syllabification. Occam's razor would therefore let us decide in favour of the former solution.

A second potential argument in favour of cyclic syllabification in German could be the substance morpheme appearing as *-(ə)n*, making adjectives out of substance nouns, as in the adjectives (with the *+ə* cases ending added) like in (52):

(52) a. silberne $^{emph.}$[zɪlbəʀnə] ~ [zɪlbɐ̯nə] 'silver' (< *Silber* $^{emph.}$[zilbəʀ] ~ [zilbɐ̯] 'silver')

b. kupferne $^{emph.}$[kʊpfəʀnə] ~ [kʊpfɐ̯nə] 'copper' (< *Kupfer* $^{emph.}$[kʊpfəʀ] ~ [kʊpfɐ̯])

c. lederne $^{emph.}$[le:dəʀnə] ~ [le:dɐ̯nə] 'leather' (< Leder $^{emph.}$[le:dəʀ] ~ [le:dɐ̯])

The forms in (52) contrast with the one in (53):

(53) goldene [gɔldənə] ~ [gɔldn̩ə] 'gold' (< *Gold* [gɔlt]).

The fact that there is no schwa immediately to the left of *n* in *silberne*, *kupferne* and *lederne* seems to suggest that the adjectivising substance morpheme has the form *+n*. The form *goldene* [gɔldənə], however, suggests that this morpheme has the form *+ən* (otherwise it would be only *goldne* ([gɔltnə] [gɔldnə]) (this form does occur as a result of syncope)). However, **silberene* (*[zɪlbəʀnə], [zɪlbɐ̯nə]),**kupferene* (*[kʊpfəʀənə], *[kʊpfɐ̯nə]) and **lederene* (*[le:dəʀne], *[le:dɐ̯nə]) are completely impossible. Therefore, one could think that syllabification is cyclic. When the adjectives are formed and syllabification applies on the level of substance adjectival formation, /zɪlbʀ+n/, /kʊpfʀ+n/ and /le:dʀ+n/ will come without a schwa immediately to the left of the final *n* (nor with a syllabic final *n*), but /gɔld+n/ will come out as [gɔldən] or [gɔldn̩] (because *dn* is not a possible coda).

However, this analysis would again lead to problems. It would mean that also the substance adjective *metallen* ([metalən] ~ [metaln̩] < Metal) (here again with a final case morpheme *+ə* added) would have to be *metal+n* and would *not* come out as *metallen* [metalən] ~ [metaln̩] after substance adjectival formation, but as **metaln* [metaln], because *ln* is a permissible coda (as in *Köln* 'Cologne'). Hence the form with a *+e* morpheme attached to it would be **metalne* [metalnə]. The only possible form is *metallene* and this formation is fully productive. In this the form contrasts with *kupferne*, *silberne*, *lederne*.

Closer inspection of the lexicon of German reveals that there is a class of substance adjectives on *-ʀn*. Most of the nouns on which these adjectives are based do not end in *-əʀ*, as do *Kupfer*, *Silber* and *Leder*. Examples are given in (54), with the substance noun to which they are related:

(54) a. blechern emph.[blɛçəʀn] ~ [blɛçn̩] 'tin' (< Blech [blɛç])
b. bleiern emph.[blaɪ̯əʀn] ~ [blaɪ̯n̩] 'leaden' (< Blei [blaɪ̯])
c. drähtern emph.[dʁɛ:təʀn] ~ [dʁɛ:tn̩] 'wire' (< Draht [dʁa:t])
d. eisern emph.[aɪ̯zəʀn] ~ [aɪ̯zn̩] 'iron' (< Eisen [aɪ̯sən] ~ [aɪ̯sn̩])
e. gläsern emph.[glɛ:zəʀn] ~ [glɛ:zn̩] 'glass' (< Glas [gla:s])
f. hölzern emph.[hœlt^{s}əʀn] ~ [hœlt^{s}n̩] 'wooden' (< holz [hɔlts])
g. steinern emph.[ʃtaɪ̯nəʀn] ~ [ʃtaɪ̯nn̩] 'stone' (< Stein [ʃtaɪ̯n])
h. stählern emph.[ʃtɛ:ləʀn] ~ [ʃtɛ:ln̩] 'steel' (< Stahl [ʃta:l])

This is a closed class, since formation of these substance nouns on *-ərn* is no longer productive. Note the form in (54d), *eisern* 'iron' (adj.). The noun from which this adjective has been derived has been stripped of its final syllable containing schwa, before *-ərn* has been added. We think that *silbern*, *kupfern* and *ledern* have been derived historically in the same way as *eisern*, and belong to the same closed class as the other adjectives shown in (54). Alternatively, they could have been formed by analogy to the adjectives in (54). In both cases, *silbern*, *kupfern* and *ledern* do not form counterexamples to our analysis, and we can continue to assume that the denominal adjectival substance morpheme is *-ən* instead of *-n*, and that syllabification is not cyclic.

5.5.3 Nouns

As mentioned above in the overview in section 5.3.3, the nominalised adjective in German behaves like the verbs with respect to the place where schwa can be found. Compare (15b) and (18), repeated here as (55a,b).

(55) a. dunklen [dʊŋklən] (~ [dʊŋkln̩]) 'dark' (adj. + case suffix)
b. (im) Dunkeln [dʊŋkəln] (~ [dʊŋkln̩]) '(in the) dark' (nominalised adj. + case)

In contrast to adjectives proper, the nominalised adjective does not contain a schwa between the liquid and the final *n*. Nouns proper also display this configuration, cf. (56).

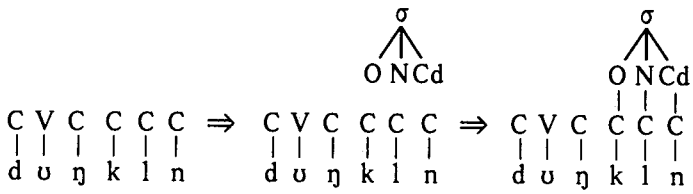
(56) a. (den) Richtern emph.[ʀɪçtəʀn] (~ [ʀɪçtn̩]) '(the) judges' (dative)
b. (den) Winkeln [vɪŋkəln] (~ [vɪŋkln̩]) '(the) corners' (dative)

It can be concluded that the nominal dative plural inflection (apart from plural formation) does not contain a schwa.[21]

One thing should still be explained. Recall from the preceding section, on adjectives, that the root of the adjective *dunkel* does not contain a schwa. Consider now the nominalised adjective in (55b). This form does contain a schwa. For (55a), syllabification applies on the underlying form /dʊŋkl+ən/. This word can be fully syllabified, without creating an empty nucleus.

This leaves us, however, with the question why we find schwa in the nominalised form in (55b). The answer is completely parallel to the explanation of the form the infinitives whose stems end in a liquid like *zittern* (cf. (35), above) take. Recall that we have made the explicit assumption that liquids can be lexically syllabic in German. The liquid is taken to be linked to the nucleus during initial syllabification:

(57)



This produces the form [dʊŋkl̩n]. The postlexical variation rule in (6) can optionally change this form into [dʊnkəln].

This concludes our analysis on lexical syllabification in German. We have accounted for the peculiarities of German schwa/zero alternation by two assumptions, namely that liquids, but not nasals, can be lexically syllabic, and that syllabification takes place lexically, but not cyclically. Furthermore, it was assumed that the adjectival inflection (including the comparative morpheme) contains schwa underlyingly, but that nominal and verbal inflection does not. We will sum up the advantages of our analyses over previous ones in our conclusion to this chapter, in section 5.7.

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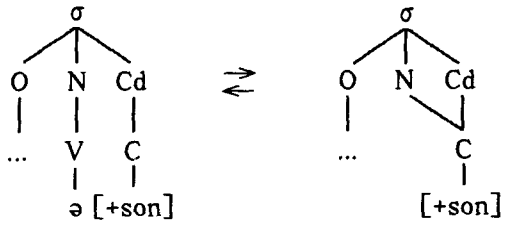
[21] In the case of a noun ending in a schwa + *n*, the dative plural does not get an epenthetic schwa, as we would expect. Rather, the dative plural nominal ending *+n* is degeminated, e.g., in *(den) Läden /lɛ:dən+n/ [lɛ:dn̩] (~ [lɛ:dn̩]) '(the) shops' (dat. plur.)*. Degemination is also found in certain other cases, e.g., in *(er) lädt (ein) [lɛ:t] '(he) invites'*. It is unclear up till now why in certain cases degemination takes place instead of epenthesis. We agree with Wiese (1988: 157) that this is an area for further investigation. Certain nominalised adjectives do contain a schwa in their final ending. These forms, however, have been nominalised *after the adjectival case ending has been added.* An example is *Näheres* 'more ample information' (literally 'closer').

5.6 Postlexical Schwa/zero alternation revisited

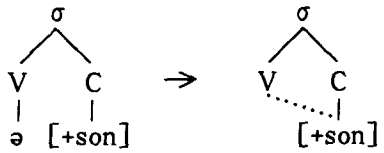
We now come back to the postlexical variation rule (6) posited at the beginning of this chapter. We mentioned that the rule was only preliminary in form. We repeat the rule here as (58).

(58) (= (6)) *postlexical variation rule*



Recall that this rule is in fact an extension (and adaptation to our framework) of Wiese's rule of Postlexical Schwa Deletion (5), repeated here as (59).

(59) (=(5) *Wiese's postlexical schwa deletion*



This rule is in fact fairly complex, because it does two things. It deletes schwa when a tautosyllabic sonorant consonant follows and lets the [+son] segment spread leftward to the V-node (in our framework this would be the nucleus node). Hence, the deletion part of rule (59) deletes schwas in places where they were first inserted in the lexical part of the phonology (recall that in Wiese's analyses even *all* schwas are epenthetic). If an analysis is viable in which for many cases, this insertion followed by deletion could be avoided, such an analysis would certainly be preferable. (As we have seen from the quotation in section 5.4.1, Wiese himself does not like very much the idea of insertion of schwa followed by deletion of the same element, as done in a more extensive way by Wurzel (1970) and Kloeke (1982)).

We now come back to our own provisional rule (58). This rule is even more complex than Wiese's postlexical schwa deletion rule. Apart from the double operation which the rule performs in its expansion with the rightward arrow, its leftward application involves two more operations: it severs the link between the C dominating the [+son] segment and the nucleus, and inserts a V dominating a schwa.

The fact that the postlexical variation rule (58) is so complicated and nevertheless expresses such a conceptually simple variation process is unsatisfactory. Some hope arises however, if we take a closer look at the operation expressed in rule (58). We see that both expansions of the rule contain duplications of the general convention of

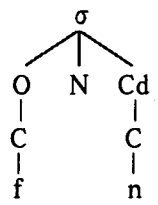
autosegmental phonology. For this, we have to recall shortly chapter 1, section 1.3. There, it was shown that there are basically two methods for filling a node that has remained empty after one-to-one association (mapping): either *spreading* takes place from an element already linked to a node either to the left or to the right of the empty node, or the empty node is filled by a neutral value *(default value assignment).* The examples of application of these processes in section 1.3 of chapter 1 concern empty onsets in French and German respectively. But in principle, the two strategies are available for linking elements on whatever two adjacent levels. We will show that a major part of the postlexical schwa/zero alternation is very elegantly explained if we assume that the spreading and default value assignment processes responsible for the alternation do not in fact take place between the levels of the subsyllabic nodes and the skeleton, but rather, between the skeleton and the melodic tier.

Recall that an empty nucleus can arise by syllabification. This nucleus is then filled in by a skeletal slot (V) by default value assignment. As we saw in the sections on lexical syllabification, a skeletal slot dominating a nasal melodic segment cannot be linked to the nucleus by lexical syllabification. Lexically, a nasal can only be linked to an onset or to a coda node. Consider now the form in (31), repeated here as (60).

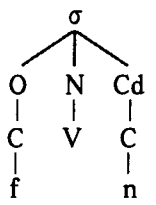
(60) laufen [laʊ̯fən] (~ [laʊ̯fn̩]) 'to walk'

As was shown in subsection 5.5.1, on the syllabification of verbs, lexical syllabification produces the syllable displayed in (61), as the second syllable of this form.

(61)

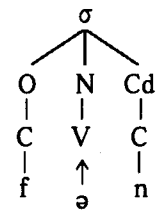


(62)

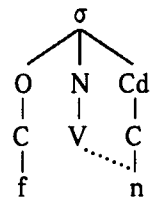


In section 5.5.1 we said that in this form default value assignment takes place (insertion of a V-slot in the nucleus). This then produces the form in (62) (see above). We mentioned earlier that postlexically, this V is in its turn filled in by ə, by postlexical default value assignment, cf. (63a).

(63) a.



b.



However, this is not the only thing that can happen. Also another strategy is available, *spreading.* This produces the form in (63b).

In (63b), the *n* spreads leftwards to the V-node. Recall that we stated in section 5.5 that nasals cannot be syllabic on the lexical level, but that postlexically, this restriction has been removed. We now see more precisely what the nature of the restriction's removal is. We postulate that postlexically, spreading and default value assignment become operative between the levels of the skeleton and the melody. With this assumption, it is not the *C* dominating *n* that can now miraculously be linked to the nucleus, but the fact that there is postlexical spreading between the melodic segment and an additional skeletal slot. In (63a), the default value is postlexically assigned to the empty V-slot, which is here, itself, the result of default assignment to the empty nucleus.

We see that, if we take (61) as the syllabified form, by the adoption of a two step default value assignment (V-slot insertion in the nucleus lexically, schwa assignment to the V-slot postlexically), the conventions of spreading and default value assignment operative on the postlexical level produce exactly the two outcomes of the variational process. This means that in order to explain the variation in (60), we do not have to have recourse to a special variational rule (58) at all.

For *R*, one thing should still be mentioned. Recall from section 5.2, that, according to many descriptions and analyses (Moulton 1962, Vennemann 1982, Benware 1986, Wiese 1988), an *R* preceded by a tautosyllabic schwa always becomes syllabic, except in very emphatic speech. Therefore, one should assume that the spreading convention takes precedence over the convention of default value assignment, while for all other cases, they are in free competition with each other.

As we already mentioned in the beginning of section 5.5, normal schwa (i.e., the schwa not alternating with zero) can be seen as an underspecified vowel. Hence, also this schwa (as found, e.g., in the adjectival inflection, see section 5.5.2) is the result of a postlexical default value insertion, but this time not by way of a two step process. Here, only the second step in the process has taken effect. We thus see that it is legitimate to see the default value assignment to the nucleus as a two step process, since the second step is independently motivated. We will come back to this in the conclusion to this chapter.

It can now be established that the rightward expansion of postlexical variation rule (58) is superfluous. The deletion part does not exist anymore, and the spreading part is simply the result of the availability of the postlexical operation of the general association conventions on between the skeleton and the melody. Which of the two conventions applies is a free choice. It is this choice that determines the phonetic shape of outcome (a syllabic sonorant or a schwa-sonorant sequence).

At this point it is appropriate to recall the structuralist point of view on this type of postlexical schwa/zero alternation. We have already quoted Moulton (1962) on this in section 5.2, note 5. According to the structuralist viewpoint, sonorant syllabicity and schwa are one and the same thing. Given our analysis, we see that this idea is by no means foolish. In our analysis, the sources of the sonorant syllabicity and the schwa

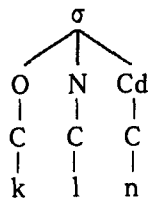
are identical: an empty V-slot at the end of the lexical derivation. Because the structuralists had neither the notion of phonological derivation nor that of hierarchical representation at their disposal, they could not express the identity formally. But, as one can now see, Moulton's point was well-taken.

One aspect of rule (58) is not covered by the just formulated postulation that spreading and default value assignment are operative postlexically between the skeletal and melodic tiers. This concerns the leftwardly applying expansion of this rule. As already mentioned, in this expansion this provisional rule severs the link between the nucleus and the skeletal element dominating the sonorant, and inserts a schwa. The delinking is necessary because, as we have seen, there are good reasons to assume that lexically, liquids, but not nasals, can be linked to the nucleus node. Yet, postlexically, syllabic liquids appear to alternate with schwa-liquid sequences. This is true at least for lateral liquids, but not necessarily for *R*. Recall again from earlier in this section and from section 5.2, that, normally, an *R* preceded by a tautosyllabic schwa always becomes syllabic (and vocalises in most varieties of German). Therefore, the delinking rule can be restricted to liquids. This type of operation is necessitated by the lexical syllabification of forms like (56b), repeated here as (64).

(64) (im) Dunkeln [dʊŋkəln] (~ [dʊŋkl̩n]) '(in the) dark' (nominalised adj. + case)

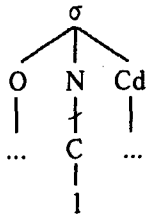
In (57), we have shown that the lexical syllabification of the rightmost syllable of this form is:

(65)



Here, the conventions of default value assignment and spreading do not help us any further in explaining the free alternation between schwa+sonorant and syllabic sonorant. We think that for this specific case, we do have the working of a specific rule, which delinks the *C* dominating *l* from the nucleus node. We formulate this rule as follows:

(66) *Lateral Nucleus Delinking*



One thing should still be said about what happens after the application of Lateral Nucleus Delinking. One could think that simple one-to-one association (mapping) could again link *C* dominating *l* to the nucleus. Thus, the application of mapping would simply reestablish the situations before the application of Lateral Nucleus Delinking (6). However, because of the general (meta-)convention (proposed by, among others, Odden 1981) that general conventions like the association (mapping) convention *may not recreate*, in the same stage of the derivation, links just destroyed by specific rules (in the same stage of derivation at least), the only way left to remedy the unlinked status of subsyllabic constituents and unlinked melodic elements is for alternative conventions (Spreading, Default Value Assignment, Dumping) to apply. Therefore, if Lateral Nucleus Delinking (66) applies, default value assignment will introduce a V as a skeletal element, and application of default value assignment one level lower will subsequently introduce a schwa. Dumping will link the *C* dominating *l* to the coda node.

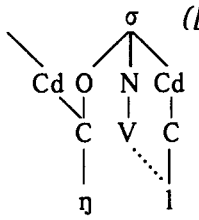
We have concluded that the Postlexical Variation Rule (58) is largely superfluous. The major part of the forms for which we provisionally posited this rule is explained by the workings of the default value assignment and spreading, postlexically applying between the levels of the skeleton and the melody. The only specific rule needed is that of Lateral Nucleus Delinking (66). This rule applies to a very specific category (lateral liquids). This is exactly what we would expect. Specific processes can be assumed to be the result of specific rules. General processes are the result of generally applying, cross-linguistic conventions. An additional advantage of lateral nucleus delinking over the provisonal postlexical variation rule (58) is, needless to say perhaps, the fact that it is a genuinely single rule, involving one, single, operation (but whose application is followed by the application of other, independently motivated, operations).

5.6.1 The Onset-Nucleus Contour Constraint

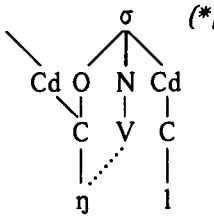
It should be noted that spreading in configurations like (61)) should take place only from right to left (i.e. from coda to nucleus position) and not from left to right (from onset to nucleus position). If it did apply from left to right, the form in (2n), repeated here as (67).

(67) Engel [ɛŋl̩] 'angel'

would receive as an additional possible pronunciation: *[ɛŋl]. The forms in (68) show the spreading operation in the second syllable for both forms.

(68) a. 

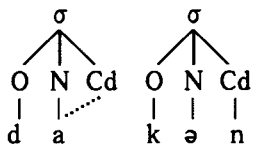
([ɛŋ$_{l}$])

b. * 

(*[ɛŋ$_{l}$])

The reason why spreading does not take place from left to right cannot be answered straightforwardly. There are at least four possibilities.

The first and least interesting one is that the direction of spreading is simply stated in the phonological grammar. This in itself would not be a revolutionary statement, given the fact that it has been shown that this direction should at least sometimes be stipulated, (recall the reversal of the direction of spreading in the history of Dutch, outlined in section 1.6.1 of chapter 1). However, this would be a language specific statement, and it would be preferable to have a more general principle from which the direction of spreading derives. Also, the direction of spreading would have to be stipulated specifically for specific cases, because of the fact that we do find spreading to the right in German. Rightward spreading from segments to the third position in the syllable occurred and occurs frequently in West-Germanic languages. This is illustrated by the Dutch case (36) of chapter 1, section 1.6.1, repeated here as (69).[22] Recall that in Modern Dutch, this process only takes place in lexical items that are diacritically marked for this direction of spreading.

(69) 

In Modern German too, we find a process of rightward spreading, and one that is more general than the Dutch one. Giegerich (1985: 58) (see also Wurzel 1981: 928-930, Lass 1976: 48ff, Kloeke 1982: 9-13, Meinhold & Stock 1980: 81) reports that under the influence of stress, tense vowels become long:

> In *'über,setzen* ('carry across') [y:] is long and tense under full stress while the corresponding vowel in *,über 'setzen* ('to translate') is short and tense [y] in absence of full stress [...].

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[22] We give here the representation as used in chapter 2, i.e., we abstract away from the skeletal slots. However, it should be noted that spreading in fact takes place here from the skeletal slot to the coda (i.e., one level higher that the spreading cases discussed above. The reason for this is that the coda cannot be filled by default segments in German. Therefore, one should assume that, in this case, default value assignment is not operative for the coda node and no default skeletal slot is introduced.

For this lengthening process Kloeke (1982: 13) formulates the following segmental rule:

(70) *Vowel Lengthening* (Kloeke 1982)[23]

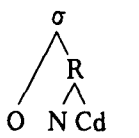
$$\left[\begin{matrix} V \\ \{ \begin{matrix} +\text{tense} \\ +L \end{matrix} \} \end{matrix} \right] \rightarrow [+\text{long}] \; / \; \left[\overline{\text{1 stress}} \right]$$

In our framework, such a lengthening process would be seen as a spreading process to the right, to the third position in the syllable. We thus see that a statement saying that spreading is leftward would have to be complicated in order to allow for rightward spreading for the vowel lengthening case determined by main stress.

The second possibility is merely a variant of the first one. In order to avoid rightward spreading, a condition against this spreading direction is posited. This condition would also not be particularly insightful, because, like in the above case, one would have to complicate this condition in order to allow for rightward spreading of a vowel to a third position in the syllable.

A third possibility is that the syllable structure is not flat like in, e.g., (69), but hierarchically structured, like in (71) (for further discussion on the choice between flat and hierarchical syllable structures, see in chapter 1: form (29) and footnote 9).

(71)



(R = rhyme)

If we assume this more conventional structure of the syllable than the flat one we have assumed so far, we could stipulate that spreading may take place only within the domain of the rhyme. Therefore, an element dominated by the onset cannot simply spread to the nucleus. This analysis has the clear theoretical advantage of a domain determined principle. A practical advantage is that the fairly specific prohibition against rightward spreading which we needed under the first analysis is no longer necessary. However, there are counter-examples against such a domain restriction. Recall the cases from Modern Dutch, Navaho and Wiyot, where there is leftward spreading from the onset position of a syllable to the coda position of a preceding one. An example was given in (38) of chapter 1, repeated here as (72).[24]

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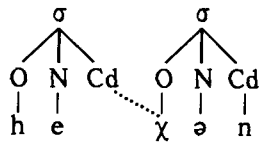
[23] Kloeke uses *[+ L]* to indicate the German the '<ä>-sound' ([ɛ]), which, although it is not tense, is also lengthened in a position bearing main stress. Examples include *Bären* [bɛ:ʀən] 'bears', *Dänen* [dɛ:nən] 'Danes', *gäben* [gɛ:bən] 'give' (conjunctive) (Kloeke 1982: 12).

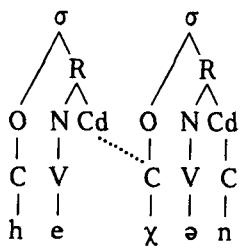
[24] Cf. note 22.

(72) *Modern Dutch:*



If the structure of this form is reanalysed as a hierarchical syllable structure like in (72), where there is a rhyme domain, we get (here with skeletal slots indicated):

(72')



We see here that χ has spread from the domain of the onset to that of the coda, whereby a possible rhyme domain restriction to spreading has been violated.

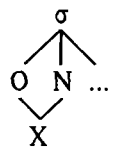
A fourth possibility is a constraint against a structure in which an onset and a nucleus of the same syllable are linked to the same segment. We think that this is the genuine reason for the fact that there is no rightward spreading from onset to nucleus. We formulate this restriction as the universal *Onset-Nucleus Contour Constraint*:

(73) *Onset-Nucleus Contour Constraint* (ONCC)

Tautosyllabic onset and nucleus nodes may not be linked to the same melodic element.

Note that this single statement entails the prohibition of two types of structure:

(74) a. *



b. *

In (74a), the X's refer to segments, or to be more precise, to skeletal slots. In (74b), the lower cases x's represent melodic elements.

The Onset-Nucleus Contour Constraint (ONCC) is motivated in several ways. First, there is simply an empirical reason. It is generally and possibly universally the case that segments may spread from a nucleus to a subsequent onset, but not from an onset to a subsequent nucleus. For an illustration, let us look at two instances of Spreading

mentioned in chapter 1, viz., the French example in (10, 11) and the German example mentioned in footnote 5. They are repeated here as (75) and (76) respectively:

(75) piano [pijano] 'piano'
(76) Hiat [hija:t] 'hiatus'

In both forms, the high vowel *i* has spread from the nucleus of the first syllable to the onset position of the second syllable, hence its realisation as *j* there (in fact, as we now know, the *i* has spread to a *C* which, because of the empty onset, is assigned by default value assignment; this *C* can itself be filled by default value assignment (in German: the glottal stop) or by spreading, which is the case we are discussing here). If we have the mirror image situation however, we cannot have spreading from the nucleus to the preceding onset. Compare the following words and abbreviations in Dutch, where the situation concerning the spreading of the high vowel is exactly the same as in French and German (both [pija:no:] and [hija:t] exist in the language):

(77) a. coïtus [ko:ʔitʌs] 'coitus'
b. stoïcijns [sto:ʔisɛɪns] 'stoic'

(78) a. A.I.O. [a:jo:] *assistent in opleiding* 'assistent in training'
b. O.I.O. [o:jo:] *onderzoeker in opleiding* 'researcher in training'

The pronunciations *[ko:jitʌs], *[sto:jisɛɪns], *[a:jio:] (or: *[a:jijo:]) and *[o:jio:] (or: *[o:jijo:]) are impossible.[25] This shows that independently from the fact we just now want to account for, i.e., that there is no spreading from the left in verbal endings like *-n* (see (9)), that there is a general restriction on homosyllabic spreading from the onset to the nucleus.

The second reason for assuming the ONCC is that it is generally observed that there must be a minimal difference between the onset and the nucleus. In the prototype of the syllable, the elements in the onset and the nucleus are as far apart as possible in degree of sonority, and therefore it has a form like *ta*, consisting of a voiceless stop (the least sonorous consonant type) and a low vowel (the most sonorous vowel type). In the case of a segment linked to both the onset and the nucleus, the difference in sonority is the absolute minimum: the only difference is the one provided by the dominance relationships themselves, i.e., the segment is realised as nonsyllabic in onset position (i.e., if the segment is a high vowel, it is realised as a glide), and is realised as syllabic segment in case it is dominated by the nucleus. It is perhaps here that we find the real reason why spreading cannot take place: an element cannot be syllabic and non-syllabic at the same time. Note that this is different from a spreading phenomenon from nucleus position to coda position (like the historical Dutch vowel lengthening case displayed in (13), above) because the coda is generally indiscriminate as to the segments it can contain.

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[25] It is equally impossible to pronounce the name of the Zambian statesman *Kaunda* (in Dutch as well as in other languages) as *[ka:wu:nda:].

A third motivation for the ONCC is that in many languages syllables starting with a glide followed by a homorganic high vowel are excluded. An example of such a language is French. In French, we do not find homorganic glide + high vowel sequences (like *ji*, *wu*, *ɥy*), although these sounds are in the phonemic inventory of French and *heterorganic* glide + high vowel sequences do occur in the language.[26] Although this restriction in itself does not provide direct evidence of the working of the ONCC, it does show that there is a very general tendency to avoid homorganic glide + high vowel sequences.

This tendency is also reported in the acoustical phonetic study by Kawasaki (1982: 24ff). He attributes it to the lack of spectral change in this kind of sequence (1982: 173). This seems to provide additional confirmation for the necessity of a minimal distance between onset and nucleus segments.[27]

We can conclude that, with the adoption of the ONCC, the independently needed spreading and default value assignment conventions (which we can assume apply postlexically) can account for the postlexical variation in German.

5.7 Conclusion

We have seen that it is possible to account for the schwa/zero alternations in German inflection as a direct consequence of syllabification. The main difference with the only other principled analysis offered, that of Wiese (1986, 1988), is that in the present analysis, there is no need to refer to grammatical categories in the statement of the domains of rules. Rather, it was assumed that of the suffixes for different grammatical categories some contain schwa, while others do not. It was shown that the infinitive marker has the form *-n* (without a schwa), the adjectival markers have the forms *-ə*, *-ən*, *-əs*, *-əʀ*, *-əm* (with a schwa (but recall that underlying schwa is in fact an empty V)), the comparative morpheme the form *-əʀ*, and certain nominal case and plural markers the form *-n*. Positing schwa in certain morphemes and not in others brings about a greater diversity in morphemes than assuming universally schwa-less forms of

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[26] Homorganic *ji* sequences do occur in French in a few loan words, e.g., *yiddish* and *yin*. Apart from these loan words in French, in English *ji* and *wu* sequences are perfectly possible: in *yeast*, *yield*, *woofer*. These French and English examples can be analysed as onsets and nuclei that are underlyingly linked to two separate melodic elements, since no spreading is involved. In that case they do not violate the ONCC.

[27] The ONCC is perhaps not an absolute universal. Wiese (forthc.) argues that for the 'hummed' vowels in Modern Standard Chinese (*pǔtonghuà*) are in fact syllabic consonants. They are the result of spreading from onset to nucleus position, since their quality can be derived from the preceding onset consonant. Also fast speech rules can sometimes violate the ONCC, as can be seen in German *haben* 'to have' which in fast speech can be pronounced [hamm̩]

the morphemes as done by Wiese. This is not at all strange. In fact, the picture is quite familiar in other languages displaying some degree of inflection. In the contrary, it would be quite novel if, as Wiese proposes, so many morphemes for different categories would have the same underlying phonological shape. To account for the difference in behaviour, Wiese proposes that the domains of application of a phonological rule (in this case, his rule of Schwa Insertion (19)) are specified in an extremely detailed way. This would make German essentially different from most other inflectional languages. In our analysis, German is in fact not that different from other languages. The difference in behaviour of the morphemes of different inflectional categories is the result of a difference in their underlying shape.

It should also be noted that in explaining difference in surface behaviour of elements, there is, in generative phonology (as well as in grammar in general), a movement away from rule specificity to differences in the lexicon, combined with general principles. Our analysis is in line with this movement, while Wiese in fact proposes a very specific rule domain specification (because of this specificity, his analysis is in fact less far removed from the linear analyses of Wurzel (1970), Kloeke (1982), Strauss (1982) as one would think at first sight).

In our analysis, no abstract elements (which themselves never show up phonetically) are posited (like Wiese's *X* elements); morphemes that show up uniformly as a single schwa are simply underlyingly an skeletal slot, which is spelled out as schwa by default value assignment.

This brings us to Issatschenko's analysis. Recall from section 5.4.2 that Issatschenko (1974) assumes two types of schwa, *schwa constans* and *schwa mobile*. Because, working in the structuralist framework, Issatschenko did not have the notion of phonological rule at his disposal, he posited these as two phonemes with the same phonetic shape. Wiese has raised the objection that in Issatschenko's analysis, where the notion of "morphophoneme" is used in order to explain the behaviour of the schwa *mobile*, it is only accidental that the two elements have the same phonetic shape. Apart from the fact that this coincidence would certainly not be fatal for Issatschenko's analysis (see our discussion of this in section 5.4.2), we see that we have actually removed this coincidence: there are not two different phonemes. As we have just seen in the preceding section, the phonetic value of both types of schwa is the result of the same default value assignment to a skeletal slot. The only difference is that for the epenthetic schwa (the *mobile*) the V to which the default value is assigned is itself the result of a default value assignment, i.e., assignment to the nucleus.

We thus see that in our analyses, the essence of Issatschenko's insight is maintained.

A further point should be made. In our analysis, we have used the working of default value assignment on two different levels, that of the subsyllabic nodes (like nucleus, onset) and that of the skeleton. The fact that we invoked the working of this principle on two different levels does not weaken our theory, but rather, it strengthens it. This is so for two reasons.

First, if we assume that default assignment is really a general principle, one would assume it to be operative on every level. We have seen it is (at least on the levels we have discussed).

Second, a single operation of default value assignment would, in the case of German schwa-epenthesis, insert a complex structure for a segment, i.e., a V dominating a̤n ə. This would boil down to inserting not only elements, but also association lines. On top of that, the insertion would be nonlocal in terms of tiers. The idea of default value assignment is more elegant and conceptually more sound if it is assumed that only an element directly one level down is assigned to a given empty element. This is precisely the case under the analysis we have just proposed: a default skeletal element is assigned to an empty subsyllabic node, a default segmental value is assigned to an empty skeletal element.

Finally, we would like to repeat the parameter settings of German syllabification, as shown in this chapter: the syllable in German generally is trinodal; all segments should be incorporated into the syllable structure; the direction of syllabification is right-to-left; and syllabification, although lexical as well as postlexical, is not cyclic.

5.8 Appendix: on the history of the German-Netherlandic dialect continuum

Above, in section 5.3, along with the data of German lexical schwa/zero alternation, we have listed some systematic differences between Standard German and Dutch. These concern the schwa in verbs and adjectives. We repeat them here. First look at verbs. The German verbs with stem-final liquids, given in (9), are repeated here as (79). Their Dutch equivalents in (10) are repeated as (80).

(79) a. zittern emph.[tˢɪtəʀn] (~ [tˢɪtn̥ʀn]) 'to tremble'
b. betteln [bɛtəln] (~ [bɛtl̥n]) 'to beg'

(80) a. sidderen [sɪdəʀən] ~ [sɪdəʀə]
b. bedelen [be:dələn] ~ [be:dələ]

German verbs with stem final nasals were given in (11), repeated here as (81). The Dutch counterparts (12) are given here as (82).

(81) a. atmen [atmən] (~ [atmn̥], *[atəmən]) 'to breath'
b. regnen [ʀegnən] (~ [ʀegnn̥] *[ʀegənən]) 'to rain'

(82) a. ademen [a:dəmən] ~ [a:dəmə]
b. regenen [ʀe:χənən] ~ [ʀe:χənə]

We see that in Dutch, a schwa is present in places where in German it has apparently been syncopated. The same contrast as between German and Dutch verbs is found

between German and Dutch adjectives. Compare the German form (15c) (here: (83)) and its Dutch cognate (16) (here: (84)):

(83) dunkle [dʊŋklə] (*[dʊŋkələ]) 'dark' (adj. + case suffix)
(84) donkere [dɔŋkəʀə]

In Proto-Germanic, the cognates of the Dutch and German schwas were full vowels. In the developent towards Common Germanic, there was a stress shift from a putative free stress to a dynamic initial stress. In the subsequent development, that towards Old West Germanic, a syncope process took place in the inflectional system, (known as Sievers' (1901) syncope law, deleting a short vowel following a heavy root syllable) cf. Gothic *kannida* - Middle Dutch *kande/kende*, changing the *-VdV* suffix of the preteritum to *-dV*)). Then, a vowel reduction took place, reducing unstressed vowels to schwa. This process is reported to have taken place in the Middle Ages (many descriptions of language history (e.g., Schönfeld 1970: 113, Van Bree 1977: 119) only give a cursory report on this). In Dutch, there were no further syncope processes.

However, in other dialects of German-Netherlandic, like High German, and even more so colloquial Austrian (for this, see Rennison 1980), there were indeed further syncope processes, the results of which have been the subject of this chapter. In these dialects, at the same time, the inflectional system was maintained to a much higher degree than in Dutch. The result was a synchronic schwa/zero alternation. We have shown above that this alternation can best be analysed in terms of epenthesis. Therefore, with other phonologists, (Rennison 1980, Wiese 1986, 1988), we assume that a reanalysis has taken place in the history of High German (and other dialects), "the earlier processes of vowel reduction and deletion haven been reinterpreted as a single rule of s[c]hwa-epenthesis" (Rennison 1980: 33). This reanalysis was possibly due to a lack of functional load of the schwa (for this notion, see Martinet 1960: 212). Unlike Wiese, however, we assume that not *all* schwas have been reanalysed as epenthetic. As we have seen, the schwas in the adjectival inflection, as well as those in the comparative and agentive morphemes have been maintained. In other inflections and in many word roots (like /dʊŋkl/), they have been erased as underlying elements (by underlying elements we include, of course, an empty skeletal V slot, which is spelled out as *ə*).

Considering inflection, an interesting question is why the adjectival inflection has evolved differently from the nominal and verbal ones. Consider once again the contrasting pair in (15b) and (18) (and in (55)), repeated here as (85):

(85) a. dunklen [dʊŋklən] (~ [dʊŋkl̩n]) 'dark' (adj. + case suffix)
b. (im) Dunkeln [dʊŋkəln] (~ [dʊŋk|n]) '(in the) dark' (nominalised adj. + case)

Our hypothesis is that this contrast is due to the metrical structure of larger prosodic constituents. We do not want to go here into the formalism of metrical theory, but the point we want to make is that inflected adjectives are almost invariably in attributive

position, i.e., in a position before the main phrasal stress. Cf. the German and Dutch forms in (86).

(86) a. das [dʊŋklə] Haus (Ger.) 'the dark house'
b. het [dɔŋkəʀə] huis (Du.) id.

For the Dutch form in (86b), many speakers of Dutch, including the author, have the tendency to elide the first schwa of the adjective in this pre-main stress position making it [dɔŋkʀə]. This elision is standard in poetry and songs, wherever it is required by the metre. It very probable that the same process was operative in the history of German. In predicative position however, as well as in the nominalised usage of the adjective, the main stress of the phrase is on the adjective. It is commonly observed that elision of a segment when the element to which it belongs (here: the phonological word) is in a position of main stress, is not likely to happen, because there is a resistance against the reduction of the number of feet.

6 Schwa and gliding in French

6.1 Introduction: the question of the status of schwa

Like German, French has highly interesting schwa/zero alternations. Unlike in German, these alternations have for the most part not been analysed as insertions. The reason for this is that the occurrence of schwa is generally not predictable: if in a certain place a schwa can be found, there are other, identical environments where schwa cannot appear. This can be seen in the forms in (1).

(1) a. place [plas] 'square, place'
b. pelouse [pəluz] ~ [pluz] 'lawn'

There can be a schwa between *p* and *l* in (1b). But there cannot be one in the for all intents and purposes identical environment in (1a).

This issue has lead to a fierce debate between linguistic schools. Structuralists like Martinet (1972) have heavily contested the phonemic status of schwa, because of its limited distribution (it does not occur word-initially, nor pre- or postvocalically) and because minimal pairs are hard to find. However, there are a few minimal pairs. We have just seen the near minimal pair in (1). Fully minimal pairs are shown in (2)-(4). ((2) and (3) have been taken from Verluyten (1988: 1), (4) from Tranel (1987: 854)).

(2) a. blond [blɔ̃] 'blond'
b. belon [bəlɔ̃] (kind of oyster)

(3) a. plage [plaʒ] 'beach'
b. pelage [pəlaʒ] 'hair'

(4) a. blette [blɛt] 'beet'
b. belette [bəlɛt] 'weasel'

(In (1b) we have seen that the schwa in *pelouse* is optional, while in (2b), (3b) and (4b) it is obligatory; we will come back to this shortly.) For generativists, the status of schwa is not decided on the availability of minimal pairs, but rather on the fact that no conditioning factor can be found by which most occurences of schwa can be predicted. This has led them to postulate that schwas are generally underlying in French.

Like the literature on German schwa/zero alternation, there is an extensive literature on the French case. In the generativist tradition, the standard linear treatment is Dell (1973, 1980, 1985). This author needs no less than ten deletion rules, a global constraint (in the 1980 and 1985 versions), as well as an epenthesis rule to account for the schwa/zero alternations (see Dell 1973: 258-259, 1980: 239-241, 1985: 263-265).

Several other analyses have been advanced since. The analyses are based on different explanatory principles. These principles concern: syllabic constraints (Anderson 1982, Noske 1982, 1988a), foot constraints (Selkirk 1982), rhythm (Bouchard 1981), syllabic prominence (Verluyten 1982, 1985), intersyllabic constraints (Morin 1982),

morphological factors (Dell 1973, 1980, 1985), speech style (Lyche 1979). For an overview, see Verluyten (1988) (see also Anderson (1982: 534) for a list of structuralist treatments).

In our treatment we will show that with help of the syllable assignment theory as laid out in chapter 1, in conjunction with a hierarchical representation of the syllable and the segments, it is possible to resolve the conflict between the structuralists and the generativists. We will show that although schwa is not fully predictable, it is predictable up to a certain degree.

6.2 Six types of schwa/zero alternation

It has been noted time and again that schwa/zero alternation in French is an extremely variable phenomenon. Nevertheless, it is possible to arrive at a typology. There are, roughly speaking, six types of apparent schwa/zero alternation in French, of which we present an overview here. For reasons of classification, we will refer in a pretheoretical way to them here either as deletions or, in one case, as an insertion.

6.2.1 Type A: prevocalic schwa deletion

The first two types we wish to mention concern the apparent deletion of schwa which is found in pre- and postvocalic position. We will first exemplify the alternation in prevocalic position, which we will call schwa/zero alternation type A. The following forms display the deletion of schwa.[1]

(5) a.	l'homme	/lə#ɔm/	[lɔm]	'the man', 'mankind'
b.	autre amie	/otʀ+ə#ami+ə/	[otʀami]	'other friend' (fem.)
(6) a.	le mari	/lə#maʀi/	[ləmaʀi]	'the husband'
b.	autre femme	/otʀ+ə#fam/	[otʀəfam]	'other woman' (fem.)

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[1] In (5a) and (6a), we have taken the feminine forms of *autre*, because it is possible to maintain that the adjectival stem does not contain a schwa and has the form /otʀ/. The schwa that does show up in the masculine form of the adjective, if followed by a consonant intial word within the same phrase, is then the result of an epenthesis process (schwa/zero alternation of type D, see below). If one assumes that the underlying adjectival stem in *autre* does contain a schwa, the underlying form of the adjective in (5a) and (6a) is /otʀə+ə/. In (5a) both schwas are deleted (by pre- and postvocalic schwa deletion (the latter is an instance of schwa/zero alternation type B, to follow shortly)), and in (6a) one the leftmost schwa is deleted by prevocalic schwa deletion. In (5a) the deletion of final underlying schwa is also an example of schwa/zero alternation type b. Note that the term "deletion" is used here only in order to systematically present the facts; it does not represent a theoretical stance on our part.

In the forms in (5), the prevocalic schwa has been deleted (in (5a) this is reflected in the orthography). In the corresponding forms in (6) where the schwa is in preconsonantal position, this has not happened.[2]

6.2.2 Type B: postvocalic schwa deletion

The second type of apparent schwa-deletion we would like to mention is postvocalic schwa deletion. We will call this type of schwa/zero alternation type B. Cf. the forms in (7), where the past participles, adjectives and nouns are followed underlyingly by a feminine gender marker *+ə*.

(7) a.	entendue	/ãtãdy+ə/	[ãtãdy]	'heard'	(fem.)
b.	jolie	/ʒɔli+ə/	[ʒɔli]	'pretty'	(fem.)
c.	risée	/ʀise+ə/	[ʀise]	'laughed at'	(fem.)

The forms in (7) can be contrasted with the corresponding other participial and adjectival forms to show that schwa is underlyingly present in the feminine forms of the adjectives and participles. However, there is a complication. In these forms too, schwa is deleted (in Standard French at least). Its presence can be traced because if there is no schwa underlyingly, final consonant truncation takes effect, cf. (8), (9).

(8) a.	plate	/plat+ə/	[plat]	'flat'	(fem.)
b.	jalouse	/ʒaluz+ə/	[ʒaluz]	'jealous'	(fem.)
c.	comprise	/kɔ̃pʀiz+ə/	[kɔ̃pʀiz]	'understood'	(fem.)
(9) a.	plat	/plat/	[pla]	'flat'	(masc.)
b.	jaloux	/ʒaluz/	[ʒalu]	'jealous'	(masc.)
c.	compris	/kɔ̃pʀiz/	[kɔ̃pʀi]	'understood'	(masc.)

In (9) the obstruents are deleted, but in (8) the deletion is bled by the presence of schwa. Today the consonant truncation process has become heavily morphologised. Nevertheless it provides us with the indication of what in linear phonology is traditionally seen as an underlying schwa.[3] Additional motivation for the presence of schwa is

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[2] The schwa is not deleted if it is followed by an *h aspiré* 'aspirated h' (sic), an element without phonetic content (except in certain Northern French dialects, where it may have the value [h]). In those cases (like *le haricot* [ləaʀiko] 'the kidney bean', *dehors* [dəɔʀ] 'outside', the schwa preceding this element is realised even if it is within the same intonational phrase. We will come back to this in section 6.4.5, footnote 13.

[3] In "Concrete Phonology" (Tranel 1981) this analysis is not accepted. Instead of a deletion of the final consonant in the masculine form, the feminine form is arrived at by way of suppletion. This entails a considerable extension of the information included in the lexicon because the quality of the final obstruent is not predictable. For this reason, Tranel's (1981) account is rejected by most phonologists.

that in southern (Midi) French, as well as in poetry, the final feminine marker schwa is not deleted.

6.2.3 Type C: schwa deletion in a two sided open syllable

The third type of schwa/zero alternation is perhaps the most general one, and for our analysis represents a core case. We will call this schwa/zero alternation type C. It concerns interconsonantal schwa deletion occurring word-internally, and stress group internally (as opposed to schwa/zero alternations at word edges and edges of a stress unit, to which we will come shortly). The schwa that is deleted is usually in the context VC CV and VC OLV.[4] Examples are given in (10) and (11). (For greater transparency and in conformity with the usage in the generativist literature on French schwa/zero alternation, the graphic *e*'s which are not realised have been barred, while the ones which are realised have been underscored; in the phonetic transcription, syllable boundaries have been indicated.)

(10) tu devenais 'you became' a. tu dəvənais [ty.də.və.nɛ]
b. tu dəvɇnais [tydəvnɛ] c. tu dɇvənais [tyd.və.nɛ]

(11) Henri devrait partir 'Henri would have to leave'
a. Henri dəvrait partir [ɑ̃.ʀi.də.vʀɛ.paʀ.tiʀ]
b. Henri dɇvrait partir [ɑ̃.ʀid.vʀɛ.paʀ.tiʀ]

The form is (11) can be contrasted with the one in (12), where schwa is obligatorily present:

(12) Jacques dəvrait partir [ʒakdəvʀɛpartiʀ] 'Jacques would have to leave'

The environment VC_CV is a familiar one. We have seen in chapers 3 and 4 that this environment, 'a two sided open syllable', is one that is typical for syllabically determined vowel/zero alternations. The fact that schwa/zero alternation in French also occurs in this environment strongly suggests that in French too, this alternation is syllabically conditioned.

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[4] We might also add the environments VCO___LV and VC___LGV. However, Morin (1982) shows that especially word-internally, the schwas in these environments do not usually alternate with zero. According to him the schwas have been "stabilised" (i.e. are of the nonalternating type (on this, see section 6.4.1 below). The alternation which word-internal schwas display in certain word categories in these environments (in verbal forms like *gard(e)rai* 'will keep' and *résist(e)rai* 'will resist' is treated by Morin as "morphologically conditioned". Below, in section 6.4.1, we will propose that the schwas that have been stabilised have a different structural status. Hence, there will be no need to refer to morphological conditioning.

6.2.4 Type D: schwa epenthesis in the environment CC]__[CV

The fourth type of schwa/zero alternation, which we call type D, concerns an apparent epenthesis which can occur inside a stress unit (which in French can be notoriously much larger than a single word). We get this in Standard French in the context CC]__[CV. See the examples in (13):

(13) a. un contact pénible [œ̃kɔ̃takt(ə)penibl] 'a painful contact'
b. un index formidable [œ̃nɛ̃dɛks(ə)fɔʀmidabl] 'a terrific index'

We also find this epenthesis in loan words adapted to the phonological system of French, as one of the spellings of the very word *schwa* in French illustrates, i.e., (14c):

(14) a. schwa [ʃva] b. chva [ʃva] c. cheva [ʃəva]

6.2.5 Type E: schwa deletion in phrase-initial syllables

We now come to two types of schwa/zero alternation which occur at the edges of a stress unit. There is an optional schwa deletion in the beginning of a stress unit. We will call this type E. A preconsonantal schwa following an initial consonant can be deleted with the possibility of leaving a highly marked onset cluster not found in other positions. This can be seen in (15) (Dell 1973: 227, 1985: 225).

(15) a. revenez [ʀəvəne] ~ [ʀvəne] demain 'come back tomorrow'
b. te fais [təfɛ] ~ [tfɛ] pas de bil 'don't worry'

Because of the possibility of creating highly marked onset clusters like *rv* and *tf* schwa-deletion in this position differs from schwa deletion at other places in the stress unit.

6.2.6 Type F: schwa deletion in phrase-final syllables

The sixth type of schwa/zero alternation, type F, seems somehow related to type E. Again it concerns schwa in a syllable at the edge of a stress unit, but this time at the right edge. Phrase-final schwas are also deleted if a highly marked coda cluster ensues. Examples are given in (16a) (Dell 1973: 236) and (16b) (the graphic *e*'s which are not realised have been barred):

(16) a. je vois l'autre [ʒəvwalotʀ] 'I see the other'
b. voilà mon oncle [vwalamɔ̃nɔ̃kl] 'there is my uncle'
c. la terre est plate [latɛʀeplat] 'the earth is flat'
d. la route est longue [laʀutɛlɔ̃g] 'the road is long'

There has been some debate at to whether forms like (16a,b) contain a schwa underlyingly. In some cases however, this is indisputable. In (16a) it is corroberated by the fact that *autre* can be feminine, hence contains the feminine marker *+ə*. Even if one would like to maintain that the root form is /otʀ/, the underlying feminine form should be /otʀ+ə/. In (16a) *l'autre* can be feminine and can nevertheless be pronounced [lotʀ] (or more precisely, [lotʀ̩]). This demonstrates that there is indeed schwa/zero alternation in this position. In the adjectives in (16c,d) the feminine marker schwa is clearly present.

We now will come back to type C, and will focus our attention on the exact nature of the syllabic conditioning of this alternation type.

6.3 Schwa/zero alternation in French as a syllabically conditioned phenomenon

The idea that French schwa/zero alternation is conditioned by syllable structure, is, given the huge amount of pregenerativist literature on the matter, relatively new. It has been advanced, albeit in an unformalised way, by Weinrich (1958: 251-260) and Pulgram (1961: 317).[5] It was subsequently advanced in a generative framework by Noske (1981, 1982, 1988a).

In these articles, we argued that schwa deletion in French is entirely the result of syllabic constraints. Although we have come to believe that other factors, like rhythm, must be involved, we maintain that syllable structure is the major conditioning factor. In our 1982 and 1988 articles we proposed two environmentless rules, one deleting schwa, the other gliding high vowels. The functioning of both rules is subject to two conditions: the *syllabification* and the *markedness* conditions (1982: 278, 1988: 62):

(17) *The Syllabification Condition*
The output of the environmentless rules must be exhaustively syllabifiable.

(18) *The Markedness Condition*
The environmentless rules *may not* apply if the syllabic markedness value of their output would be higher than that of their input, they *can* apply if the syllabic markedness value of their output is equal to that of their input, they *must* apply if the syllabic markedness value of their output is lower than that of their input.

The syllabic markedness value is computed by way of a table listing the markedness values of onsets and rhymes (in 1982, 1988 we used the term 'rhyme' instead of 'nucleus') which are then added, and to this sum a value 1 for each syllable is added.

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[5] The contributions by Weinrich and Pulgram have been brought to our attention by Morin (1987: 835). Morin quotes Pulgram (1961) erroneously as "Pulgram (1965)".

Today, we no longer believe that the markedness approach is explanatorily adequate. Although, as Verluyten & Bertels (1987) show, our account is certainly not inferior to others with respect to the correctness of its predictions (measured against transcriptions of monitorings of spoken French), we think the markedness as used in Noske (1982, 1988a) is not a primitive, but the result of other, more primary, factors.[6] This will become clear below. Also, for schwa deletion at least, the Syllabification Condition practically does the whole job and the Markedness Condition seems superfluous.[7]

In addition to all this, we feel that the approach whereby schwa is first syllabified, i.e., incorporated into syllable structure and is then again deleted is counterintuitive. It would be much better if the schwa/zero alternation in French could be analysed, not as a phenomenon only related to syllabification, but as a *direct result* of this process, just as we have done with the vowel/zero alternations in Tonkawa (Noske 1987 and chapter 3), Yawelmani (Noske 1985 and chapter 4), German (chapter 5). (And, as we have seen in the case of Yawelmani, also certain *consonant*/zero alternations are analysed in this way).

Therefore, we will focus our attention on the six types of schwa/zero alternation in French as outlined in the previous subsection, and consider how these alternations can be analysed as being the result of syllabification. It may then be that in these core cases other factors like rhythm are active which ultimately produce the alternation. Bearing this in mind, let us look in the literature to see whether proposals in this vein have ever been made before.

The only proposal we have been able to find where schwa/zero alternation in French is indeed analysed as the *result* of syllabification has been made by Tranel (1987). We will treat this proposal here briefly.

6.3.1 Tranel (1987)

Tranel (1987) is a proponent of the rule approach to syllabification. The specific syllabification model he proposes consists of several rules. The most basic one is the language-universal rule given in (19).

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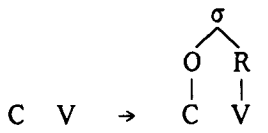
6 For criticisms of our (1982, 1988a) proposal see Spa (1987, 1988).

7 This concerns the fact that in the form *tu devenais* 'you became', the pronunciation *[tydvnɛ] is ruled out. In Noske (1982: 286; 1988: 72), this was explained by the computation of the markedness value (i.e., 5) for this form, while the pronunciations with one or both schwas realised received a lower markedness value (i.e., 4). Apart from being highly marked, the cluster *vn* is simply an illicit syllable onset, except in word initial position. In this position, a very wide range of onset clusters is allowed, like *tf* in *te fais pas de bil* [tfɛpɑdbil]. It seems that normal conditions on the coocurrence of segments in the onset are not applicable to this position.

(19) *Basic Syllable Formation* (Tranel 1987: 851):



Tranel claims that this rule corresponds to the 'CV rule' by Steriade (1984) and the Onset Creation Rule by Hyman (1984, 1985).[8] Tranel assumes that a schwa has not got the same structural representation as a full vowel. Whereas a full vowel has a representation as in (20), an alternating schwa has one as in (21a).

(20) skeleton: V where v is some vocalic value
melody: v

(21) skeleton: a. b. V
melody: ə []

In (21a), the schwa is floating, i.e., it is not linked to a skeletal slot. The form in (21b), on the other hand, represents a schwa which is linked to a skeletal slot. The former schwa cannot be integrated into syllable structure by Basic Syllable Formation, because the latter requires a V on the skeletal tier. The structure in (21b) represents a schwa which is always realised, as it is found in some forms. Examples of such forms are given in (1b), (2b), (3b), repeated here as (22a,b,c).[9]

(22) a. belon [bəlɔ̃] (kind of oyster)
b. pelage [pəlaʒ] 'hair' (of an animal)
c. belette [bəlɛt] 'weasel'
d. pelouse [pəluz] ~ [pluz] 'lawn'

The form in (4b), repeated as (22d), however, displays an alternation. This contrast is the result, in Tranel's opinion, of the fact that the forms in (22a-c) would contain the schwa with a structure as in (21b), while in (22d), the schwa would have the structure of (21a). What happens if a consonant-schwa sequence cannot undergo Basic Syllable Formation (because the schwa is floating, i.e., it has a structure as in (21a))? Then,

> ... the consonant will either syllabify leftward into coda position, as long as a rime precedes a nonsaturated coda (Morin 1974), or it will remain unsyllabified, if the preceding coda is saturated or if no rime precedes. If syllabified into coda position, the consonant will not require the assistance of schwa for its pronunciation, hence the derivation of

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[8] It is not clear what Tranel exactly means by "corresponds to". At any rate, Hyman's *Onset Creation Rule* is different from his *Basic Syllable Formation*. As we have seen in chapter 2 (form (1)), the former rule delinks a moraic consonant from its mora and links it to the mora of the following vowel.

[9] The stability of schwa in *belette* and *pelage* can be contested. According to the pronunciation dictionary of Warnant (1968) the schwas in these words are optional.

> forms like (10c), where the schwa is automatically realized as zero since it not integrated into a syllable (see Harris 1983: 35).
> (Tranel 1987: 851)

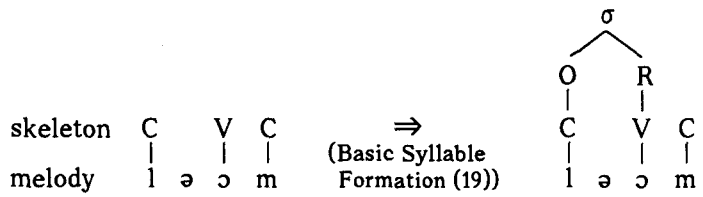
The form "(10c)" of Tranel's paper is given here as (23) (Tranel 1987: 849). It concerns the case where a consonant followed by a schwa is preceded by a vowel.

(23) à jeter [aʒte] (⇒ [aʃte] by voicing assimilation) 'to throw away'

In (23), the *ʒ* is syllabified into the first syllable. Unfortunately, Tranel does not provide the reader with a structural illustration how the syllabification of the consonant "leftward into coda position" exactly takes place. In particular, it is not clear whether he uses the term 'coda position' simply to indicate postvocalic tautosyllabic consonants linked to the rhyme, or whether 'coda' is a genuine node. Therefore, we cannot be clearer on this in our rendering of Tranel's theory.

The structure of the floating schwa in (21a) accounts for the apparent deletion of schwa in prevocalic position (alternation type A). There are no word initial, or intravocalic, schwas in French (our analysis of French syllabification to be presented below predicts they cannot exist, cf. section 6.4.5), hence all prevocalic schwas are preceded by a consonant. This gives the following configuration (taking the form in (5a) *l'homme*, as an example):

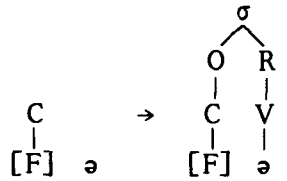
(24)



The schwa is 'bridged' by Basic Syllable Formation (19) which has only access to skeletal slots. In this way the syllable [lɔm] is formed and the schwa remains floating. (The *m* is incorporated into the syllable by "leftward syllabification into coda position", of which, as already mentioned, Tranel does not give an explicit account.)

If an unsyllabified consonant precedes the floating schwa, it is syllabified by a late, language-specific rule, with direct access to the melodic tier, *Schwa-syllable Formation.*

(25) *Schwa-syllable Formation* (Tranel 1987: 851)



The application of this rule take place in the form in (26a) (Tranel 1987: 846).

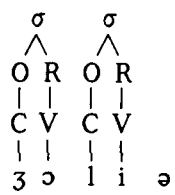
(26) a. une fenêtre [ynfənɛtʀ] 'a window'
b. la fenêtre [lafnɛtʀ] 'the window'

In (26a), the *f* cannot be incorporated into the first syllable (*nf* being an unpermissable coda). Therefore, the *f* will remain unsyllabified, until the late rule of Schwa-syllable formation (25) applies. This will create a V-slot dominating the schwa (which has now become a full-fledged segment) and the sequence *fə* is incorporated into syllable structure. In (26b), on the other hand, the *f* is syllabified into coda position of the first syllable. Schwa-syllable formation (25) cannot apply because its structural description is not met, and the floating schwa, because it is not incorporated into syllable structure, is not realised.

We see that by positing Basic Syllable Formation (19), Schwa-syllable Formation (25), as well as by invoking the principle of "leftward syllabification into coda position", Tranel accounts for part of the alternations of type C.

We can now see how Tranel's framework can account for the alternation type B, the postvocalic schwa deletion. A postvocalic floating schwa will not be in a configuration where it is preceded by an unsyllabified consonant, because at the point in the derivation where Schwa-syllable Formation (25) is applicable, Basic Syllable Formation (19) will already have applied, incorporating the previous vowel into a syllable. Therefore, there will be no unsyllabified consonant to the left of the floating schwa, and the structural description of Schwa-syllable Formation (25) will not be satisfied. As an illustration we take the form in (7b) (*jolie*), after the application of Basic Syllable Formation (19):

(27)

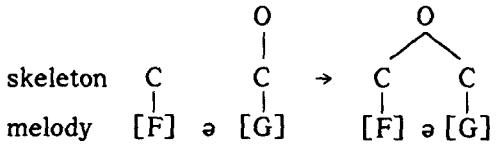


We now come to another type of schwa/zero alternation. For expository reasons, we first go to type E, the one taking place in the first syllable (cf. (15)), repeated here as (28).

(28) a. revenez [ʀəvəne] ~ [ʀvəne] demain 'come back tomorrow'
b. te fais [təfɛ] ~ [tfɛ] pas de bil 'don't worry'

Recall that schwa is optionally deleted in this position. For this, Tranel proposes yet another, apparently optional, syllabification rule, *Onset accretion across schwa*. This rule is given here in (29).

(29) *Onset accretion across schwa* (optional, restricted to phrase initial position)

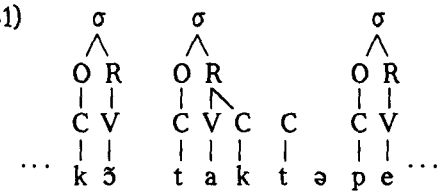


This rule, if it applies, should apply before Schwa-syllable Formation (Tranel does not specifically mention this).

As for type D alternations (the epenthesis case, cf. (13)), Tranel (1987: 855) supposes that there is in fact no epenthesis: "a floating schwa may be freely present at the end of words." This means that the form in (13a), repeated here as (30) has, after the application of Basic Syllable Formation and "leftward syllabification into coda position", the structure in (31).

(30) un contact pénible [œ̃kɔ̃takt(ə)penibl] 'a painful contact'

(31)



As for schwa/zero alternation of type F, (illustrated in (16), *je vois l'autre*, *oncle*, etc.), Tranel does not provide an explanation. The only way it could be explained is that "leftward syllabification into coda position" (which, as mentioned, he does not formalise) incorporates the second consonant (the *r* in both examples). This would leave the floating schwa unsyllabified and hence not realised. However, this type of "leftward syllabification into coda position" would have to be constrained to stress unit final position, because it would otherwise also function in word groups like *un contact pénible* (30), which as we have seen contain a floating schwa according to Tranel. In that case the schwa would never be realised, because the *t* would be incorporated into the coda position. Then, Schwa-syllable Formation (25) would not function, because there is no unsyllabified consonant left over. The only way this could be prevented is to include a very specific clause in the rule of Schwa-syllable Formation, stipulating that at the right edges of a stress unit, it may function in a broader way than otherwise and create complicated and highly marked consonant clusters. This equals positing a separate rule.

6.3.2 Criticism of Tranel (1987)

At first sight, Tranel's account, although it lacks explicitness, seems to be a nice explanation. It directly links syllabification and schwa/zero alternation. However,

there are two major drawbacks to his explanation.

The first one is inherent to the rule approach to syllabification. Recall from chapter 4, section 4.3.1, and chapter 5, section 5.3.4, the special rules that were used to incorporate unsyllabified segments into syllable structure. They are repeated here as (32) and (33).

(32) *Archangeli's Yawelmani Epenthesis* (= (12) of chapter 4)

$$\emptyset \rightarrow \overset{\sigma}{\underset{|}{X}} \; / \; \_\_ \; X'$$

(33) *Schwa Epenthesis* (Wiese 1988) (= (19) of chapter 5)

a. $\emptyset \rightarrow V \; / \; \_\_ \; X]_{word}$

b. Associate an empty V with schwa

Recall from the respective chapters that *X'* in Archangeli's notation and *X* in Wiese's mean an unsyllabified skeletal slot. The criticism that can be raised against these rules (apart from the one which we have already mentioned in chapters 4 and 5, i.e., the fact that their structural descriptions refer to a segment's unsyllabified status), is that they happen to create an output that is syllabifiable, whereas their input is not. A real link between syllabification and the existence of these rules is not established. Therefore, these rules form a *conspiracy* with syllabification itself in order to create a permissible syllable structure. Let us consider Tranel's rule of Schwa-syllable formation (25). In contrast to regular syllabification (i.e. the Basic Syllable Formation (19) and the coda syllabification into coda position (whose exact nature, as mentioned, remains a mystery)), Schwa-syllable formation (25) is a fairly specific rule, *especially devised* to incorporate floating schwas. This means that syllabification of the floating schwas does not come from general principles (or independent rules), but is the result of a rule that works *only* on the floating schwas. We see that there is a strange collaboration, or even a conspiracy, between the floating nature of schwa and Schwa-syllable Formation (25).

The second drawback of Tranel's analysis is that it cannot account for the variability of schwa deletion, especially, but not exclusively, in the case of several subsequent schwas. This can be seen in examples like (10), which we repeat here as (34), (35) and (36) (Dell 1973: 245; 1985: 248-249):

(34)	tu devenais	'you became'
(35)	la queue de ce renard	'this fox's tail'
(36)	il a envie de te le demander	'he feels like asking it you'

These forms have the following possible pronunciations (with syllable boundaries indicated by "." (the listings of possible combinations of realisations and nonrealisations of schwa are exhaustive):

(37) a. tu dɛ̲vɛ̲nais [ty.də.və.nɛ]
b. tu dɛ̲vɛ̸nais [ty.dəv.nɛ]
c. tu dɛ̸vɛ̲nais [tyd.və.nɛ]

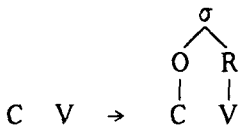
(38) a. la queue dɛ̲ cɛ̲ rɛ̲nard [la.kø.də.sə.ʀə.naʀ]
b. la queue dɛ̸ cɛ̲ rɛ̸nard [la.køt.səʀ.naʀ]
c. la queue dɛ̸ cɛ̲ rɛ̲nard [la.køt.sə.ʀə.naʀ]
d. la queue dɛ̲ cɛ̲ rɛ̸nard [la.kø.də.səʀ.naʀ]
e. la queue dɛ̲ cɛ̸ rɛ̲nard [la.kø.dəs.ʀə.naʀ]

(39) a. il a envie dɛ̲ tɛ̲ lɛ̲ dɛ̲mander [i.la.ɑ̃.vi.də.tə.lə.də.mɑ̃.de]
b. il a envie dɛ̸ tɛ̲ lɛ̸ dɛ̲mander [i.la.ɑ̃.vit.təl.də.mɑ̃.de]
c. il a envie dɛ̸ tɛ̲ lɛ̲ dɛ̲mander [i.la.ɑ̃.vit.tə.lə.də.mɑ̃.de]
d. il a envie dɛ̲ tɛ̲ lɛ̸ dɛ̲mander [i.la.ɑ̃.vi.də.təl.də.mɑ̃.de]
e. il a envie dɛ̲ tɛ̸ lɛ̲ dɛ̲mander [i.la.ɑ̃.vi.dət.lə.də.mɑ̃.de]
f. il a envie dɛ̸ tɛ̲ lɛ̲ dɛ̸mander [i.la.ɑ̃.vit.tə.ləd.mɑ̃.de]
g. il a envie dɛ̲ tɛ̸ lɛ̲ dɛ̸mander [i.la.ɑ̃.vi.dət.ləd.mɑ̃.de]
h. il a envie dɛ̲ tɛ̲ lɛ̲ dɛ̸mander [i.la.ɑ̃.vi.də.tə.ləd.mɑ̃.de]

In (38b,c) and (39b,c,f) the *d* has changed into *t* by regressive assimilation (but in (39b,c,f) it is not degeminated).[10] Tranel's account predicts that only the forms in (37c), (38c) and (39c) can occur. This is so because the *d* in both (37), (38) and the first *d* in (39) is taken into coda position and the *v* in (37), the *d* as well as the *t* in (3), and the *t*, *l*, and the second *d* in (39) remain unsyllabified. The reason for this is that the schwas are floating and Basic Syllable Formation cannot apply in these cases. Then the Schwa-syllable Formation (25) will take effect and will create the syllables *və* in (37), *sə* and *rə* in (38), *tə, lə* and *də* in (39). Tranel's account cannot produce the forms where schwas other than the leftmost are deleted (i.e., (37b), (38b,d,e), (39d,e,g,h), or forms where schwas apart from the first schwa have been deleted (39b,f). Finally, it cannot produce the forms in which all schwas have been realised. All in all, Tranel's analysis can only predict a small subset of the data.

Apart from these two main drawbacks, there are a couple of other problems connected to Tranel's analysis. Let us first look at the rule of Basic Syllable Formation (19), which we repeat here as (40):

(40) *Basic Syllable Formation:*



By its SD, this rule is not able to work on all forms it is intended to work on. The problem concerns onsetless syllables. If a (stress unit initial) word starts with a vowel,

[10] Dell (1973: 245, 1985: 248-249) does not display the voicing assimilation in his phonetic forms of (38), (39).

there is no possibility to realise it, because in order for Basic Syllable Formation to be able to function, a consonant should be obligatorily present. A sentence initial vowel, e.g., in *un homme se promène dans la rue*, 'a man is walking in the street', would not be realised. The problem can easily be solved by splitting up Basic Syllable Formation into two rules: one in which a full vowel (in Tranel's analysis: a skeletal V-slot) projects a rhyme and a syllable node, and a second one which adjoins a consonant to the left of the V-slot linked to the rhyme with the syllable (via the projection of an onset).

A second additional problem of Tranel's analysis is that he cannot really account for the presence of schwa in forms like (13a) (=(30)), *un contact[ə] pénible*. As we have seen, he postulates that an underlying floating schwa is always present in forms like these, including those where it is not shown in the orthography. Unfortunately, he cannot present words ending in clusters where this underlying floating schwa is not present. One need not be a hardline structuralist to conclude that in this case, the schwa is epenthetic, because it is apparently predictable. Tranel simply does not account for this.

Yet another problem is, as we have already seen, the fact that Tranel does not formalise the working of "leftward syllablification into coda position", as well as the fact that its possibilities of operation seem much greater at the right edge of a stress unit than elsewhere.

6.4 Syllabification in French in the Syllable Assignment Theory

Looking at the inability of Tranel's proposal to account for the optionality of schwa in many cases, including the core examples like *tu devenais*, one would think that accounting for schwa/zero alternation by analysing it as a direct result of syllabification is doomed to failure. This, however, is not the case. We will now show that it is possible to devise a syllabification model for French, which, by making use of the basic assumption of the syllable assignment theory proposed in chapter 2, can produce all the variants of core examples like *tu devenais*, as well as account for schwa deletion in prevocalic position.

6.4.1 The structures of the stable and the unstable schwas

First a word must be said about the structure of schwa. We have seen in the preceding chapter that the structure of an underlying schwa is an empty V-slot, whose phonetic value is filled in by default value assignment. We postulated this for German. Since in French, like in German, schwa is the neutral vowel, we think that in this respect the languages are similar and that therefore the same structure for schwa exists in French. Apart from normal schwa in French, which alternates with zero in certain

cases, we have seen above that there are examples of word-internal schwas which are completely stable, i.e., they do not alternate with zero. These schwas do not differ in their behaviour from normal full vowels. Therefore, these schwas, like full vowels, are linked to material in the melody (or, depending on the theory on featural structure one adheres to, to some material below the skeleton). This means that an alternating schwa in French has the representation as the structure as in (41a), while a nonalternating one has the structure as in (41b).[11]

(41) a. V b. V
        |
        ə

6.4.2 The nature of the assigned syllable and syllabification

Recall from chapter 1 that the kind of syllable which is imposed by syllabification, is a language specific choice. French, as noted by Schane (1972: 207-208) (cf. the Introduction), has CV as its preferred syllable structure. This is an indication that the imposed syllable structure is binodal, consisting of an onset and nucleus, cf. (42):

(42) *Syllable structure assigned by syllabification in French:*

Let us now look at the process of syllable structure imposition, which, as we have seen in the previous chapters, is analysed as a result of triggering processes. If we want to analyse the schwa/zero alternation in French as in the examples (33), (34), (35) (*tu devenais*, *la queue de ce renard*, *il a envie de te le demander*), there are two things that need to be incorporated into the triggering process of syllable structure imposition: (i) the optionality of the schwa in a great number of cases, (ii) the fact that in a sequence of syllables containing schwa, schwa can not be deleted in two consecutive syllables ("deleted" is used here in a pretheoretical sense; one could also say "not realised").

For the first point, the optionality, it would seem to be a good approach to have the optionality somehow *built into* the process triggering syllable imposition.

The second point, the fact that in a sequence of two potential schwas (ignoring intervening consonants), only one can be deleted, suggests that the realisation of

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[11] One of the characteristic features of French schwa (as opposed to full vowels) is its lack of stressibility (except in the direct object pronoun of an imperative: *fais-le* [fɛlə] 'do it'). It is not unlikely that this is also a result of the difference in structure between full vowels and schwa. This assumption leads to the question why, given the assumption that non-alternating schwas have the same structure as full vowels, we nevertheless do not find stressed schwas of this type. The answer lies in the fact that these schwas are never in word final syllables, whereas word stress in French is on the last syllable containing a full vowel.

schwa is dependent on whether an adjacent one has been realised. The information as to whether an adjacent schwa has been realised or not cannot be available in a syllabification process where all syllables are created simultaneously (and in which the optional realisation of schwa is decided). In contrast, in a process where syllables are created in a given order, this information is available.

We have seen in chapter 4 that in Yawelmani, iterative, directional syllabification precisely predicts the epenthesis sites. This suggests that a syllabification in a given order for French could indeed possibly account for the prediction of the right points where schwa should obligatorily be realised.

To formalise these insights, we would like to assume that the process of imposing syllable structure is the result of an ordered set of triggering processes. This is the language specific part of syllabification in French, although, as we will see, the ordering is conditioned by universal principles. Recall from chapter 2 that the syllable structure imposition is triggered by certain unsyllabified elements. As we have seen in chapter 3 for Tonkawa, these can be elements of a single category, e.g., in the case of Tonkawa, consonants.

An extension of this line of thought is that the triggering can take place by several types of elements, but that the triggering for each type takes place at a different time in the derivation, i.e., the triggerings by the different elements are ordered with respect to each other. This will be the core of our proposal for syllable structure imposition in French.

Before we go on and formulate our specific proposal, recall from chapter 2 that after the syllable structure has been imposed, *mapping* (i.e., one-to-one association) takes place as an automatic process. It has been shown (cf. section 2.2 of chapter 2) that although they are general conventions, *dumping* and *spreading* are not automatic processes, but that their application is a language specific and process specific choice. This is also true for the point in the derivation where these processes apply. For French, we postulate that they apply later than mapping. Our syllabification proposal for French is as follows:

(43) *French Syllabification*

a. syllable imposition triggered by as yet unsyllabified full vowels (including nonalternating schwas), followed by mapping;
b. *optional* syllable structure imposition, triggered by as yet unsyllabified
c. empty V's (alternating schwas), followed by mapping;
d. dumping;
e. syllable imposition triggered by consonants;

As other prosodic structure assignment, these processes are directional. However, there is no direct bearing of the directionality on most of the outcomes of the structural assignments. For this reason, we will postpone discussing directionality to later

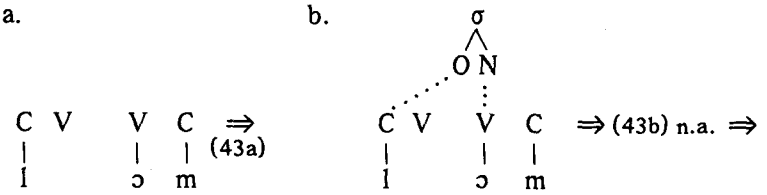
in this chapter, i.e., sections 6.5.2 (including subsection 6.5.2.2 on the directionality of dumping) and 6.7 (the conclusion to this chapter).

6.4.3 The alternation types A,C and D

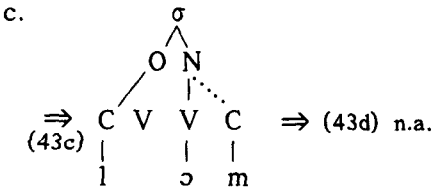
Let us now look at how this proposed syllabification model works on various forms and predicts the schwa/zero alternation. We first look at the case of a prevocalic schwa, i.e., alternation type A. Recall the example in (5), repeated here as (44). The syllabification of this form takes place as in (45).

(44) l'homme /lə*ɔm/ [lɔm] 'the man'

(45) a. b.



c.

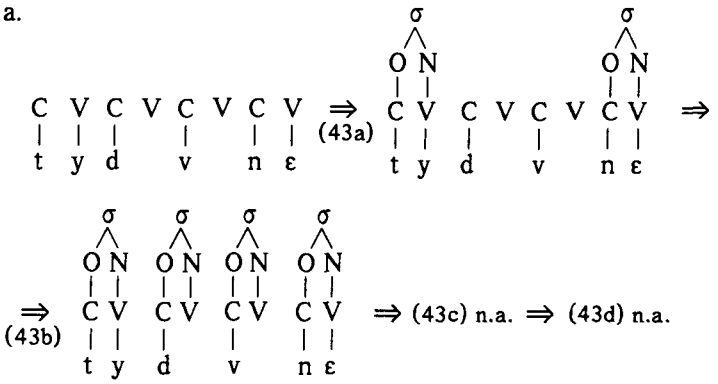


In (45b) the optional imposition of syllable structure triggered by schwas (empty V's) will not apply, because syllable structure has already been erected above the empty V with a link (between onset node and the C to the left of this empty V) and a link (between the nucleus node of the same syllable and the V to the right of the empty V. Therefore, because of the prohibition of crossing association lines, this empty V cannot trigger imposition of syllable structure in this case, because no free path is available between this V and the level on which the syllable structure is imposed. Put differently, the V cannot be 'sensed' anymore by the syllable structure imposition mechanism, hence no triggering can take place.

We now come to the example of *tu devenais*, i.e. alternation type C (alternation type B will be treated in section 6.4.5, below). We shall show how the different stages of the derivation work for each of the possibilities of schwa imposing a syllable structure. Recall that schwa triggers the syllable structure imposition optionally, so we have the following four possibilities: (i) both schwas (empty V-slots) in *tu devenais* trigger syllable structure imposition, (ii) the leftmost schwa (empty V-slot) triggers imposition but the rightmost one does not, (iii) the leftmost one does not trigger imposition but the rightmost one does, (iv) neither schwa (empty V-slot) triggers imposition.

First, let us consider possibility (i) – both empty V's trigger syllable structure imposition:

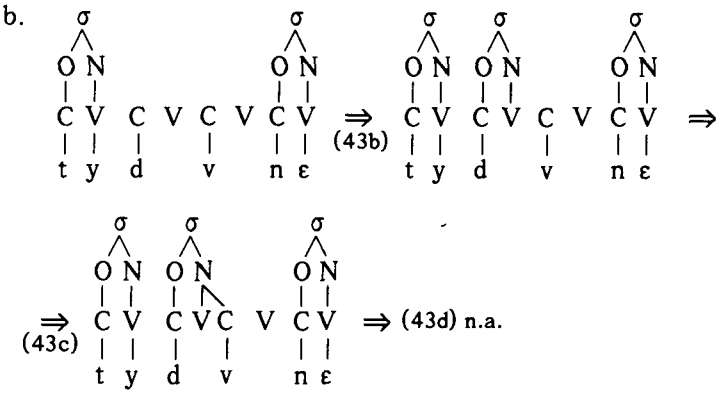
(46) a.



In this form, dumping (43c) and syllable structure imposition by consonants (43d) are not applicable because there are no unsyllabified consonants left after the application of (43b), the optional imposition of syllable structure triggered by empty unsyllabified V's. After the filling in of the default values for the empty V's, this form comes out as [tydəvənɛ], which is indeed one of the possible phonetic outcomes (cf. 37a).

Let us now consider possibility (ii) – the leftmost empty V triggers syllable structure imposition, but the rightmost does not. The first stage of the derivation of the form (imposition of syllable structure triggered by full vowels) is the same as in (46a); therefore we do not repeat it here. The difference starts with the application of (43b):

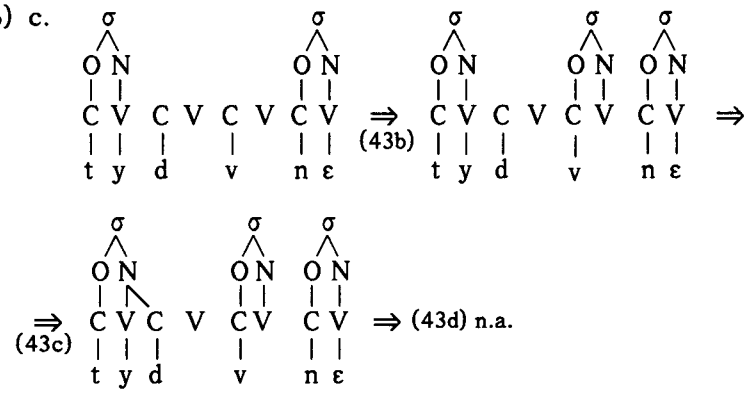
(46) b.



In (46b), when (43c) (dumping) takes effect, one C is unsyllabified and dumped to the nucleus node. This happens because the resulting syllable (CVC) is a permissible syllable in French, and does not violate the syllable structure conditions. Syllable structure imposition triggered by unsyllabified consonants cannot take place, because there are no consonants left which are not incorporated into syllable structure. Therefore, after default value assignment of schwa to the empty syllabified V, the outcome is [tydəvnɛ]. This is another of the possible realisations of *tu devenais* (cf. 37b). The second empty V has not been incorporated into syllable structure and therefore remains phonetically unrealised.

Let us now consider case (iii), that of the only the rightmost empty V triggering syllable structure imposition. Here, after syllable structure imposition has been triggered by full vowels (43a), we get the following derivation:

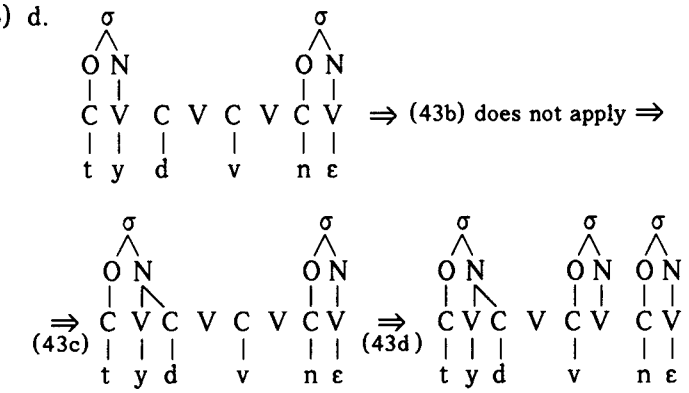
(46) c.



In (46c), the second empty V is incorporated into syllabic structure and subsequently dumping takes place of the *d* to the first syllable (the only place the syllable structure condition allows it to be dumped to). Again, syllable structure imposition triggered by as yet unsyllabified consonants does not take place, because there are no such consonants. The phonetic outcome of (46c) arising after default value assignment of schwa to the empty syllabified V, is [tydvənɛ], the third possible phonetic outcome of tu devenais (cf. (37c)).

Finally, let us consider what happens in case (iv), the case in which neither empty vowel triggers syllable structure imposition. We start again after the full vowels have triggered syllable structure imposition:

(46) d.



The last step shown in the derivation in (46d) shows the imposition of a syllable induced by the as yet unsyllabified C. The nucleus node of this syllable will be mapped to the V to the right of the C. The thus configuration created after the default value assignment of schwa to the empty syllabified V produces the outcome [tydvənɛ] (cf.

37c). We see that two different possible paths, (i.e., possibilities (iii) and (iv) lead to the same phonetic outcome, i.e., (37c).

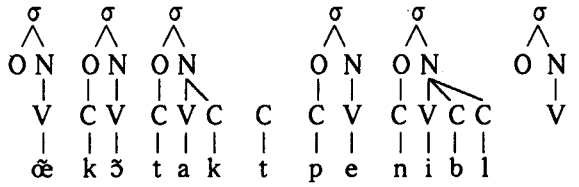
We have shown that the (non-)triggering of syllable structure imposition produces all the possible realisations of *tu devenais*. It is not difficult to also see that the forms involving more contiguous schwas in (34) and (35) (*la queue de ce renard* and *il a envie de te le demander*) all possible phonetic outcomes, as listed in (37) and (38), are produced.

We now come to the epenthesis case, i.e., schwa/zero alternation type D. We have seen that this apparent epenthesis takes place in the forms given in (13), repeated here as (47).

(47) a. un contact pénible [œ̃kɔ̃takt(ə)penibl] 'a painful contact'
b. un index formidable [œ̃nɛ̃dɛks(ə)fɔʀmidabl] 'a terrific index'

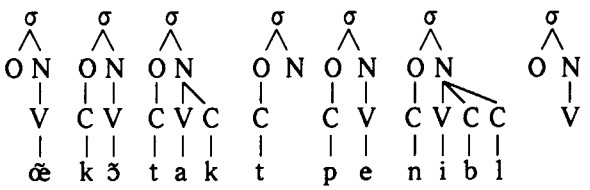
We take (47a). After syllabification (43) has reached its third stage, i.e., (43c) (dumping), the syllable structure will be:

(48) a.



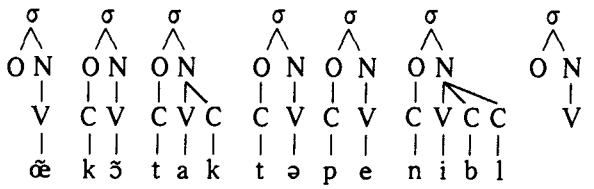
The focus of our attention is here the unsyllabified *C* dominating *t*, not the configuration of *ibl* at the end of the stress unit (to which we will come shortly, in section 6.4.5). We also postpone discussing the optionality of the appearance of schwa in the forms in (47) till section 6.4.5. Because of clause d. in (43), a syllable structure will be imposed, triggered by the unsyllabified C. The onset will then be linked to the C by *mapping:*

(48) b.



At this stage, we get a situation similar to one which we have encountered in German in the previous chapter. An empty nucleus is filled by V through *default value assignment*. Then, the empty syllabified V is filled in as schwa default value assignment, this time operating at one level down:

(48) c.



This explains schwa/zero alternation of type D in our framework. We have now accounted for the alternation types A,C and D.

6.4.4 Motivation for the ordering of the triggerings of syllable structure imposition

Before going on with the remaining types B, E and F, we wish to treat first a point of theoretical interest. It concerns the ordering of the application of the triggering processes in (42). The triggering processes themselves are not specific to French, but are universal to language, and are therefore of the same type as the ones presented in the previous chapters, involving syllable structure imposition in Tonkawa, Yawelmani, Tigrinya, German. But what is specific here is the *ordering* of the triggerings.

The question can be raised whether apart from the motivation to let this proposal work, other motivations can be found for the proposed ordering. For this, we have to consider a general observation made by many generative phonologists, namely that the order of rule application often reflects the order of historical development. This is particularly important with respect to the ordering of the syllable structure imposition by consonants.

The well-known process of consonant truncation in French at word endings is historically a syllabically conditioned process. It roughly had the effect of deleting obstruents in syllable-final position. The apparent reason was that syllable final obstruents were not allowed. Present-day truncation in French has been analysed in this way, among others by Spa (1975).[12] However, given the important and growing number of exceptions, it should be assumed that the present-day alternation cannot be considered a simple deletion, but should be analysed as a morphologised process. Historically, however, it should be seen in this way.

Using our syllabification model, this simply means that at that period in the development of French, like in many Romance languages, (i) syllable structure did not allow for a syllable final obstruent; (ii) consonants did not trigger syllable structure imposition. Later the restriction was relaxed, and the language allowed for syllable final obstruents. Also, as can be seen by the adoption of loan words as *contact*, even combinations of obstruents became permitted word-finally. These clusters can trigger

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[12] Spa (1975: 81, fn.3) indicates that also word-internal obstruents were not pronounced at a certain stage in the history of French. He cites the case of *espérer* [ɛspeʀe] 'to hope', which in the middle ages was pronounced [epere].

epenthesis in the case they are not at the end of a stress unit. This is exactly what we have seen in (48).

All of this means that French has changed fairly recently from a consonant deleting language to an epenthesising language. (Recall from our general introductory discussion in chapter 1 on segmental alternation conditioned by syllable structure, that if in a language morphology produces sequences of segments not allowed in syllable structure, either epenthesis or deletion takes place.)

This brings us to our actual point. Nowadays, as the epenthesis in (47) illustrates, consonants "demand" to be syllabified in French (only the consonants subject to truncation do not do so (hence the truncation), and their number is decreasing). This is a relatively recent innovation. It is therefore natural that the triggering of syllable imposition by consonants is ordered relatively late in the derivation, if there are more types of triggering. This is exactly what we have proposed, which seems to suggest that our analysis is genuine.

Apart from the motivation for the late ordering of the triggering of syllable structure imposition by consonants, there is also motivation for the relative ordering of syllable structure imposition by full vowels and the triggering of the same process by schwas. As already mentioned (cf. note 11), a schwa can never bear stress in French. This is equally true for primary stress as it is for secondary stress. This can be accounted for by stating in the phonological grammar that during the erection of metrical structure, schwa cannot be labeled as the strong branch of a foot. This, however, would require a fairly complicated machinery which would have to look at a quite specific quality of the syllable. This is otherwise not necessary in French, as stress assignment is not quantity sensitive in the language.

Another solution is available however: if it is stated that the erection of metrical structure takes place as soon as the initial syllable structure has been created, i.e. directly after the workings of (43a) (syllable structure imposition triggered by full vowels), the fact that schwa cannot be stressed falls out automatically. Foot construction, the first step in the erection of metrical structure, takes place on syllables. The schwas are not yet incorporated into syllable structure, hence cannot be part of metrical structure at the stage that the dominant branches are designated as such. This directly explains why schwa cannot be stressed. There is an additional reason to assume that stress assignment takes place immediately after the workings of (43a). We will come back to this when we treat schwa/zero alternation of type F, below.

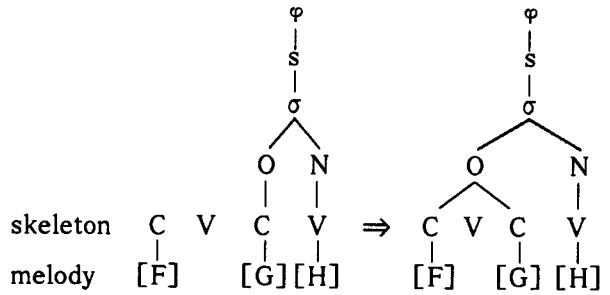
6.4.5 The alternation types E, F and B

We now come to type E, the deletion of schwa in the first syllable of a phrase. Recall the examples given in (15), repeated here as (49).

(49) a. revenez [ʀəvəne] ~ [ʀvəne] demain 'come back tomorrow'
b. te fais [təfɛ] ~ [tfɛ] pas de bil 'don't worry'

Our solution here is quite close to Tranel's. The assumption here is that there is an attraction process, attracting consonants in phrase-initial position to the following syllable. Because it takes place only at one end (here the left end) of a phonological phrase (or main stress unit) it must be metrically determined. Attraction under the influence of metrical structure is well documented in the phonological literature. See, e.g., Hoard (1971: 137-138) and Selkirk (1982) for similar processes in English. Elements are attracted to the syllable which bears the stress. Hence the *t* in *hefty* is syllabified into the former syllable: [hɛft.ɪ] (Selkirk 1982: 367). This attraction takes place as soon as stress has been assigned, i.e., after syllable structure imposition triggered by vowels (43a). The process has the following general effect in phrase-initial position:

(50) *Onset attraction* (in phrase initial position)



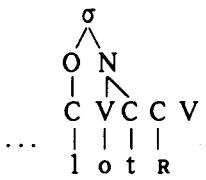
The attraction takes place presumably under the influence of secondary stress, and is therefore less strong than the one under the influence of main stress, which we will treat shortly. The result of the relatively weak attraction force is that the actual attraction only takes place optionally.

The schwa/zero alternation of type F – the apparent deletion of schwa at the right edge of a stress unit – is conditioned in the same way. Recall the examples given in (16), repeated here as (50).

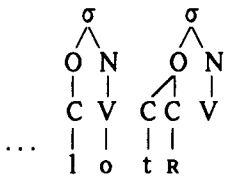
(51) a. je vois l'autr**ə** [ʒəvwalotʀ] 'I see the other'
b. voilà mon oncl**ə** [vwalamɔ̃nɔ̃kl] 'there is my uncle
c. la terre est plat**ə** [latɛʀɐplat] 'the earth is flat'
d. la route est longu**ə** [laʀutɛlɔ̃g] 'the road is long'

The attraction process is very similar to the attraction at the beginning of a phrase: an unsyllabified consonant at the edge of the phrase is attracted to the syllable at the word edge. Taking (50a) as the illustration, we see that the following configurations arises after the derivation has passed stage (42a) (= syllable structure imposition induces by full vowels):

(52) a.

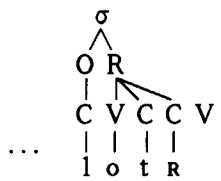


b.



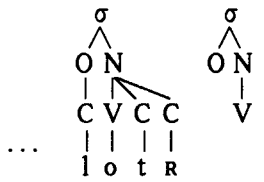
The attraction force here is stronger, and as a result the attraction is obligatory. This is so because the force is the result of the influence of the final, primary, stress. We now assume that the unsyllabified *C* dominating *t* and *r* in (51) is attracted into the final syllable of the phrase:

(53)



This produces the highly marked syllable ending *tr*.[13] If, after the attraction has applied, syllable imposition applies triggered by an empty V (schwa), then the following situation arises:

(54)



The empty V is linked to the syllable whose imposition it has triggered. We now see that there is no C available for the onset to be mapped to, because *t* and *r* are linked to the former syllable and are maintained there because the attraction force persists. The result is a syllable which has no genuine lexical phonetic content at all. By "lexical phonetic content" is meant phonetic information at the level of the melody. The only content it could get is the default value of V, viz. *ə*. However, there are reasons to assume that before it gets this default value because of the deficient character of the syllable, it is deleted (except in one style, to which we will come shortly). The deletion takes place by convention which we give in (55):

(55) *Deficient Syllable Erasure*
Delete any syllable devoid of lexical phonetic content.

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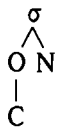
[13] Probably because of the highly marked status of this syllable ending *tʀ* is often simplified: *quatre* [katʀ] ~ [kat] 'four'. The deletion of *ʀ* in this environment is obligatory in certain dialects, like Quebec French.

This convention also explains why there are no word initial, or phrase initial, schwas in French, as mentioned in section 6.3.1: such schwas would be deleted automatically, because their optional (cf. (43b)) incorporation into syllable structure would automatically trigger Deficient Syllable Erasure (55). As a result the schwa, (more precisely: the empty V), because it is never realised, would disappear from the lexicon. Apart from a last syllable in (54), two other kinds of syllables would be deleted for the same reason:

(56) a. 

b. 

In both (56a) and (56b), the skeletal slots are not linked to melodic material. Although the skeletal slots contain some specific information (notably whether it is filled by C or by V), this *C* or *V* only contain information necessary for subcatorisation as to which subsyllabic node the skeletal slot can be linked. The C/V information can also be considered as information partially equaling major class features in purely linear phonology. These are clearly features having to do with higher level organisation, and do *not* convey specific phonetic information.

It may seem unnatural that an element is inserted and then again deleted. It should be noted, however, that the processes of syllable structure imposition and the mapping of the skeletal slots to the subsyllabic nodes are independent of each other. It is a logical consequence of this that the deletion of syllable structure can occur after its imposition.

We now recall shortly the two examples given in (47) in section 6.4.4. They are repeated here as (57):

(57) a. un *contact pénible* [œ̃kɔ̃takt(ə)penibl] 'a painful contact'
b. un index formidable [œ̃nɛ̃dɛks(ə)fɔʀmidabl] 'a terrific index'

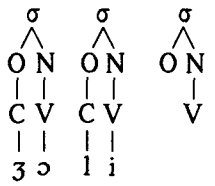
The appearance of the syllable-final stop-liquid clusters *bl* and *dl* in these examples are explained in a way fully parallel to the *tʀ* cluster in *l'autre*. We still have to account, however, for the optionality of the appearance schwa in *contact(ə)*, *text(ə)* in these forms. The explanation is the following: depending on speech style, the stress domains can vary in French. In the case of (57), the forms may contain a single stress domain (in which case the schwa is inserted as explained in section 6.4.4 (see (48)). In another speech style, these forms may each contain two stress domains. For (57a) these will be: *un contact* and *pénible*, for (57b): *un texte* and *formidable*. If there are two domains in each case we are faced with a situation as found in (52)-(54), where a consonant cluster is found at the end of the stress domain. Therefore in these latter cases, attraction of *t* to the former syllable will take place, parallel to the attraction of *ʀ* in *autre* in (52)-(54).

We now come to type B of the catalogue of schwa/zero alternations, and we will see that Deficient Syllable Erasure (55) also accounts for this alternation type. This because schwa following a vowel is never realised. This can be seen in (7), repeated here as (58).

(58) a. entendue /ɑ̃tɑ̃dy+ə/ [ɑ̃tɑ̃dy] 'heard' (fem.)
b. jolie /ʒɔli+ə/ [ʒɔli] 'pretty' (fem.)
c. risée /ʀise+ə/ [ʀise] 'laughed at' (fem.)

The schwa is phonetically not realised in these cases. Our syllabification algorithm (43), however predicts a optional syllable structure imposition for the schwa. This will then give rise to the following structure in the case of (59):

(59)



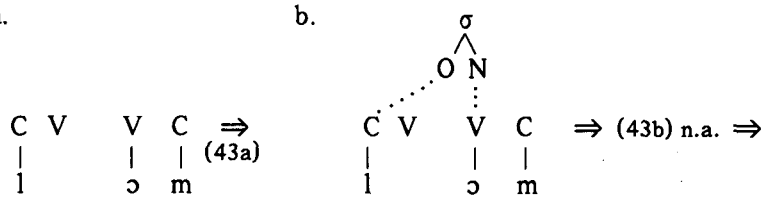
The empty V is linked to the syllable whose imposition it has triggered. We now see that there is no C available for the onset to be mapped to. Therefore, Deficient Syllable Erasure (55) will take effect here.

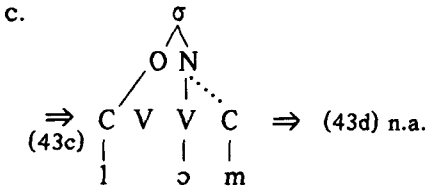
We mentioned above that there is one specific style in which the deletion does not take place. This style is poetry and related styles like the versification used in songs in serious music. Indeed in French verse, the words in (58), *entendue*, *jolie* and *risée* all contain three syllables, the final ones being only schwas. Equally, the schwas of alternation type E, displayed in (51) (*l'autre*, *oncle*, *longue*, *plate*), are realised in French verse. This is another indication that a syllable was originally built which in the case of verse was maintained. It should be assumed that in French verse, Deficient Syllable Erasure (55) is simply not operative.

This assumption leads to an interesting prediction: an empty V, which has never been incorporated into syllable structure by virtue of (43b) will not be realised as ə in poetry. Prevocalic schwa deletion (type A) presents such a case. Cf. the example in (44), repeated here as (60). The syllabification of this form was displayed in (45), repeated here as (61).

(60) l'homme /lə#ɔm/ [lɔm] 'the man'

(61) a. b.





As we see, the empty V in prevocalic position does *not* trigger the imposition of a syllable structure (In this position the empty V itself is always preceded by a consonant, hence a syllable is built over it by association of the onset node which is part of the syllable imposed by (43a)). This fact accounts for the absence in poetry of phonetic forms like *[ləɔm] for (60), whereas the fact that postvocalic schwas are linked to syllable structure at one stage of the derivation explains why we do find in poetry phonetic forms like *[ãtãdyə] for (58a).[14]

6.5 On the organisation of the phonological grammar

French, we should consider the theoretical implications of our proposal, against the background of the syllable assignment theory presented in chapter 1 and the analyses of syllabification and syllabically conditioned alternations of other languages presented in chapters 3 to 5.

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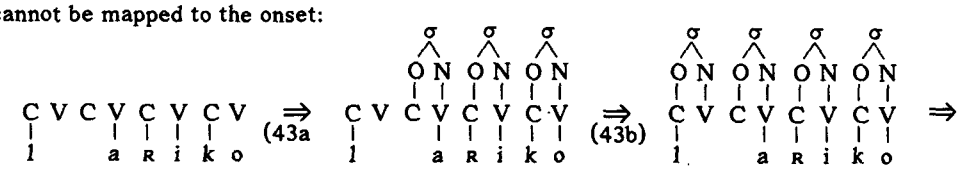
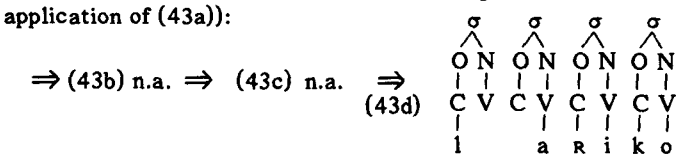
[14] Words containing a so-called *h aspiré* 'aspirated h' (sic), already mentioned in section 6.2.1, note 2, like *la haricot* [laʀiko], *[laʀiko] 'the kidney bean', can be analysed as containing a C on the skeleton which is not linked to an element on the segmental tier. This element will be mapped to the onset (but will not receive a phonetic value), and therefore the *l* cannot be mapped to the onset:



⇒ (43c) n.a. ⇒ (43d) n.a.

If optional syllable structure imposition triggered by empty V's does not apply, the first syllable of the form will be imposed by virtue of (43d) – syllable structure imposition triggered by consonants (here the C dominating *l*). The derivation in this case is (after the application of (43a)):



Both possibilities, application and non-application of (43b), lead (after the filling of the empty V with its default value, ə) to the same outcome, [ləaʀiko].

The account of the French schwa/zero alternations differs from the account of the segmental alternation in Tonkawa, Yawelmani and German on two important points. The first point is that there is an ordering of the different types of triggerings of the imposition of syllable structure, determined by the character of the triggering element. The second point is that we did not specify here the direction of syllabification (we will come back to this in the conclusion to this chapter, section 6.7).

6.5.1 The ordering of the triggerings of syllable structure imposition

Concerning the first point, let us recapitulate the role of the ordering in the triggerings of syllable structure imposition in French. French syllabification as presented in (43), consists of the imposition of a syllable structure triggered by a full vowel. This is followed by mapping (one-to-one association) between the skeletal tier and the tier containing the subsyllabic constituents. Then, optional imposition of syllable structure takes place triggered by V's unlinked to the skeletal tier. After this, dumping takes place, and then syllabification triggered by as yet unsyllabified consonants.

All the mechanisms in the account of French syllabification also occur in the other syllabification proposals presented in previous chapters. As already mentioned in section 6.4.4, the difference between syllabification in French and syllabification in the other languages is a difference in *configuration* of these mechanisms with respect to each other. In other words, the difference does not concern the fact *whether* a certain principle is operative in a given language (in this case, French), but what its *position* is in the organisation of the phonological grammar. Thus, for example, in French, dumping takes place after syllabification triggered by full vowels and empty V's, but before syllabification triggered by consonants. In the other languages, dumping takes place only after triggering of syllable structure imposition by all kinds of segments (except that, as we have seen, in Tonkawa syllable structure imposition is not triggered by consonants at all). Hence, on the (meta-) level of principles, the difference between the languages is formal rather than substantive.

In fact, it is not only French syllabification that differs in a formal way from those of the other languages, but also, e.g., syllabification in Tonkawa (chapter 3), the only language of the four analysed in the present work in which syllabification applies cyclically. Cyclicity is also a formal property of the organisation of principles with respect to each other.

This brings us to a point already alluded to in the introduction of the present work. In the past decade, the principles and parameters approach has been developed as an explanatory tool for differences among languages. A parameter may have been switched "on" or "off" in a given language, or may have the value of another type of polarity (like "leftwardly applying" or "rightwardly applying"). An example of such a parameter is the direction of syllabification or of other prosodic structure assignment

("leftward" or "rightward"). In syntax, a well-known parameter is the Pro-Drop parameter ("on" or "off").

A modification to this approach has been advanced by Huang (1982) and Muysken (1989: 134-135) and Lefebvre & Muysken (1988).[15] The extension concerns the configuration of the modules of the grammar with respect to each other. In their view, it is the organisation of the grammar, i.e., the way the modules (or principles) are configured with respect to each other, and not only the parametrically determined application of the principles, which is supposed to be different for different languages. The organisation of French syllabification as we propose it, vis-à-vis syllabification in, e.g., German, fits precisely in this view of the formal properties of grammar.

6.5.2 The question of directionality

Apart from the organisation of the principles with respect to each other, our account of French syllabification differs from that in the other languages treated in this work on a second point: the directionality. For the other languages, we have been able to specify the direction of the application of syllabification.

As we have seen in chapter 4, sections 4.4.1 and 4.4.2, the motivation for the direction of the syllabification can be based on three points: (i) the location of the epenthesis sites (ii) the location of the deletion sites and (iii) the direction of the maximalisation of clusters, i.e., onset or coda maximalisation. Since only schwa can be deleted in French, prevocalically (type A) as well as postvocalically (type B), the criterion of the location of the deletion sites will be of no avail in determining the direction of syllabification. The other two criteria cannot be used either to determine the syllabification in French, since both directions would create the correct syllabic structures. We will first demonstrate this for epenthesis, and then for cluster maximalisation.

6.5.2.1 The criterion of the epenthesis site

Concerning epenthesis, we have seen in chapter 4, section 4.4.2, that for a language where the maximal syllable is CVC, in an environment VCC, the epenthesis site is between the first and the second C if syllabification takes place from right to left, and is after the second C if syllabification is takes place from left to right. Equally, in a sequence VCCCV, the epenthesis site is between the first and second C if syllabification is leftward, but between the first and second C if syllabification is rightward.

For French, however, a change in direction does not change the epenthesis site. This is so for two reasons. The first reason is that first full vowels have triggered syl-

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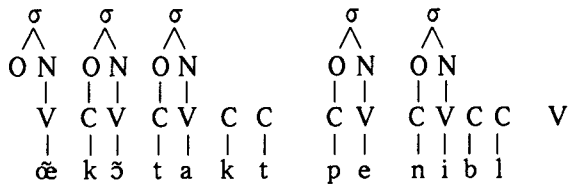
[15] Huang (1982) argues that for Chinese, wh-movement should not be part of syntax, but of logical form. This implies that the configuration of the modules in the grammar of Chinese is different in this respect from that in the grammar of, e.g., English.

labification and then (after the subsequent application of mapping and dumping) only syllabification triggered by leftover (as yet unsyllabified) consonants. Because mapping and dumping take place throughout the phrase *before* the triggering of syllable structure imposition by leftover consonants, the question of which consonant of two adjacent consonants is syllabified first is not determined by the direction of the process of scanning for unsyllabified skeletal elements in (43b) and (43d), but on the question regarding which of the consonants has already been incorporated in syllable structure by mapping or dumping at the time when syllable structure imposition by leftover consonants (43d) applies. Let us take the epenthesis in (13) (repeated in (47) and here in (62)).

(62) a. un contact pénible [œ̃kɔ̃takt(ə)penibl] 'a painful contact'
b. un index formidable [œ̃nɛ̃dɛks(ə)fɔʀmidabl] 'a terrific index'

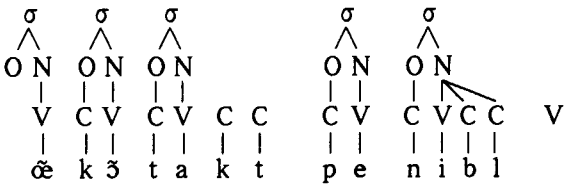
We have already shown part of the derivation in (48). We return to this derivation here and now start at an earlier stage. After the imposition of syllable structure (43a) triggered by full vowels and one-to-one mapping, the syllabic structure of (61a) is as in (63a).

(63) a.



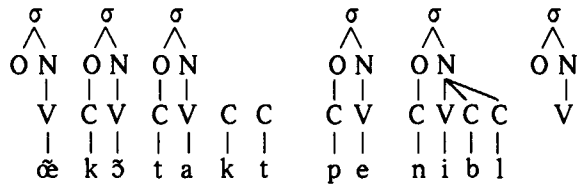
Then stress will be assigned, as pointed out in section 6.4.5. The syllable containing *i* will receive main stress and as a result of this, as shown in the same section, the C's dominating the *b* and the *l* will be attracted to this syllable:

(63) b.



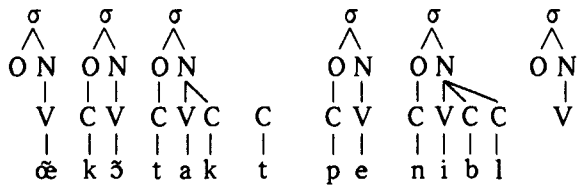
Then, (43b), syllable structure imposition triggered by empty V's, takes effect, followed by mapping. Recall from the previous section (see form (50)), that stress attraction must have applied before (43b) applies (in fact stress attraction applies once the stress has been assigned).

(63) c.



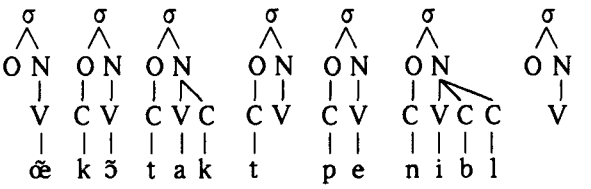
We have now reached the stage where dumping applies. The C dominating the *t* cannot be dumped to the onset of the next syllable, because *tp* is not a permissible onset in French. C dominating *t* cannot be dumped to the third syllable (the one containing V dominating *a*) either, since this would be nonlocal dumping, which we can assume is forbidden. Hence C dominating *t* cannot be dumped at this stage to a subsyllabic node. C dominating *k* cannot be dumped rightwardly (to the fourth syllable) since here again the dumping would be nonlocal. (*in addition this dumping would create also a non-permissible syllable viz. kp*). It can, however, be dumped to the nucleus of the third syllable, the one containing V dominating *a*:

(63) d.



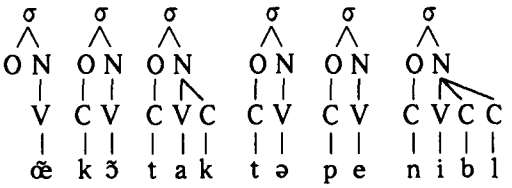
As already described in section 6.4.4 (48b), through the fourth clause of the syllabification mechanism (43d), a syllable structure imposition takes place triggered by the as yet unsyllabified consonant:

(63) e.



Then, as already described in section 6.4.3, default value assignment takes place twice, filling the empty nucleus with a V (on the level of the skeleton) and filling this V with schwa (on the level of the melody). (Also, because of Deficient Syllable Erasure (55), the final syllable is deleted.)

(63) f.



As one can now clearly see, the site of the epenthesis is first of all the result of the fact that C dominating *t* remains unlinked to syllabic structure until (43d) (syllable structure imposition triggered by as yet unsyllabified C's) takes effect, while C dominating *l* could be incorporated into syllable structure at an earlier stage, i.e., at the time of application of (43c), viz. dumping. This relative ordering of the incorporation into syllable structure of the C's dominating *k* and *t* respectively is the result of the ordering of (43c,d) and is not influenced by the direction of application.

The location of the epenthesis site is also the result of the fact that because of the binodal syllable structure in French, the nucleus is always to the right (within the same syllable) of the subsyllabic node (onset, which is subcategorised for consonants) to which a consonant is mapped, in contradistinction with being dumped), after syllable structure imposition by (43d). (This is different, of course, in a language where the syllable is tripositional. In such a case a consonant could also be mapped to the coda).

6.5.2.2 The criterion of cluster maximalisation

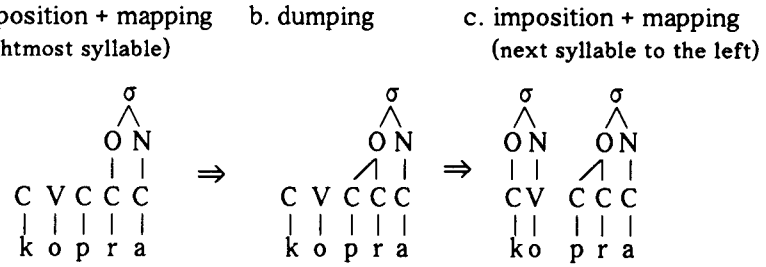
The second thing the direction of syllabification can determine is the maximalisation of clusters, at the right end or at the left end of a syllable. If syllabification takes place leftwardly normally a maximal number of consonants is linked to the onset of a given syllable (by way of mapping and dumping), before the following syllable is imposed.

If syllabification is rightward, it is the rightmost node of the syllable (i.e., the nucleus in case of a binodal syllable, the right margin in case of a trinodal syllable), to which a maximal number of segments is linked. (In this latter case, however, there is an additional principle to which we will come shortly.)

The forms in (64) are an illustration.

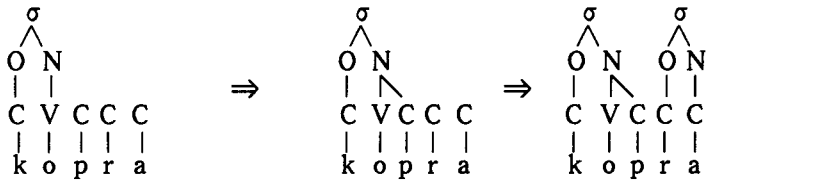
(64) *form to be syllabified* (in a hypothetical language)

(65) *leftward syllabification*



(66) *rightward syllabification*

a. imposition + mapping (leftmost syllable) b. dumping c. imposition + mapping (next syllable to the right)



There is an additional, interfering principle that says that the onset should not be left empty if a consonant can be linked to it. That means that in the case of rightward syllabification an intervocalic consonant is syllabified to the latter syllable. This fact has been mentioned by, among others, Itô (1986: 5, 1989: 223). It has been expressed in the Onset Principle (Itô 1989: 223):

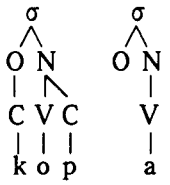
(67) *Onset Principle*: Avoid $_{\sigma}$[v]

This principle (in the form as Itô expressed it or in some related form) should come into operation when a rightward syllabification has produced the following configuration (we take the hypothetical form *kopa*), after syllable structure imposition of the first syllable, and dumping of the C dominating *p* to this syllable:

(68) a.

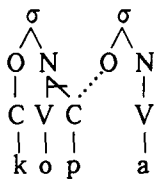
Then, syllable imposition and mapping will create a second syllable:

(68) b.



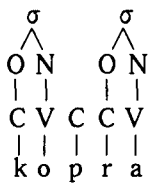
Here, the because of the Onset Principle, the C dominating *p* will be delinked from the nucleus of the first syllable and linked to the Onset of the second one:

(68) c.



The directionality of syllabification will decide on the rightward or leftward syllabification of a consonant in a sequence V__CV (as in (64), *kopra*) only if dumping takes place after each syllable imposition. If, as we propose for French, dumping applies only after the imposition of all syllables in a phrase (apart from the 'epenthesis' syllables created by virtue of (43d), (cf. our treatment of epenthesis in section 6.4.3 and the relative ordering of (43c) and (43d)), dumping could go in either direction, because - the subsyllabic nodes of both syllables to which dumping could in principle take place are present:

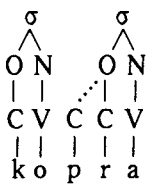
(69)



In (69) both the nucleus node (of the former syllable) and the onset node (of the latter syllable) are available for C dominating *p* to spread to. Here it is not the direction of *syllabification*, but the direction of *dumping* that determines to which syllable C dominating *p* will be dumped. Hence, for languages such as French, where syllable structure is organised in a such a way that the imposition of all syllables in a phrase precedes dumping, the direction of dumping decides to which syllable a consonant is linked.

French is a language which normally maximises onsets (apart from from *s*+obstruent sequences, see below). This is explained if we assume that the dominant direction of dumping in French is rightward. By rightward dumping, the C dominating *p* in (70) will be linked to the onset of the second syllable:

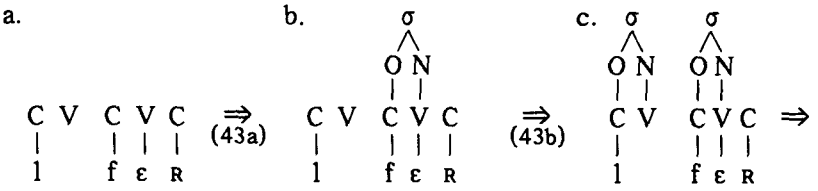
(70)



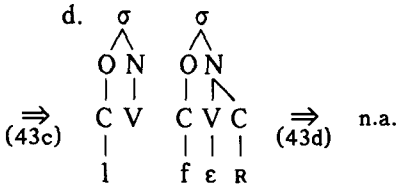
If dumping cannot take place to the right, dumping will be tried in the recessive (as opposed to dominant) direction, i.e., to the left. Cf. the example in (71), of which we show the syllabification in (72).

(71) le fer [ləfɛʀ] 'the iron'

(72) a. b. c.



d.



In (72c), the C dominating *ʀ* cannot be dumped to an onset node to the right. The reversal of the direction of dumping makes the skeletal element then spread leftwards, the recessive direction. Note that the notions of dominant and recessive direction were used before in chapter 3, on syllabification in Tonkawa, where we postulated that syllabification was leftward (the dominant direction), but that if syllabification in this direction fails, rightward syllabification (the recessive direction) takes place (cf. section 3.3 of chapter 3, in particular (22): "measures taken when syllabification fails"). The general assumption here is that any operation (like syllabification, dumping) that takes place in one direction can also in principle take place in the other direction if this is necessary. The dominant direction is a language particular choice. The opposite direction, however, remains available as a possible mode of application, if the operation in the dominant direction fails.

Now a word must be said about *s*+obstruent clusters. These clusters are quite common as onsets word-initially:

(73) a. station [stasjɔ̃] 'station'
b. strict [stʀikt] 'strict, precise'
c. spécial [spesjal] 'special'
d. scandal [skɑ̃dal] 'scandal'
e. scrupule [skʀypyl] 'scruple'
f. sphère [sfɛʀ] 'sphere'

Word-internally, however, *s*+obstruent clusters cannot form onsets. Rather, in such cases, the *s* is part of the preceding syllable. This fact has been pointed out by, among others, Lowenstamm (1979: 28; 1981: 589). The syllable boundary in forms like those in (74) is typically after the *s*. ("." indicates a syllable boundary in the phonetic forms).

(74) a. aspirer [.as.pi.ʀe.] 'to aspire'
b. ausculter [.ɔs.kyl.te.] 'to auscultate'
c. astuce [.as.tys.] 'craft'

Lowenstamm invokes the rule of Closed Syllable Adjustment (which changes *e* and *ə* to *ɛ* in closed syllables) to show that this is indeed the correct syllabic division.[16] The rule apparently functions to produce *ɛ* in the second member of pairs as:

(75)	a. étudiant	[etydiɑ̃]	'student'
	b. estudiantin	[ɛstydiɑ̃tɛ̃]	'typical of students'
(76)	a. gérer	[ʒeʀe]	'to manage'
	b. gestion	[ʒɛstjɔ̃]	'management'
(77)	a. fêter	[fete]	'to celebrate'
	b. festin	[fɛstɛ̃]	'festive'

It can be seen that in forms like (75b), (76c), and (77c) the *s* must belong to the first syllable because the rule of Closed Syllable Adjustment has applied. Lowenstamm provides additional motivation for the syllabic divisions in (74) by mentioning the fact that there are many French words starting with *ɛ* followed by *s* + stop, as in (78), but there are no words starting with *e* followed by *s* + stop.

(78)	a. Esquimau	[ɛskimo]	'Eskimo'
	b. espoir	[ɛspwaʀ]	'hope'
	c. estomac	[ɛstoma]	'stomach

Hence, it can be concluded the *s*+obstruent is not a normal permissible onset in French. The question then arises how it is possible that we nevertheless find this cluster word-initially.

Although it is not the main aim of this work to explain these facts, we will go into this briefly, as the *s* +obstruent clusters could be adduced as a counterexample to the analysis just proposed involving the rightward dumping of a skeletal element to a subsyllabic node.

We think that it is necessary here to briefly consider the history of French. In Latin the combination *s*+stop was as an onset allowed both word-initially and word-medially. Examples are given in (79):

(79)	a. stāre	[sta:re]	'to stand'
	b. spectāre	[spekta:re]	'to look at'
	c. scīre	[ski:re]	'to know'
	d. cōnstāre	[ko:nsta:re]	'to stand still'
	e. exspectāre	[ekspekta:re]	'to expect'
	f. cōnscīre	[ko:nski:re]	'to be aware of'

In the history of Gallo-Romance (and also precursors of certain other modern Romance languages, like Spanish), the combination of *s*+ stop was not a possible onset

[16] The rule Closed Syllable Adjustment has been contested by, among others, Tranel (1988). However, the criticism does not affect the examples mentioned here.

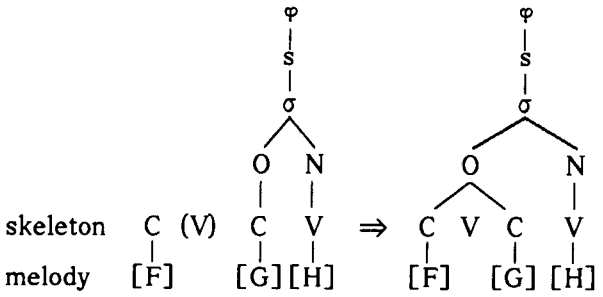
anymore. Probably as a result of leftward syllabification, an epenthetic *e* was epenthesised in front of it: cf. Old French *estat* 'state'. (This form subsequently again underwent a change as a result of syllabic constraints: the syllable final *s* was deleted as, for a period of time French did not allow for obstruents syllable-finally (cf. also section 6.4.4 and note 12) and became *état* [eta].) Later, under influence of word formation by scholars and scribes, words from Latin beginning with *s*+plosive were again introduced in French. Consider the word pair in (80).

(81) a. étable [etabl(ə)] 'shed, stall' < Old French estable < Lat. stabula
b. stable [stabl(ə)] 'stable' (adj.) < Old French estable < Lat. stabilis

The noun *étable* in Modern French stems from Old French, whereas the adjective *stable*, although attested in Old French as *estable* (Greimas 1968: 265), has come into Modern French as *stable*, through the influence of Latin. It is not surprising that this partial relatinisation happened especially with more abstract, 'learned' words, while concrete every-day words (like *étable*) kept their epenthetic *e* as inherited from Gallo-Romance.

The question is now why in the course of the Old French period, *s*+stop became again possible as an onset again. The answer lies, we think, in the development of the stress system. As Pope (1956: 82) indicates, the stress system developed in Later Old and Middle French from one in which the main stress was on the word level to the present one where the main stress is phrasal. Under this influence, the attraction of consonants to the onset as described in section 6.4.5 (see above) may have become possible. Indeed the mechanism of Onset Attraction (50) may have come into existence during this period. As a result, through the force of the attraction, the combination *s*+obstruent may have again become possible. The only difference with onset attraction as formulated in (50) is that there is no intervening V. This means that we can reformulate (50) to (81), making the intervening empty V optional:

(81) *Onset attraction* (in phrase initial position) (second version)



We can now see that the possibility of *s*+obstruent in French is the result of the workings of the same attraction force deleting schwa in an initial syllable (i.e. schwa alternation type E). This analysis is further corroborated by the fact that more recent loan words from Greek or adapted from Greek containing complex onsets not found in the

normal lexical inventory of French are not simplified as in English; witness the words in (82):

(82) a. psychologie [psikɔlɔʒi] 'psychology' (Engl. [saikɔlədʒɪ])
b. pneumatique [pnømatik] 'pneumatic' (Engl. [nju:mætɪk])
c. xylophone [ksilɔfɔn] 'xylophone' (Engl. [zaɪləfəʊn])
d. gnome [gnom] 'gnome' (Engl. [nəʊm])

Because of Onset Attraction (81), French (a language which, as English, is not very liberal in adapting foreign sounds and sound combinations in loan words), has accepted the word-initial onsets *ps*, *pn*, *ks* and *gn*, whereas English has simplified them.

6.6 High vowel/glide alternation

We now turn to the high vowel/glide alternation, which as the phenomenon of schwa/zero alternation affects the number of syllables of a given form. We will present here a modernised version of our 1982 analysis, adapted to the present framework. First we will present an overview of the facts.

6.6.1 Synopsis of the facts

The facts that have to be accounted for are given in (83).[17]

(83) i. no glide can be preceded by a tautosyllabic obstruent-liquid cluster;
ii. in other cases there exists a free alternation between high vowels and glides in prevocalic position;
iii. there are exceptions to the statements in (i) and (ii) in words whose phonetic forms always contain a glide;
iv. whenever a high vowel followed by a heterosyllabic vowel is permitted, (as in (84), (85)) the gap between these vowels can optionally be filled by a glide homorganic to the high vowel.

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[17] The restriction in (83i) has been expressed by Dell (1976: 85; 1980: 215; 1985: 239) in the output filter *Oblicons* (called Olicons in Dell (1976)):

$$*[-\text{son}]\begin{bmatrix}+\text{son}\\+\text{cons}\\-\text{nas}\end{bmatrix}[+\text{cons}]$$

This constraint says that no obstruent-liquid (or obstruent-glide) cluster can be followed by a consonant on the surface. De Kok and Spa (1978: 69) have expressed this restriction in their global constraint *Olisem* (. is a syllable boundary):

$$/.[-\text{son}]_1\begin{bmatrix}+\text{son}\\+\text{cons}\\-\text{nas}\end{bmatrix}_1\begin{bmatrix}-\text{cons}\\+\text{high}\\-\text{mid}\end{bmatrix}/ \supset \left[.[-\text{son}]_1\begin{bmatrix}+\text{son}\\+\text{cons}\\-\text{nas}\end{bmatrix}_1\begin{bmatrix}-\text{cons}\\+\text{high}\\-\text{mid}\end{bmatrix}\right.$$

Olisem says that "if on the underlying level a syllable boundary is followed by the se-

We will give examples of each of these cases. First, (83i), cf. (84):

(84)	a. Adrien	[adʀiɛ̃]	*[adʀjɛ̃]	'Adrien'
	b. grief	[gʀiɛf]	*[gʀjɛf]	'grievance'
	c. influence	[ɛ̃flyɑ̃s]	*[ɛ̃flɥɑ̃s]	'influence'
	d. trouer	[tʀue]	*[trwe]	'to punch a hole'
	e. publier	[pyblie]	*[pyblje]	'to publish'

Examples of cases referred to in (83ii) in which there is free variation between a high vowel and a corresponding glide are:

(85)	a. l'ouest	[luɛst] ~ [lwɛst]	'the West'
	b. nier	[nie] ~ [nje]	'to deny'
	c. nuage	[nyaʒ] ~ [nɥaʒ]	'cloud'
	d. tu as vu	[tyavy] ~ [tɥavy]	'you have seen'
	e. skier	[skie] ~ [skje]	'to ski'
	f. il y a	[ilia] ~ [ilja]	'there is'

Examples of forms that always contain a glide (referred to in (82iii)) are given in (86) and (87):

(86)	a. trois	[tʀwa]	*[tʀua]	'three'
	b. truite	[tʀɥit]	*[tʀyit]	'trout'
	c. pluie	[plɥi]	*[plyi]	'rain'
	d. bruit	[bʀɥi]	*[bʀyi]	'noise'
	e. groin	[gʀwɛ̃]	*[gʀuɛ̃]	'muzzle'

---

quence: one or more obstruents, one or more sonorous nonnasal consonants (= liquid or glide), closed vowel, then syllable boundary must also be there on the surface level" (De Kok & Spa 1978: 70, translation ours). This sequence is needed in order to prevent a proposed rule (optionally gliding a unstressed high vowel before another vowel), to apply to a high vowel preceded by an obstruent-liquid cluster. This global constraint has an advantage over Dell's constraint, in that it leaves forms like those in (86) unaffected (De Kok and Spa assume that they contain a glide underlyingly, so Olisem does not refer to them). However, apart from the dubious theoretical status of the concept of global constraint (which destroys the entire concept of rule ordering and levels of derivation), there are major problems connected to De Kok & Spa's analysis. In order to make their analysis of French high vowel/glide alternation work, however, these authors need, apart from the afore mentioned optional gliding rule, an obligatory dieresis rule working in the opposite direction, gliding a nonround high vowel when preceded by at least two tautosyllabic consonants. They thus derive the forms in (84b) like *grief* [gʀiɛf], from underlying forms containing a glide (like /gʀjɛf/). It is strange that in this analysis, forms that *always* show up with a high vowel derive from underlying forms containing glides, while there is also a gliding rule making glides out of high vowels. Because there is no further motivation for these two rules working in each other's opposite direction, this analysis is at least suspect.

(87) a. voir [vwaʀ] *[vuaʀ] 'to see'
b. puisse [pɥis] *[pyis] '(he) can' (subjunctive)
c. tienne [tjɛn] *[tiɛn] '(he) holds' (subjunctive)
d. bois [bwa] *[bua] 'wood', '(I) drink'
e. bien [bjɛ̃] *[biɛ̃] 'well' (adv.)
f. puits [pɥi] *[pyi] 'well' (n.)

Finally, examples of (83iv), cases showing that whenever a high vowel followed by a heterosyllabic vowel is permitted (as in (84), (85)), the gap between these vowels can optionally be filled by a glide homorganic to the high vowel, are shown in (88) and (89), which correspond to (84) and (85) respectively:

(88) a. [adʀijɛ̃]
b. [gʀijɛf]
c. [ɛ̃flyɥɑ̃s]
d. [tʀuwe]
e. [pyblije]

(89) a. [luwɛst]
b. [nije]
c. [nyɥaʒ]
d. [tyɥavy]
e. [skijer]
f. [ilija]

The normal case, given in (83ii), is that there is a free variation in prevocalic position in French. The exception referred to in (83i), the fact that normally we do not find a free high vowel/glide alternation in prevocalic position if the vowel element in question is preceded by more than one tautosyllabic consonant is the result of a very simple constraint prohibiting a tautosyllabic onset cluster of three elements (apart from the special case of a *s*+plosive+liquid cluster).

The only exception to (83i) and (83ii) is formed by the cases referred to in (83iii) (examples have been given in (86) and (87)). We have shown elsewhere (Noske 1982: 261-263; 1988a: 48-50) that the diphthongs given in (86) and (87) are monophonematic, i.e., they constitute a single diphthongal phoneme. Hence a constituting element can not be altered independently from the other.[18] The reasons for this are, briefly: (i) they are always realised as rising diphthongs and do not alternate freely with high vowel+vowel sequences; (ii) many of the diphthongs in the examples in (87) alternate morphologically with a single vowel (like in *peux* [pø] '(he) can' (cf. (87b), [pɥis]), *tenir* [təniʀ] 'to hold' (cf. (87c), [tjɛn]), *buvons* [byvɔ̃] '(we) drink (cf. (87d), [bwa]), *bon* [bɔ̃] 'good' (adj., cf. (87e), [bjɛ̃]). We assume with Kaye and Lowenstamm (cf. note 18) that the elements constituting these diphthongs should be in the same subsyllabic node, in our case the nucleus. Thus the syllabified forms of, e.g., (86c) and (87d)

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[18] Kaye & Lowenstamm (1984) use this argument in connection with a different assumption. This assumption is that syllable structure is present underlyingly (a point of view which we reject, as syllable structure is usually not idiosyncratic, but can be predicted). They then posit a constraint, the Nuclear Integrity Constraint, (NIC), which says (among other things) that no elements may be taken out of the nucleus, while others remain in it: "resyllabification must involve the entire nucleus".

should be respectively as in (90a,b):[19]

(90) a.

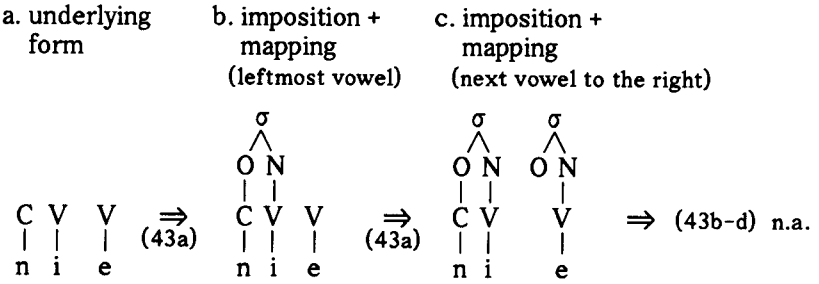
b.

6.6.2 High vowel/glide alternation as a result of a free choice of direction: an analysis that has to be rejected.

After having indicated the reasons for (83i) and (83iii), let us now focus on the core case of (83ii), the free alternation between high vowel and glide in prevocalic position (we will come to the cases in (83iv) in a moment). Given our analysis of schwa/zero alternation above, one could then think that it is possible to analyse the variation as a result of a freedom of direction of syllabification. Recall that in French, the choice of the direction of syllabification (more specifically of (43a,b,c,d) does not influence the outcome because the different processes of triggering of syllable structure imposition are ordered with respect to each other, and after each triggering process mapping applies. It is largely the optionality of the syllable structure imposition by empty V's (43b) that accounts for the variability of the occurence of schwa.

Let us consider what happens if a form like (85b) is syllabified. Here the direction of syllabification comes into play. Let us first assume that syllabification, more specifically, the triggering of syllable imposition triggered by as yet unsyllabified full vowels (43a), takes place from left to right. The syllabification of (84b) then takes place as (91):

(91) *left-to-right triggering of syllable imposition*



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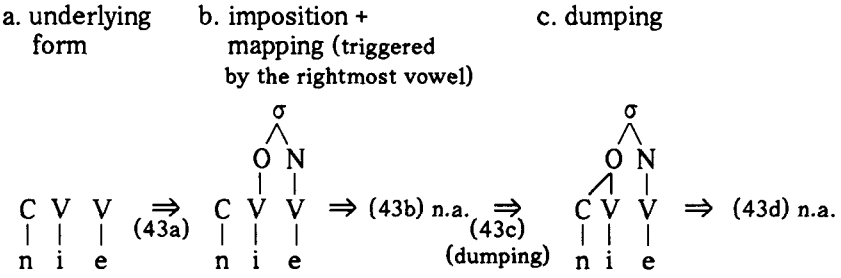
[19] Unlike the representation of diphthongs employed for German (see (32) and note 15 in chapter 5), we assume that the French monophonematic dipthongs do not have two skeletal slots, as, apart from a few isolated cases (like *mettre-maître*, *patte-pâte*), vowel quantity in general plays no role in French.

The derivation in (91) produces the phonetic outcome [nie]. First the leftmost vowel triggers syllable structure imposition. The subsequent application of mapping maps the V linked to *i* and the C linked to *l* to the subsyllabic nodes onset and nucleus respectively. Then, the next full vowel, V linked to *e*, triggers syllable structure imposition and mapping takes place again. The onset of this second syllable remains unlinked, because there is no element which can be mapped to it.

Let us now assume that the triggering of syllable imposition by as yet unsyllabified full vowels (43a) takes place from right to left. It is necessary to mention one point here, i.e., the hypothesis (which we will reject later) that a high vowel can be both syllabic and nonsyllabic. Hence, the high vowels in French belong to the set of segments which can be linked to both the nucleus and the onset. The content of this set varies from language to language. In English (and, as we have seen in chapter 5, German), the set also comprises liquids and nasals. In French, it consists only of high vowels, while in Yawelmani, which does not have syllabically conditioned high vowel/glide alternation, this set of segments is empty.

Right-to-left syllable imposition triggering by as yet unsyllabified full vowels, then, would take place as follows:

(92) *right-to-left triggering of syllable imposition*



The phonetic outcome is here [nje]. V dominating *e* first induces syllable imposition. Then, the V dominating *e* is mapped to the nucleus node. V dominating *i* is subsequently linked to the Onset node. Then, dumping (43c) links the C dominating *n* to the onset node. Because all skeletal elements are now linked to a subsyllabic node, no further syllable imposition takes place.

The two logically possible directions of application of (43a), where syllable structure imposition is triggered by full vowels, thus produce two different phonetic forms, [nie] (for left to right application) and [nje] (for right to left application). These are precisely the two possible pronunciations that are given in (85b). This entails that if we assume that both directions of syllabification (more precisely, of application of (43a)) are possible in French, then both pronunciations are accounted for.

Given our analysis of schwa/zero alternation, this would seem a nice proposal. However, there are severe problems connected to this type of analysis. First, consider the following contrast:

(93) l'ouest [luɛst] ~ [lwɛst] ~ [luwɛst] 'the West' (cf. (85a), (89a))

(94) a. le wagon [lə wagɔ̃] 'the wagon'
b. le whisky [lə wiski] 'the whisky'
c. le yaourt [lə jauʀt] 'the yoghurt'

In (93), the schwa of the article *le* is obligatorily deleted (which is also reflected in the orthography), while in (94) the deletion of schwa is not possible. In (94) the glides must be underlyingly specified as such, i.e., they are subcategorised be linked to an onset node.[20] This contrast between (93) and (94) cannot easily be explained if it is assumed that the high vowels can be linked to the onset node by right-to-left triggering of syllable structure imposition. This would not explain why even if they are realised as a glide by right to left application of (43a), they nevertheless trigger the deletion of the schwa. This would predict as a possible outcome *[ləwɛst], just like [ləwagɔ̃]. This can be avoided if it is assumed that they are *initially* syllabified as a high vowel and only later changed into a glide. We will come back to this shortly.

There is another drawback in the analysis of high vowel/glide alternation as a result of a freedom in the choice of the direction of application of the triggering of syllable structure imposition by as yet unsyllabified full vowels (43a). This becomes evident if we try to syllabify the forms in (84) in this way. We take (84b) as an example. First we consider what happens in the case of a left-to-right application of the triggering of syllable structure imposition by as yet unsyllabified consonants (43a).[21]

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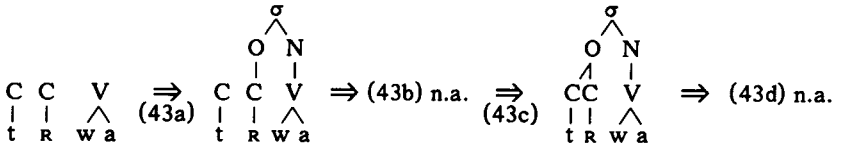
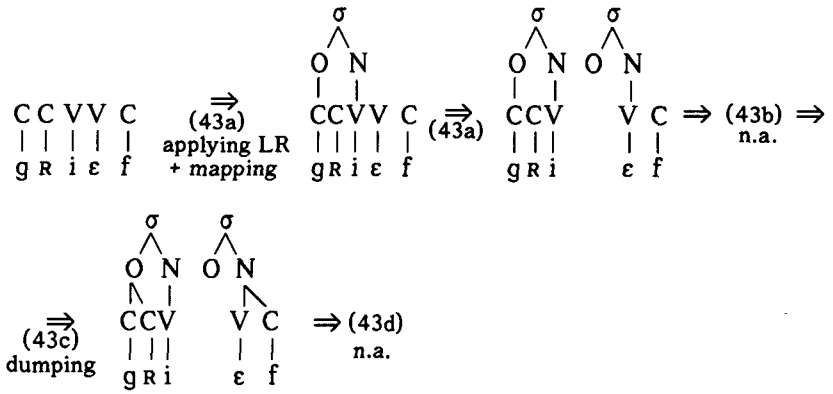
[20] De Kok & Spa (1980) note that the verb endings *-ions, -iez* are always realised with an initial glide (and hence like the forms in (94) contain glides subcategorised for the onset node), unless this would result in a OLG cluster (like in *entrions*). This also pertains to the noun ending *-ion*, the ordinal ending *-ième* (cf. *deuxième* [døzjɛm] 'second' vs. *quatrième* [katriɛm] 'fourth'), and the adjectival ending *-ien* (cf. *sibérien* [sibeʀjɛ̃] 'Siberian' vs. *ombrien* [ɔ̃bʀiɛ̃] 'Umbrian' (Jaap Spa, personal communication). The fact that OLG clusters are avoided (which do not constitute permissible onsets in French) indicates that in those cases the glide is probably forced to be syllabified in the nucleus. This could be explained by means of an *emergency measure* (not unlike the reversal of the direction of syllabification in Tonkawa discussed in chapter 3) which overrides the subcategorisation for onset of the initial segments of suffixes like *-ions, -iez, -ion, -ième, -ien.*

[21] The forms where a obstruent-liquid cluster is always followed by a glide (i.e., the exceptions to the statements in (83i,ii), and referred to in (83iii), are syllabified as follows. (Recall that the monophonematic diphthongs in French contain a single skeletal slot, cf. note 18). (86a), *trois* [trwa] *[trua] 'three', is taken here as an example:

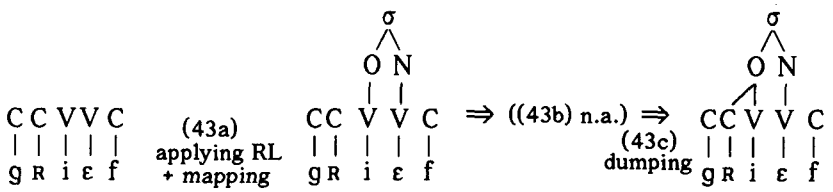


(95)



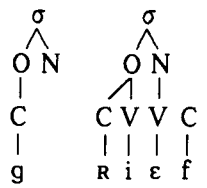
In (95), the V dominating *i* induces syllable imposition (43a). The mapping process links C dominating *g* to the onset of the imposed syllable, and V dominating *i* to the nucleus. Then syllable structure imposition by as yet unsyllabified vowels (43a) continues to apply in rightward direction and the V dominating *ε* induces the imposition of a second syllable. Subsequently, dumping (43c), which as we have seen in its dominant application (which will be attempted first) links as yet unlinked skeletal slots rightward, cannot apply to link the C dominating *ʀ* to the Onset of the first syllable. Therefore it will switch over to its recessive mode, i.e., leftward operation. This will link the C dominating *ʀ* to the onset. In the same way, C dominating *f* will be dumped to the nucleus of the second syllable. This produces the possible outcome [gʀiɛf]. Now consider what happens if the application of (43a) is from right to left and if the V dominating the high vowel can be linked to both onsets and nuclei:

(96) *syllabification of (84b) involving right-to-left application of (43a)*



By dumping (43c), the C dominating *g* cannot be incorporated in the onset, since this would mean a glide preceded by a obstruent-liquid cluster, a disallowed sequence (as stated in (83i)). It appears here that we are faced with a problem. Given our syllabification proposal in (43), after dumping (43c) syllable structure imposition triggered by as yet unsyllabified consonants (43d) should apply. This would produce the following syllable imposition:

(97) *



After default value assignment of the empty nucleus with V, and default value assignment of this V with schwa, this form surfaces as *[gərjɛf]. The problem here is that our analysis predicts an impossible form here and that we cannot rule out this impossible form in a principled way.

6.6.3 A rule based account of gliding

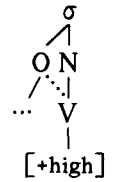
As already mentioned, instead of the analysis of gliding as a direct consequence of syllabification, we would like to posit that high vowels (more precisely, V dominating a high vowel value), are subcatorised for linking to the nucleus exclusively. In addition, we propose a specific rule changing the categorial status of the high vowel. In our (1985, 1988a) analysis, this "environmentless" rule was formulated as follows:

(98) *Semivocalisation* (Noske 1982: 290, 1988a: 76)

$$\begin{bmatrix} +\text{high} \\ +\text{syll} \end{bmatrix} \rightarrow [-\text{ syll}]$$

We propose here basically the same rule, reformulated in a hierarchical framework:

(99) *Gliding* (optional)



This rule, which applies after syllabification (43), says that a V dominating a high vowel linked to the nucleus node is optionally linked to the onset node to the left, which may or may not be linked to other skeletal elements.

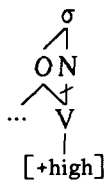
As a result, the V in question is delinked from the nucleus node. To see this, recall the Onset-Nucleus Contour Constraint, presented in section 5.6.1 of chapter 5, which we repeat here as (100):

(100) *Onset-Nucleus Contour Constraint* (ONCC)

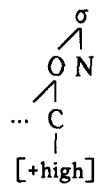
Tautosyllabic onset and nucleus nodes may not be linked to the same melodic element.

This constraint, together with the convention proposed by Odden (1981), mentioned in section 5.6 of chapter 5, that association lines may not be delinked immediately after they have been established (hence the link between V and the onset node created by the Gliding rule may not be severed by a convention immediately after the application of this rule), means that the only way out is to delink V from the nucleus. Recall that this constraint is applicable also in French (cf. section 5.6.1 of chapter 5). Thus the result is as in (101).

(101)

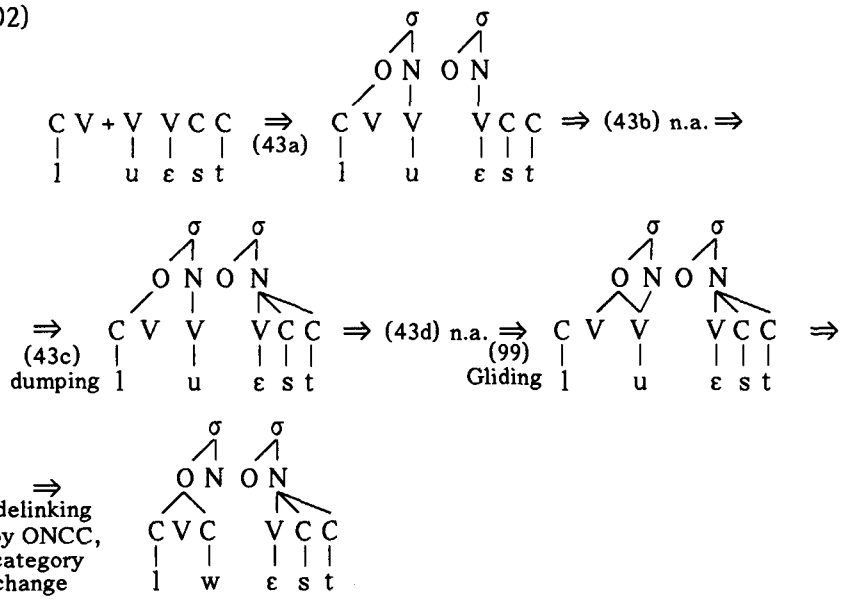


(102)



As a result of the rule of Gliding, the subcategorisation of V has changed, and can as a result the skeletal element is now a C, cf. (102) (above). (In the forms presented here, we have also changed *u* to *w* on the melodic tier, for greater transparancy. One should realise, however, that *u* and *w* have the same phonetic content. They differ only in syllabicity. In our framework this is formally expressed by the fact that they are linked to a different type of subsyllabic node.) This all means that in the case of (85a) (or (93a)), we have the following derivation, when Gliding applies:

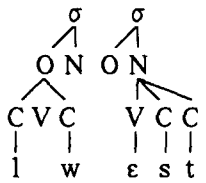
(102)



First syllabification (43) applies. The two full V's, subcategorised for being linked to nuclei only, trigger syllable structure imposition (43a) (whatever the direction of application of (43a). Then, mapping takes place. C dominating *l* is linked to the onset of the

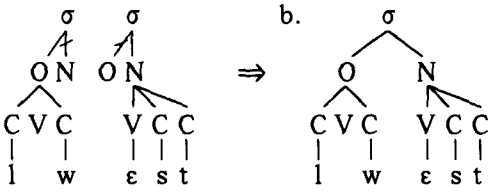
first syllable. Then (43b) is in principle applicable. It cannot apply, however, to the unlinked V, since this would mean crossing association lines (cf. our discussion on this in section 6.4.3, especially form (45) and subsequent discussion). Then, dumping of left over consonants (43c) applies (the syllable structure conditions permitting). Finally, syllable structure imposition by as yet unsyllabified consonants (43d) is in principle applicable, but cannot apply, because there are no unsyllabified consonants at this stage. After syllabification Gliding (99) applies optionally. The V dominating *u* is linked to the onset. As a result of the ONCC, the link between the V dominating *u* and the nucleus node is severed. We now have the following situation:

(104)



This is a non-optimal syllable structure. There is an empty nucleus, followed by an empty onset. Note that it is possible to make a single syllable from the constituents that are filled, i.e., the onset of the first syllable, and the nucleus of the second syllable. We propose that there is a contraction mechanism that creates an optimal syllable structure from existing material consisting of subsyllabic nodes. This mechanism, or rather convention, will reorganise the subsyllabic material. A contraction of the two syllables will thus take place:

(105) a.



With the contraction, the empty nucleus of the first syllable and the empty onset of the second one disappear automatically, as these are only *positions* in syllable structure which cannot exist without being part of a syllable.

The question can now be raised why a form like (83b), *grief*, cannot undergo Gliding (99). The answer is, very straightforwardly, that, as stated in (83i), *gʀj* does not constitute a permissible onset in French. Therefore, Gliding (99), which we assume is subject to the general syllable structure conditions of French, will not apply.

6.6.4 Hiatus filling

Still one phenomenon needs to be explained, i.e., the statement in (82iv) that whenever a high vowel followed by a heterosyllabic vowel is permitted, the gap between these vowels can optionally be filled by a glide homorganic to the high vowel.

The possible pronunciation of *nier* as [nije], is the result of an optional spreading. As mentioned before (cf. section 1.2 of chapter 1), the question whether spreading takes place is a language and process specific choice. For French, on the level of the skeleton and the subsyllabic nodes, we assume it to be optional. As a result, we may get the following configuration after the application if the triggering of syllable structure imposition by as yet syllabified full vowels (43a) has applied from left to right (cf. (106)).

(106) *optional spreading:*

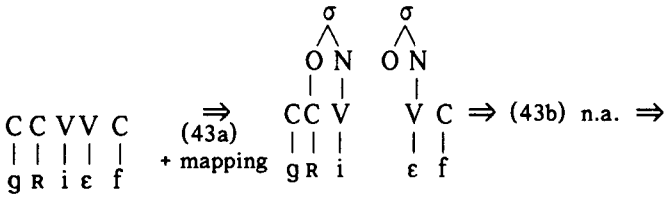
Although, as we have said, V's dominating a melodic high vowel element may not be linked by convention to the onset node (in contrast to Gliding (99)), this spreading must be permitted. We think that this can be explained by expressing the subcategorisation by the following negative partial syllable structure condition:

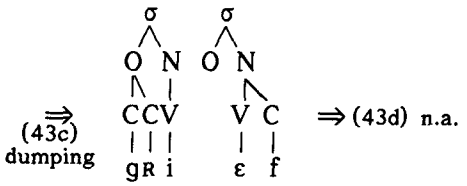
(107) * O
|
V

This condition is subject to the Linking Constraint (Hayes 1986), which says that association lines must be interpreted exhaustively. Thus, if V is also linked to another subsyllabic node, (107) does not apply to that configuration. Another example of the way the linking constraint can apply is the situation in Italian, where syllable final obstruents are dissallowed, but where obstruents as part of a geminate (which is also linked to the onset of the following syllable) are permitted.

Optional spreading can also apply in the cases where the high vowel *must* taken to be in the nucleus of the syllable. This is the case in the forms given in (84). We take (84b) as an example (as we did in section 6.6.2).

(108)

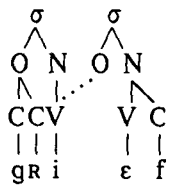




In (108), the V's dominating *i* and *ɛ* induce syllable structure imposition (43a). The mapping process links the V's dominating *i* and *ɛ* to the nuclei and the C dominating *ʀ* to the onset of the leftmost imposed syllable. Subsequently, dumping (43c), which, as we have seen, in its dominant direction of application (which will be attempted first) links as yet unlinked skeletal slots rightwardly, cannot apply to link the C dominating *g* to the Onset of the first syllable. Therefore dumping will switch over to its recessive mode, i.e., leftward operation. This will link the C dominating *g* to the onset. In the same way, C dominating *f* will be dumped to the nucleus of the second syllable. Then, optional Gliding (99) is in principle applicable, but can not apply, because this would create the impermissible onset *gʀj*.

Now we have the same situation as the one in (106) and spreading can apply:

(109)



This produces the outcome [gʀijɛf], given in (88b).

6.6.5 High vowel/glide alternation: concluding remarks

As a conclusion to this subsection on high vowel/glide alternation we can say that the facts as listed in (83) can be explained as follows.

Statement (83i) – no glide can be preceded by a tautosyllabic obstruent-liquid cluster – is the result of a syllable structure condition prohibiting onset clusters consisting of obstruent+liquid+glide.

Statement (83ii) – in other cases (than (83i) there exists a free alternation between high vowels and glides in prevocalic position – is the result of the optional application of the Gliding rule (99), together with the workings of the Onset-Nucleus Contour Constraint.

Statement (83iii) – there are exceptions to the statements in (83i) and (83ii) in words whose phonetic forms always contain a glide – is the result of the fact that these glides in the forms in question are part of a monophonematic rising diphthong.

Statement (83iv) – whenever a high vowel followed by a heterosyllabic vowel is

permitted, the gap between these vowels can optionally be filled by a glide homorganic to the high vowel – is the result of a simple spreading effect.

6.7 Conclusion

In this chapter we have shown that it is possible to analyse the schwa/zero alternations of French as a direct result of syllabification. Unlike Tranel's (1987) account we have been able to explain *all* types of schwa/zero alternation as a direct result of syllabification, and not just a subset. In order to do this, we have proposed that syllabification takes place in four stages. The existence of four different stages of syllabification has been motivated independently by the historical development of consonant truncation in French and by the nature of stress placement in the language.

We thus see that syllabification in French is organised differently from the syllabification in the other languages treated in this work. This situation, we feel, lends support to Huang's, Muysken's and Lefebvre's view that languages may differ in the way their modules are organised and configured with respect to each other.

We now come to the question of the directionality. Directionality does not seem to play a major role in the results of syllable structure imposition. Nevertheless, two of the four operations mentioned in the syllabification algorithm in (43) have been shown to be directional, viz. syllable imposition triggered by as yet unsyllabified ful vowels (43a) and dumping (43c).

Concerning syllable imposition by full vowels (43a) we have seen in section 6.6.2 (see (96) and (97)) that right-to-left application would produce the wrong results for high vowels preceded by OL clusters (incorrectly predicting that *[gəʀjɛf] is a possible pronunciation of *grief*). Therefore, we assume that this mechanism takes place from left-to-right.

With respect to dumping (43c), it has been shown in section 6.5.2.2 that this mechanism is *also* rightward, because of the nature of cluster maximalisation.

It has not been possible to determine on any specific grounds the directionality of the other two mechanisms of syllabification (43), i.e. optional syllable imposition by empty V's (43b), and syllable structure imposition by consonants (43d). Given that the direction of (43a) *as well as* that of (43c) is rightward, there are now two possiblilities: either the directions of application of the four submechanisms can be set independently, or there is in fact a single (dominant) direction setting for syllabification. Since this would be the simplest state of affairs, and would make French not different in this respect from other languages like Tonkawa, Yawelmani and German, we take the zero-hypothesis there is indeed a single direction setting for French syllabification. As we have seen this setting is from left-to-right.

Finally, with respect to high vowel/glide alternation we have shown that one cannot dispense with the concept of rule governed syllabic change altogether. Although in this

analysis general principles (like the ONCC) play a role, one has to have recourse to the concept of a specifically formulated rule.

7 Conclusions

In this work it was our aim to show that the relationship between syllable structure and syllable changing processes like the 'conspiracies' mentioned by Kisseberth (1969a, 1970) can be explained. We have formulated a theory of the structure of the syllable, the *true constituent model*, and one of the assignment of this structure, the *syllable assignment theory*.

It was shown that the *true constituent model* of the syllable is able to explain facts that other theories cannot account for. A major point distinguishing this model from other models is the fact that the presence of syllabic subnodes is predetermined and is not a function of the presence or absence of segments.

In connection with this it was demonstrated, among other things, that very general insertion processes like glide insertion (in hiatus position) or glottal stop insertion (in hiatus position as well as at the beginning of a word starting with a vowel) can best be seen as the filling of empty positions. This type of process was analysed as one of *default value assignment*, a process well-known in autosegmental phonology.

We have also shown that reduplication in certain languages involves the superimposition of a specific syllable type, involving three positions (or subsyllabic nodes), to a copy of the stem. In addition, we saw that in the case of Oykangand, *spreading* (another autosegmental principle) takes place from the copy of the stem to the empty onset position of the syllable to which the stem itself is linked.

These two processes demonstrate that (initiallly) empty nodes play a role in syllabic phonology.

Because of these considerations, we posited a theory of syllabification, the *syllable assignment theory*, in which, as in reduplication, a specific syllable is superimposed on the segments. This type of syllabification, in conjunction with the independently motivated principles of autosegmental phonology, was shown throughhout this work to account for syllabically conditioned alternation processes in a very natural way, in that these are mostly a *direct result* of syllabification.

We have shown that the *rule* and *template matching* approaches to syllabification, which have been opposed in the literature, are both unsatisfactory from the point of view of the analysis of alternation processes related to syllable structure. For the *rule approach* this is so because under this type of syllabification, processes that are clearly related to syllable structure have to be formulated as specific rules, which obscures their general character, as well as their relationship with syllable structure. The *template matching approach* is inadequate because it does not allow for empty nodes. In addition, this type of theory fails to meet minimal requirements of scientific explicitness: the very word *template* is used in an ambivalent way. It remains unclear whether *template* means a *set of well-formedness conditions* or a *structure*.

Next, we addressed the typology of the syllable. We adduced evidence from the Germanic languages Dutch and German, as well as from the Amerindian languages Wiyot and Navaho that the syllable superimposed by syllabification in these languages contains three positions and not two, just as the syllable superimposed by Mokilese reduplication contains three positions. This was done by showing how spreading applies in all of these languages, as well as how default assignment applies in Navaho.

We concluded that the observed difference between the West-Germanic languages and languages like Wiyot and Navaho on the one hand, and many other languages on the other, is the result of a difference in the nature of the syllable assigned by syllabification: these languages have tripositional syllables, whereas others have bipositional ones. In the course of this work we have seen that in addition to the above mentioned languages, Tonkawa (chapter 3) and Yawelmani (chapter 4) also have a tripositional syllable. The syllable type of French (chapter 6), however, is bipositional.

Regarding the theory on syllable structure, we showed in chapter 2 that the popular moraic theory by Hayes (1989), which potentially could be an alternative to our theory, is inadequate and has no empirical basis. This theory uses the concept of *mora*, which stems from metrical theory and incorporates this into syllable structure as a *constituent part.*

First, it was argued that the lack of an adequate account for the behaviour of glides, which was mentioned in the literature as a severe drawback of Hyman's (1985) model, remains a problem in a moraic model where consonants are intrinsically nonmoraic, as in Hayes' model. In such a model, one cannot account for the free variation between high vowels and glides which is often found in languages.

Second, we have shown that major problems arise because of the hybrid character, partly autosegmental, partly metrical, of the type of representation which a moraic syllable model entails. As a result, there is practically no constraint in the possibilities of association in this model.

Third, we mentioned that Hayes has to posit, idiosyncratically, that moras are not subject to Parasitic Delinking, a principle which he himself invokes for the deletion of other nodes.

Fourth, we have shown that the crucial types of compensatory lengthening which Hayes adduces as motivation for a moraic model, may also be described by a true constituent model, where spreading takes place to the subsyllabic constituents.

Fifth, the two types of CL which cannot be accounted for by the spreading of a segment to a subsyllabic constituent in the true constituent model, i.e., CL through vowel loss and CL through glide formation, were shown to be represented in an empirically inadequate way in Hayes (1989). As Minkova (1985) has shown for CL true vowel loss, and as we have shown above for CL through glide formation, these CL types are the result of a minimal foot quantity requirement.

Sixth, the nonexisting CL types excluded in the moraic syllable model proposed by Hayes are also excluded in the true constituent model.

We concluded that the moraic model of the syllable proves unsatisfactory and that the true constituent model is a better alternative.

In the next two chapters, 3 and 4, we addressed syllabification and syllable related alternations in two Amerindian languages, viz. Tonkawa and Yawelmani. These languages were studied in detail in earlier analyses that are quite complex and problematic.

We have provided an explanation for the different phenomena of vowel deletion and vowel shortening taking place in Tonkawa. We have shown that it is possible to explain these phenomena by analysing them as a result of the assignment of syllable structure. This analysis supplants the complicated linear analyses by Kisseberth (1970a) and Phelps (1973, 1975).

The language specific parts of this assignment are the following: (a) syllabification is cyclic (in addition to being postcyclic); (b) the geometry of the canonical syllable of Tonkawa is trinodal; (c) syllable assigment is triggered by consonants only; (d) the dominant directionality of syllabification is right-to-left.

During the analysis of Tonkawa the notions of dominant and recessive directions of of a phonological operation were introduced. The idea of a recessive direction of application is not limited to syllabification. Every directional operation can in principle apply in a recessive direction – the direction opposite to the normal one – when this is needed.

In our analysis of Yawelmani we showed that it is possible to analyse seemingly syllabically conditioned and 'conspiring' alternations as being conditioned by syllabification and syllable structure, and not as processes independent from syllable structure, as was done in previous analysis by Kuroda (1967), Kisseberth (1969a, 1969b, 1979) and Archangeli (1983a,b; 1984). The language specific parts of syllabification in Yawelmani are identical to that in Tonkawa in that (a) the assigned syllable is trinodal and (b) syllabification takes place form right to left. They differ in two parameters: (c) syllabification in Yawelmani is only postlexical; (d) syllabification is triggered by all segment types, consonants as well as vowels.

The next two languages treated were German and French. In the phonology of both languages, the behaviour of schwa plays a central role.

Like for Tonkawa and Yawelmani, it was shown that in German segmental alternation is a direct result of syllabification: the schwa/zero alternations in German inflection derive directly from syllabification. In our analysis, in contrast to other ones, there is no need to refer to grammatical categories in the statement of the domains of rules. Rather, it was proposed that of the suffixes for different grammatical categories some contain schwa, while others do not. It was shown that the infinitive marker has the form *-n* (without a schwa), the adjectival markers have the forms *-ə*, *-ən*, *-əs*, *-əʁ*, *-əm* (with a schwa (but recall that underlying schwa is in fact an empty V)), the comparative morpheme the form *-əʁ*, and certain nominal case and plural markers the form *-n*. The difference in behaviour of the morphemes of different inflectional categories is the result of a difference in their underlying shape.

We have also shown that the distinction made by Issatschenko (1974) between two types of schwa, *schwa constans* and *schwa mobile*, has a correlate in modern hierarchical phonological theory. Because, working in the structuralist framework, Issatschenko did not have the notion of phonological rule at his disposal, he posited these as two phonemes with the same phonetic shape. Wiese (1988) has raised the objection that in Issatschenko's analysis, where the notion of "morphophoneme" is used in order to explain the behaviour of the schwa *mobile*, it is only accidental that the two elements have the same phonetic shape.

We have actually removed this coincidence: there are not two different phonemes. The phonetic value of both types of schwa is the result of the same default value assignment to a skeletal slot. The only difference is that for the epenthetic schwa (the *mobile*) the V to which the default value is assigned is itself the result of a default value assignment, i.e., assignment to the nucleus.

Finally, we would like to repeat the parameter settings of German syllabification: (a) syllabification is lexical as well as postlexical, but not cyclic; (b) the syllable in German generally is trinodal; (c) all segments should be incorporated into the syllable structure; (d) the direction of syllabification is right-to-left.

Also for French, we have shown that the schwa/zero alternations are a direct result of syllabification. Unlike the only other attempt at this in the literature, i.e. that of Tranel (1987), we have been able to explain *all* types of schwa/zero alternation as a direct result of syllabification, and not just a subset.

We have proposed that syllabification takes place in four stages. The existence of four different stages of syllabification has been motivated independently by the historical development of consonant truncation in French and by the nature of stress placement in the language. We thus see that syllabification in French is organised differently in this respect from the syllabification in the other languages treated in this work.

The following parameter settings been shown to be valid for French: (a) syllabification is only postlexical; (b) in contrast to Tonkawa, Yawelmani and German the French syllable is binodal; (c) all segments except empty V's should be incorporated into syllable structure; (d) the direction of syllabification is left-to-right.

Summarising, it can be said that at closer inspection, the phenomena of segmental alternation in Tonkawa, Yawelmani, German and French are not so different from each other as they may at first sight seem. They are all a direct result of the process of syllable structure assignment. The difference in behaviour between the four languages is explained by differences in the setting of four parameters (and for French, by a different configuration of the modules of the phonological grammar).

Therefore, we feel that by developing this theory we have gained further insight in the organisational principles which govern the behaviour of language.

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