belangrijke rol moet spelen bij de analyse van lettergrepen.

In hoofdstuk 3 wordt een volledige analyse gegeven van de Nederlandse lettergreep. Deze analyse wordt vergeleken met de analyse die onlangs is voorgesteld door Mieke Trommelen (Trommelen 1983). De vergelijking wordt toegespitst op de mogelijkheden die beide analyses bieden bij de verantwoording van de verschillende verschijningsvormen van het verkleiningssuffix (bijv. **tje, etje** enz.).

In hoofdstuk 4 staat de representatie van klemtoonverschijnselen centraal. Uitgebreid wordt ingegaan op twee varianten van de zgn. metrische klemtoontheorie. In de "ortodoxe" variant spelen binair vertakkende boomstructuren een belangrijke rol, terwijl in de "ketterse" variant klemtoonpatronen worden gekarakteriseerd met behulp van een eenvoudiger hierarchische structuur, waarin een groepering in constituenten geen rol speelt. Ik betoog dat aan beide varianten, in een enigszins gewijzigde vorm, een complementaire rol kan worden toebedeeld. Voorts stel ik voor dat de relatie tussen hoofdklemtoontoekenning en toekenning van nevenaccenten anders gezien moet worden dan gebruikelijk is in beide varianten van de metrische theorie. Nevenaccenten kunnen namelijk het best geanalyseerd worden als nauwelijks taalspecifieke bijverschijnselen van het hoofdaccent, niet als iets dat aan hoofdklemtoontoekenning ten grondslag ligt.

In hoofdstuk 5 wordt het klemtoonpatroon dat we in ongelede Nederlandse woorden aantreffen uitgebreid onderzocht. Eerst wordt de relatie tussen lettergreepstructuur en klemtoon, zoals we die in het Nederlands aantreffen, besproken. Vervolgens wordt een inventaris opgesteld van zgn. dominante klemtoonpatronen, op basis van een corpus bestaande uit ongelede substantieven en adjectieven. Tenslotte worden verschillende metrische analyses voorgesteld en vergeleken. De voorkeur gaat uiteindelijk uit naar een analyse die in verschillende opzichten aansluit bij de voorstellen die in hoofdstuk 4 op meer algemene gronden werden gedaan.

Part I

Introduction

Chapter 1

The Framework of Nonlinear Phonology

1.1. Introduction

In this chapter I will discuss current views on the structure of phonological representations within the theory of generative grammar, thus providing the context within which the present study of syllable structure and stress is placed. After a brief sketch of these views in section 1.2, sections 1.3 and 1.4 will provide a discussion of the theory of **autosegmental phonology** and the theory of **metrical phonology**. It is my intention to provide insight into the basic structure and principles of the two theories and to make clear the type of argumentation that has led to their development. Since chapters 2 and 4 will be concerned with issues that fall within the scope of metrical phonology, this introductory chapter is devoted primarily to autosegmental phonology.

It is not my intention to give a complete introduction to the theory of nonlinear phonology here. I will discuss neither all phenomena for which nonlinear treatments have been suggested nor all the different competing proposals that occur in the literature. I have selected topics that involve some of the central issues and will limit myself in several places to giving the views I adhere to. Detailed introductions to both autosegmental and metrical phonology can be found in Van der Hulst and Smith (1982a) and McCarthy (1982).

1.2. A sketch of the nonlinear framework

The theories discussed in this section have both emerged from the research program that was initiated in Chomsky and Halle's **The Sound Pattern of English** (SPE; Chomsky and Halle 1968). Although there are many differences between the SPE approach and current approaches, a number of fundamental assumptions have been maintained without change, such as the distinction between underlying and surface representations, rule ordering and the belief that the significance of generalizations corresponds to formal simplicity. The theory proposed in SPE has a **derivational** aspect and a **representational** aspect. The former aspect involves issues such as the formulation of phonological rules, rule application and rule ordering, whereas the latter aspect involves the structure of phonological representations at each level of the derivation. One can say that the changes that I will discuss here all involve the representational aspect.

The changes that we have witnessed over the past few years have been caused, not by changing the methodology in any way, but by extending the empirical domain of the theory considerably. The following quote from Chomsky (1955: 29) could apply to a large extent to SPE, where suprasegmental features are approached as if they were segmental features:

> In this study, suprasegmental features (pitch, stress, juncture) have not been seriously considered. Ultimately of course, these phenomena must be incorporated into any full syntactic theory, and it may be that this extension still requires a more elaborate system of representation.

In SPE the phonological representation is **unilinear**, i.e. it consists of a single sequence of segments and boundary symbols. Segments consist of an unordered set of features, each of which has a binary value. This sequence is associated with a hierarchical structure that is non-phonological, but morphological and syntactic. Currently a phonological representation is considered to be a three-dimensional object, in which we find not just one sequence of segments, but several sequences. Hence the representation is called **multilinear** or **nonlinear**. These sequences (called **tiers**) are linked to a central tier that consists of abstract units to which the segments on the other tiers are associated. This pivotal tier also constitutes the interface between the (morpho)syntactic hierarchical structure and a prosodic hierarchical structure. From the point of view we have today the quote given above sounds almost like an understatement.

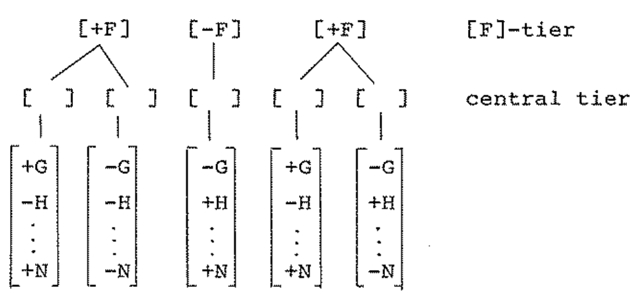
I will now sketch in abstract terms the two ways in which the SPE conception of phonological representations has been altered, before proceeding with a discussion of the type of data that have motivated the changes. I will also pay some attention to the question how the changes that have been proposed are to be combined.

The view of segments as unordered sets of specified features has been abandoned for the following reason. It has been shown that the scope of a specified feature need not be a single segment, implying that not all features are synchronized by the same temporal function. The scope of a feature may both be smaller and bigger than a single segment. Before giving some examples let me emphasize that the term **segment** must be redefined if features are to be allowed to have different scopes. We must first determine what it is that features may have within their scope. The current view is that features have scope over abstract units, called **slots** (also sometimes referred to as **timing points**). These slots are essentially traditional SPE-segments deprived of all (or most) of their features, leaving only two brackets. According to one view slots are completely unspecified units, represented with the symbol "X", according to another we find two types of slots, usually represented by the symbols "C" and "V". These different views will be discussed in section 2.2.1.3.:

(1) [ ]

The sequence of pairs of brackets is referred to as the **central tier**. There is of course no objection to calling the units that constitute the central tier **segments**, as long as we realize that the interpretation of this term has been changed. The second point to be precise about is the status of features. The idea is that features are also segments; segments on their own, hence **autosegments**. If, in a particular language, there is good reason to represent the feature [F] as having scope over more than one slot then a sequence of such features is regarded as a sequence of [F]-**segments**. On the assumption that all other features are synchronized (i.e. have the same scope, in this example over one slot only), the following representation is the result:

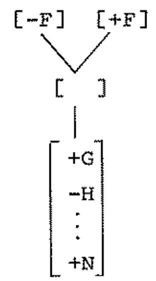
(2)



An understandable, but strictly speaking confusing, term to use for the third tier is **segmental tier**. It is possible to maintain that such a cumulative tier does not even exist and that it just happens to be the case here that the [G]-tier, the [H]-tier and all other tiers (except the [F]-tier) are subject to the same function that associates them to the central tier. However, since **wide scope** is the special case rather than the norm I will assume that the third tier has a theoretical status and that features are bundled in the traditional way, unless there is evidence to the contrary.

Instead of wide scope a feature may also have **narrow scope:**

(3)



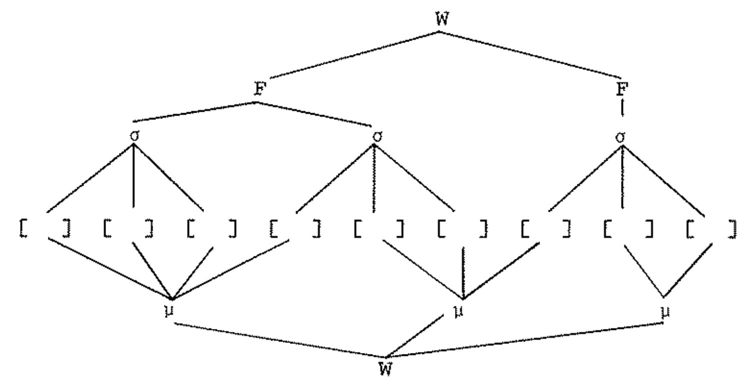
The need for giving features both wide and narrow scope (the reasons for which I will discuss in the next section) has led to the development of the theory of **autosegmental phonology**.

The second change in our conception of phonological representations is logically independent of the first. As noted above, the only hierarchical structure that is imposed on the row of segments in SPE is of a morpho-syntactic nature. This hierarchical structure tells us that substrings of segments constitute morphemes, words and finally phrases and sentences. Even in SPE it is pointed out that syntactic bracketing is not appropriate in all cases to characterize the domain over which intonational contours extend. To remedy this defect certain rebracketing operations are suggested. In subsequent work it has been pointed out that the mismatch between morpho-syntactic structure and some other kind of structure is more serious. The clearest examples involve rules that specify what sequences of segments are wellformed in a particular language. In SPE it was assumed that the domain of these rules was the morpheme, but many phonologists have pointed out that another unit would be more appropriate. This unit was the **syllable**. The logical conclusion of introducing phonologically motivated units comprising substrings of segments was that a complete hierarchical structure was assumed, distinct from the morpho-syntactic structure, although not unrelated to it. This view did not only arise from a need to

have an **intonational phrase** or a **syllable**. New views on stress completed the development by providing arguments in favor of several constituents smaller than intonational phrases and larger than syllables, viz. the **foot** and the **(phonological) word**. The new theory of stress was termed **metrical phonology** but soon afterwards this term was used to refer to a theory of phonological constituent structure in general.

The independence of morpho-syntactic and phonological constituent structure is acknowledged by assuming two distinct tree structures imposed on the string of segments, that is the interface between these two structures.

(4)



In (4) I have indicated the string of segments as pairs of brackets. Above I referred to such pairs of brackets as slots, to which features or feature bundles present on different tiers are linked. It turns out now that these slots can be interpreted as the smallest units, the terminal symbols, of the phonological constituent structure. Putting the two theories together in this way we can no longer look upon a phonological representation as a two-dimensional object. In fact this would have been impossible anyway for a case in which two features were **autosegmentalized**. This explains why the theory that is discussed here is called **three-dimensional** (as well as **nonlinear**).

The combination of the autosegmental conception and the two-sided hierarchical conception has another consequence. An important insight captured in autosegmental phonology is that the relation between autosegments and slots need not always be stipulated. In certain cases this relation is predicted by rule. In the simplest case the relation can be brought about by associating autosegments to slots in a directional fashion, going from left to right, associating autosegments and slots in a one-to-one fashion:

```
(5)        [+F] [-F] [+F] ...
             :    :    :
           [  ] [  ] [  ] ...
```

The dotted lines indicate the structural change of the rule that introduces the association lines, which are themselves represented by a closed line (cf. 6). If a one-to-one association was the only possibility it would be less obvious to distinguish between autosegments and slots in the first place. However, autosegmental phonology was invented precisely because the association is not always one-to-one. The original claim of autosegmental phonology is that, where deviations from the one-to-one pattern arise, the number of autosegments is different from the number of slots. Two types of situations may arise. Either there are more slots or there are more autosegments:

```
(6)   a.   [+F] [-F]              b.   [+F] [-F] [+F]
             |    |                      |    |
           [  ] [  ] [  ]              [  ] [  ]
```

According to the theory of autosegmental phonology representations as in (6) may lead to cases in which features have either wide or narrow scope:

```
(7)   a.   [+F] [-F]              b.   [+F] [-F] [+F]
             |    |\                     |    | /
           [  ] [  ] [  ]              [  ] [  ]
```

In (7a) we find **spreading** and in (7b) **dumping**; these are technical terms that I will continue to use here. Ignoring the issue as to whether spreading and dumping are the norm or the exception, it will be clear that a mismatch between the number of slots and the number of segments always holds within a particular **domain**. The most general position is that autosegmental association can in principle be bound to all domains that the theory defines. This includes morpho-syntactic domains as well as phonological domains.

Let us be more precise about what it means to say that association is bound to a particular domain. We must make a distinction between two types of cases. Suppose we have one autosegment and three slots. It is then either the case that the autosegment is already associated to one of the slots in

the lexical representation by stipulation (because it is not predictable by rule) or that there is no such pregiven association. If the autosegment is lexically associated we might simply say that the association rule is bound to a particular domain D:

```
(8)   [+F]
        |\ \
     ([  ] [  ] [  ])D
```

The autosegment that is associated to the first slot in D will spread to the other slots in this domain. But now consider the other logical possibility where the autosegment is not associated to any particular slot, and suppose furthermore that the representation consists of several autosegments and D's in a row. To make this more concrete imagine a language in which whole syllables are characterized by the presence or absence of a particular feature, such that all segments belonging to the same syllable are either [+F] or [-F]. A case in point could be the phenomenon of emphasis occurring in many Arabic dialects (see Van der Hulst and Smith 1982b):

```
(9)       [-F]               [+F]               [-F]

      ([  ] [  ])D  ([  ] [  ] [  ])D  ([  ] [  ])D
```

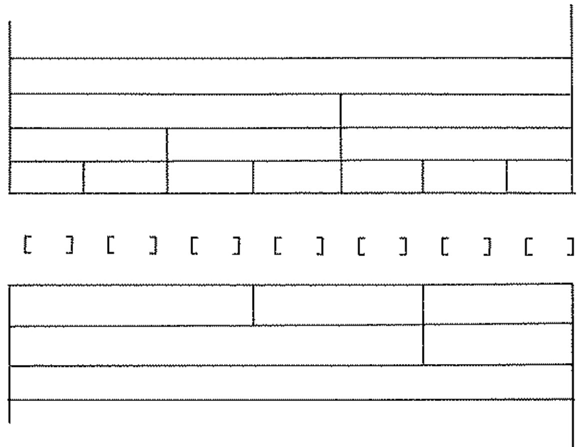
This time it is clearly insufficient to say that the association rule is bound to a particular domain, because it is not clear to which syllable each autosegment should go in the first place. Since (11) is the association that we want to derive, (10) seems to be a more appropriate input representation than (9):

```
(10)  [    [-F]    ] [      [+F]      ] [    [-F]    ]

      [ [  ] [  ]  ]D[ [  ] [  ] [  ] ]D[ [  ] [  ]  ]D

(11)      [-F]               [+F]               [-F]
          /  \              /  |  \             /  \
      ([  ] [  ])D  ([  ] [  ] [  ])D  ([  ] [  ])D
```

It turns out to be the case then that we must be able to express that a particular domain comprises not only a sequence of slots, but also one or more autosegments. The following figure illustrates this conception of phonological representations ("AS" stands for autosegment):

(12) ...
word level AS's
foot level AS's
syllable level AS's
segment level AS's

morpheme level AS's
word level AS's
phrase level AS's
...



To mention just one other example, in most vowel harmony systems we find morpheme level autosegments. I should emphasize that the view on the combination of autosegmental theory and the theory of domains presented here is not a commonly accepted view, to the extent that the issue is addressed at all. The study of autosegmental features in domains other than the morpheme or the word (usually meant as a morpho-syntactic domain) has so far not supplied us with very well documented examples. The present view is advanced in Van der Hulst and Smith (1982b), who were inspired by Hart (1981), where a slightly different view is offered. In forthcoming work Vago applies and elaborates this version of autosegmental phonology, where autosegments occur on different levels.

The above suffices to give the reader an idea of the theory of nonlinear phonology. In the next section I will discuss the various types of data that have played a crucial role in the emergence and further development of autosegmental phonology.

1.3. Autosegmental phonology

1.3.1. The characterization of complex segments

The standard theory is characterized by what Goldsmith (1976) has called the "absolute slicing hypothesis". An abstract representation of speech sound is split up into slices, called segments. Each slice is specified with

exactly one value for each feature of the total set of features that is required to represent speech sounds. Hence segments have no linearly ordered subparts. In the majority of cases segments can be interpreted as functions from points in time to a particular state of articulatory organs. So if a segment is specified as [+nasal] this means that at the time of producing this segment the velum is in lowered position. In actual life it may be the case that the velum is lowered slightly earlier causing a preceding segment to be nasalized during part of its production. The absolute slicing hypothesis embodies the claim that such a half nasalized vowel is not represented as [-nasal, +nasal]. The definition of segments on which this hypothesis is based only allows specifications such as [@F], where @ ranges over + or -. In the SPE theory it is also possible to have an integer as the feature value, indicating a certain degree of, for example, nasalization. Since in this example nasalization is dependent on the presence of a neighbouring nasal, the integer is only required as part of the phonetic representation, and not as part of the underlying representation, where the vowel in question is specified as [-nasal], thus abstracting away from the nasalization that occurs at the surface. In some cases, however, we cannot abstract away from the fact that an articulatory state changes during the production of one slice, because in such cases the change is an intrinsic property of the segment, i.e. it is not dependent on the presence of some neighbouring sound. Examples are numerous: affricates, pre- and postnasalized consonants, pre- and postaspirated consonants, (short) diphthongs (see Ewen 1982 for a discussion of many of these segment types, usually referred to as **complex segments**). During the production of an affricate we have a change from a stop to a fricative. Strict obedience to the absolute slicing hypothesis requires that we characterize such segments with a feature that is specified with an integer or a separate feature that directly refers to this change. In SPE the first possibility is blocked because all features are binary at the phonological level. The new feature to characterize affricates is called [delayed release]. Similarly, we will need features like [prenasal], [postnasal], [preaspirated], [postaspirated], [diphthong] etc. With respect to tones too, there is need for what we might call here **contour features** (as opposed to **level features**). In this case we need features like [rise] and [fall].

There is no objection as such to adding these features to the inventory. The reason for questioning this strategy comes from the fact that we miss certain generalizations by using contour features. The crucial argument has been advanced by Anderson (1976) with special reference to the contour features [prenasal] and [postnasal] and by proponents of autosegmental phonology (Goldsmith 1976) with reference to tonal contour features.

Consider the following example. In many African tone languages a phenomenon occurs called **downdrift**. The term downdrift refers to a gradual lowering of the pitch height of tones that are phonologically speaking the same. More specifically we find that a high tone is lowered slightly when it follows a low tone. So in a sequence ...HLH... the second H is lower in pitch than the first. Sequences of high tones stay at the same pitch height. The following rule expresses this fact:

(13) H -> ↓H / L –

('↓H' indicates 'lowered high'). In languages that have both downdrift and falling tones it may be the case that H is lowered after both a low tone and a falling tone. Hence the rule must be complicated in that case:

(14) H -> ↓H / {L, F} –

Conjunctions comprising contour tone features and level tone features are not exceptional. They show up again and again and may constitute the norm rather than the exception. When the context bar is on the right L appears together with F, when it is on the left L appears with R(ise). Recurrent conjunctions require an explanation. There must be something that the conjoined environments have in common and our formalism must be able to express this.

In the case at hand an explanation is available if we decide to abandon contour features and replace them with sequences of level features. So F is replaced by a sequence consisting of a high tone feature and a low tone feature (HL). It will be clear that given such a move we can return to the simpler downdrift rule in (13), but more importantly we no longer face the problem of recurrent conjunctions.

The mere decision to abandon contour features does not necessarily entail that we must also abandon the absolute slicing hypothesis embodied in SPE. In fact the decision to eliminate tonal contour features had already been taken by Woo (1969). The conclusion she drew from this was that it is impossible for short vowels to have contour tones. Assuming that long vowels can underlyingly be represented as a sequence of two short vowels Woo predicted that only long vowels can bear contour tones.

There are indeed cases where contour tones are not permitted to occur on short vowels. A case in point is Lithuanian where complex tones (i.e. rising or falling tones) can only occur on long vowels or sequences of short vowels

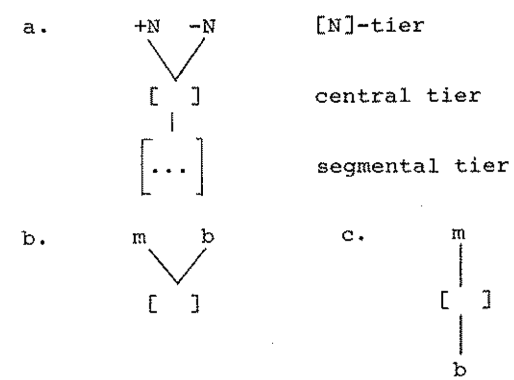
and sonorant consonants (cf. Kenstowicz 1970). This in itself supports the view to represent these tones with two level features. Languages of this type can be said to have a constraint prohibiting more than one tonal feature linked to a single segment.

Unfortunately the prediction as such is false. There are many cases where short vowels bear a contour tone, either underlyingly or at a later stage in the derivation. It seems then that our conception of segments must be altered in order to allow single segments to have two different specifications for one feature.

The same conclusion follows from Anderson (1976), who gives an argument that is completely parallel to the "downdrift-argument" involving nasalization of vowels preceding either a nasal consonant or a prenasal consonant. In the cases he discusses there is no evidence for representing the complex consonants as two segments underlyingly, hence the decision to represent a prenasal consonant as [+nasal] and [-nasal] directly implies that we must revise our conception of segments.

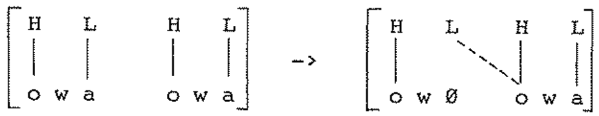
The model that has been sketched in the previous section finds part of its motivation in supplying a representation of complex segments, using sequences of level features. As I already indicated above (cf. 3), in this model a complex segment is represented as consisting of minimally three tiers (cf. 15a). This view on complex segments is not the only one that one will find in the autosegmental literature. Clements and Keyser (1983) represent complex segments by associating two fully specified segments to a single slot (cf. 15b), while Kaye and Vergnaud (1984) propose to represent complex segments without assuming linear order of the relevant components (as in 15c):

(15)



The view expressed in (15a) relies on the fact that we may have segment-level autosegments, i.e. autosegments that do not automatically spread to neighbouring segments. The alternative would imply that, given the presence of complex nasals in a certain language, all segments for which the feature [nasal] is relevant, are associated with this feature, that is represented on an autosegmental tier, which itself does not belong to a specific domain. By saying that complex segments can be characterized in terms of segment-level autosegments we do not exclude the possibility that complex segments may arise by being associated to two higher level autosegments. This is typically the case with contour tones in African languages, if a short vowel comes to bear a contour tone when a neighbouring vowel is deleted. In most such cases the tones are morpheme-level autosegments:

(16)



This example is taken from Elimelech (1976). Here I will not try to decide on the question as to how complex segments must be represented, because the consequences of the various alternatives for the theory as a whole are not always discussed in the literature and hence not completely clear. The essential point is that in the more widely accepted alternatives (expressed in 15a and 15b) complex segments are characterized in a way that is incompatible with the absolute slicing hypothesis. This is not the case in the proposal advanced by Kaye and Vergnaud (1984), so it remains to be seen to what extent their theory makes crucial use of different tiers in order to characterize complex segments.

1.3.2. Supporting arguments for representing features on independent tiers

The study of tone has given the main impetus to the development of autosegmental phonology and its application in this area has convinced many more than its application to other areas such as vowel harmony.

The first phenomenon that supports the autosegmentalization of certain features involves what has been called **stability**. In (16) an example of vowel deletion was given, leading to the emergence of a contour tone. However, I did not stress the fact that, while the vowel was deleted, the tone stayed behind. Given the autosegmentalization of tonal features this phenomenon does not strike us as very unexpected. This is precisely the

point. By representing features on different tiers we predict independent behaviour and this is what we find. Of course independent behaviour does not always involve deletion, but this is something that can be considered as the extreme case.

A short reflection on the issue will reveal that a strictly segmental (i.e. SPE type of) approach is going to miss the point completely. To handle the facts in (16) we need two rules. The first rule copies the tone of the vowel to be deleted on the next vowel. The second rule deletes the vowel. In an analysis of this type we have not explained why the tone has stayed behind.

A second and even stronger argument in favor of separating a tonal and a segmental tier involves **defective morphemes**. In tonal analyses one will encounter morphemes that consist exclusively of tone and also morphemes that (although they contain a vowel or, better, a tone-bearing unit; TBU) have no tone. In a strictly segmental framework such entities are problematical, especially the "segmentless" tones. Within the autosegmental model defective morphemes are not real anomalies. If morphemes consist of two independent tiers then there is no reason why one could not be lacking.

A third argument involves the phenomenon that words consisting of different numbers of syllables may show a behaviour which strongly suggests that they have the same **tonal melody**. Consider the following example, discussed in Odden (198Ø). In Shona a certain class of prefixes triggers a rule that lowers sequences of high toned syllables in the stem, no matter how many syllables this stem contains. This suggests that sequences of high toned syllables are associated with a single autosegment H. The rule triggered by the prefixes changes this H to L. Another argument involving the notion tonal melody is the following.

In Edmundson and Bendor-Samuel (1966) Etung is described as having the following melodies on words consisting of one, two and three syllables:

(17)

1 syllable	2 syllables	3 syllables
L	L L	L L L
H	H H	H H H
$\widehat{LH}$	L H	L H H
$\widehat{HL}$	H L	H L L
-	L $\widehat{HL}$	L H L
-	H $\widehat{LH}$	H L H
-	L $\widehat{LH}$	L L H
-	H $\widehat{HL}$	H H L

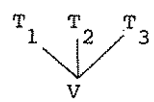
The notation $\widehat{HL}$ indicates a contour tone. Goldsmith (1976:132-134) discusses these facts:

> The conclusion is clear: we have in Etung a small class of tone formulas that may be spread over words of one, two or three syllables, proceeding from left to right. These melodies are L, LH, HL, H, LHL, LLH, HHL, and HLH. The occurrence of contour tones that motivate Leben's left-to-right mapping in Mende occur here, but the melodies HHL and LLH make it clear that the Obligatory Contour Principle is too strong in fact.

There are several issues that are relevant here, but let us first concentrate on the argumentation in favor of the autosegmental mode of representation. The facts from Etung provide us with three arguments.

Firstly, it is clear that in a strictly segmental framework it is not possible to express the generalization that there are eight melodies, simply because the notion melody has no status in such a framework. Secondly, the gaps receive a straightforward explanation, which would not be available if we were working with contour features. We can account for the gaps in table (17) by saying that Etung has a constraint which prohibits more than two different tone features being associated to one tone-bearing unit (cf. Halle and Vergnaud 1982):

(18)



where 1=/=2=/=3

Thirdly, consider the distribution of contour tones: they only occur on the last vowel. As stated in the preceding section and also in the quote from Goldsmith (1976), tones are associated to tone-bearing units (TBU's) in a one-to-one fashion, going from left-to-right. If the tones outnumber the tone-bearing units, left-over tones are dumped on the last tone-bearing unit. This **explains** why contour tones in Etung are found on the final vowel only. If tones were characterized by segmental features it would remain a mystery why a bisyllabic word cannot have a contour tone on the first vowel.

At this point the most important arguments supporting the autosegmental model have been discussed. Proceeding on the assumption that the model has been sufficiently motivated I will discuss a number of essential

conventions and principles in the next section.

1.3.3. Principles of autosegmental phonology

In the quote from Goldsmith (1976) reference is made to two principles: the **Obligatory Contour Principle** (OCP) and left-to-right **mapping.**

According to the OCP, proposed by Leben (1971, 1973), we exclude the possibility that adjacent autosegments have the same value. Hence we exclude ...H H ... or ... L L ... in all cases. Goldsmith points out that the facts from Etung are problematical for such a view since the total set of melodies comprises all eight possibilities that we have with two tones and at most three of them in a row. If the OCP is a genuine universal principle there should be only six melodies:

(19)

NO OCP	OCP
L L L	L
L H H	L H
L L H	L H
H H H	H
H L L	H L
H H L	H L
H L H	H L H
L H L	L H L

It seems that Goldsmith is correct in saying that the OCP cannot be maintained as a universal principle (cf. Halle and Vergnaud 1982). Even Mende, the language that Leben used to argue in favor of the OCP, appears to have melodies of the forbidden type (cf. Dwyer 1978, and Conteh et al. 1983). This reduces the OCP to a principle that **allows** one to collapse identical autosegments if there is no reason to leave them separate.

The mapping rule too dates back to Leben (1971). In his original conception this rule merged the tonal tier and the segmental tier, so that the surface representation conformed to the SPE-theory. In this form the rule is also found in Williams (1971), with the difference that Williams' version of the mapping rule did not contain the **dumping** clause. It will be evident that the mapping-as-merger rule could not be maintained because the whole issue of short vowels with contour tones remains problematical in that case. Hence Goldsmith (1976) proposes to let the rule introduce

association lines, leaving the tonal and segmental features on different tiers.

Leaving tones and segments on different tiers raises the question how they are related. This question is ambiguous. There are, to be precise, two questions to be answered:

(18) a. What constitutes a wellformed relation between the tonal and the segmental tier?

b. How does this relation come into being?

Goldsmith provides the answer to the first question by formulating a Wellformedness Condition (WFC):

(19) **Wellformedness Condition**
a. Association lines do not cross (no X-ing)
b. All TBU's are associated to at least one tone
c. All tones are associated to at least one TBU

The answer to the second question involves first of all three **Association Conventions** (AC's):

(20) **Association conventions**
a. **Mapping**
Insert association lines between **one** tone and **one** TBU
-going from left-to-right/right-to-left
-starting with the left/rightmost tone and TBU
b. **Dumping**
Left-over tones are associated to the nearest TBU
(to their right/left)
c. **Spreading**
Left-over TBU's are associated to the nearest tone
(to their left/right)

The part between parentheses is relevant if there is a choice and the first option mentioned in each case is considered to be unmarked. In the study of tone I am aware of no example where tones are associated from right-to-left, so it is perhaps not the case that we need the different options for all three association conventions. I refer to Haraguchi (1977) and Clements and Ford (1979) for further detailed discussion of the association conventions.

Goldsmith's original idea was that the WFC holds at every level of the derivation. If in the course of the derivation a violation of the WFC arises (for example because a TBU is deleted) the relevant AC applies to make the representation conform to the demands of the WFC. I will return to this view below.

Subsequent developments have shown that the AC's are not only parametrized in the sense that the left/right options must be fixed, but also in the sense that it depends on the language in question whether they apply at all. In Clements and Ford (1979) it is argued that tones that are left over after one-to-one mapping or set afloat in the course of a derivation may either be left floating (in which case they are not phonetically interpreted) or be associated by a language-specific rule. This position, which was also embodied in Williams' Mapping Rule, is adopted in Halle and Vergnaud (1982) as well. A consequence is that the third clause of the WFC must be eliminated and also that **dumping** can no longer be regarded as a universal convention.

Halle and Vergnaud (1982) go one step further and argue that automatic **spreading** too must be rejected. Whether or not spreading takes place is a language-particular matter, they argue. In languages that have no automatic spreading TBU's that remain unassociated will surface with the "unmarked tone value" that each TBU is supposed to have as a segmental specification. Hence clause b of the WFC can be eliminated too. Instead of assuming segmental values, others (e.g. Kiparsky 1983, Pulleyblank 1982) have proposed to leave all segments unspecified for tone. At the end of the derivation TBU's that are not associated with an autosegment are supplied with a **default value**.

The result of the development just discussed is that both the WFC and the inventory of AC's are considerably reduced:

(21) **WFC:** no X-ing
AC: mapping

In Pulleyblank (1982) we find a defence of this type of impoverished autosegmental theory.

A sceptical tonologist could argue at this point that the universal principles of autosegmental phonology given in (21) embody the claim that the least marked situation is the one in which each TBU is associated to precisely one tone (and vice versa) and furthermore that a model in which tones are segmental features expresses this claim much more straightforwardly. Only the first part of this statement is correct, however. The second part, meant as a rejection of the autosegmental representation of tones, totally ignores the arguments that have been provided in favor of this model and can therefore not be taken seriously. The issue whether **spreading** and **dumping** are universal conventions or not is logically independent from the fact that a strictly segmental model is incapable of explaining both the representation and the particular distribution of contour tones. The same holds for the other arguments that were discussed in the previous section.

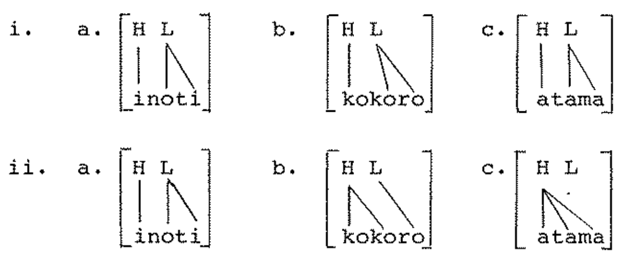
Let us proceed with a discussion of the association conventions and turn to the last one, viz. **mapping**. In Goldsmith (1976) it is realized that the mapping rule as formulated in (20a) is inadequate to handle all types of tone languages. The following example reveals the crucial point to be made here. In Haraguchi (1977) the autosegmental model is applied to Japanese dialects. In Standard Japanese words have a tonal pattern starting with at most one low toned syllable, followed by a rise to high, that lasts for at least one syllable, possibly followed by a fall to low. Consider the following examples:

(22) a. i n o t i b. k o k o r o c. a t a m a

Haraguchi's analysis is to assume a word melody HL and a rule that lowers the high tone of the first syllable if the second syllable is high as well. Hence he starts out with the following underlying representations:

(23)

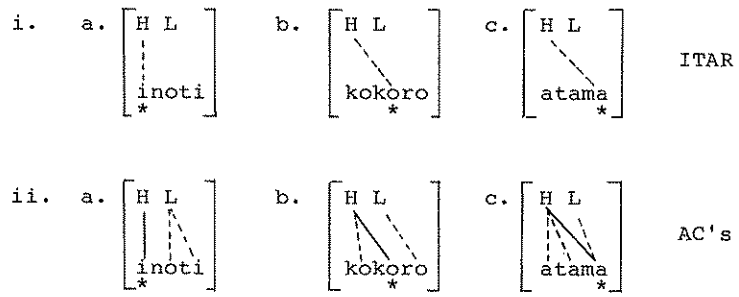

If we let the AC's apply, the representations in (23) will be changed into those in (24i), whereas a correct characterization of the tonal pattern of these words requires (24ii) (ignoring initial lowering for the moment):

(24)


Let us keep in mind here that Haraguchi assumed that both spreading and dumping are universal conventions. Only in the first case we obtain the correct result. The problem at issue is solved by calling upon the notion of a **starred syllable**, which is essentially the same notion as **accented syllable**, as used in McCawley (1977). It is claimed that in each word a particular TBU is designated as starred and furthermore that mapping is preceded by what is called an **Initial Tone Association Rule** (ITAR), that can be formulated as follows:

(25) **Initial Tone Association Rule**
Associate the H tone to the starred syllable

Once this ITAR has applied the AC's can take over, which, in Haraguchi's version of the autosegmental model, means spreading, dumping and mapping:

(26)


The presence of dumping necessitates adding a contour tone simplification rule to the analysis, to explain why the final syllable of **atama** does not have a falling tone.

The necessity to have rules like (25) entails that it is, strictly speaking, not correct to say that the WFC holds at every level. Rather we must say that the WFC comes into play after all language-specific rules, that refer to floating autosegments (like the one in 25), have applied. I refer to Odden (1984) for a discussion of this point.

Languages using stars are traditionally called **pitch-accent** languages, whereas languages not using stars have been referred to as (**true** or **lexical**) **tone languages**. An illuminating discussion of this distinction is found in McCawley (1978), and also in Clements and Ford (1979).

In the examples just given the location of the star is unpredictable and hence a lexical property of the words in question. Haraguchi also analyzes cases, however, in which the location of the first syllable with a high tone is predictable. This raises the question as to whether in such cases there is a rule that assigns stars, applying prior to (25), or whether we assume another type of ITAR:

(27) Assign the H tone to the TBU in position P

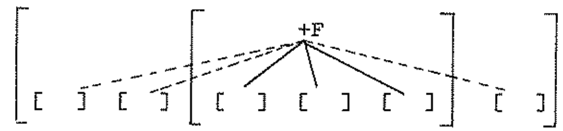
If (27) is adopted the next question might be whether we need the star at all. It would also be possible to say that alleged lexically starred syllables are simply lexically associated to a high tone. Hyman (1982) defends the view that we can do without stars and this position is also held by Pulleyblank (1982). Going into this issue in more detail would go beyond the limited goals of this chapter, however. The consequences of eliminating stars for an autosegmental analysis of the data analyzed in Haraguchi (1977) are discussed in Van der Hulst (forthc.).

The autosegmental model discussed in this section has not only been applied to tone, but also to other suprasegmental phenomena such as intonation and vowel harmony. In the next section I will show how the autosegmental model has been extended, limiting myself, however, to the area of vowel harmony. For the autosegmental approach toward intonation I refer to Liberman (1975), Goldsmith (1976) and, in particular to Pierrehumbert (198Ø).

1.3.4. Extension of autosegmental theory to vowel harmony

The proposal to extend the empirical domain of the autosegmental theory to vowel harmony is made in Clements (1976). Clements claims that it is possible to apply autosegmental phonology to vowel harmony, and that this model explains a number of essential properties of this phenomenon. The crucial point is this. If we say that a certain feature [F] is autosegmental in a language L this is essentially **all** we have to say to account for the fact that L has harmony involving the feature [F]. In particular we do not have to write a language-specific harmony rule. Assuming the WFC as a universal principle, the autosegment [@F] will be associated with all "[F]-bearing units" that are in its scope. Let me clarify this with a schematic example. In many cases of harmony affixes harmonize to the stem they are attached to; this is called **root-control** by Vago (198Øa) who offers a useful introduction to the phenomenon and analysis of vowel harmony:

(28)

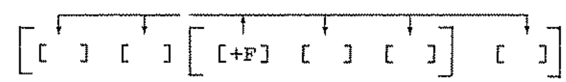


Thus we explain why harmony is unbounded and bidirectional. In the current segmental treatments there are various differences. With respect to the representation of roots we have at least two choices. Either we specify one of the vowels (usually the first) as [+F], leaving the others unspecified, or we specify all vowels as [+F] in the underlying representation. In the first case we need a mirror image iterative rule to account for the values of the remaining stem vowels and the vowels of the affixes. In the second case we need two rules, a redundancy rule specifying that all segments of a stem must agree in their value for [F] and in addition the mirror image iterative rule to account for the affix vowels. Of course, various variants can and have been proposed.

The two special properties of the segmental rule that is required in both variants of the segmental approach (viz. mirror image, iterativity) correspond exactly to the two things that could not be otherwise given the autosegmentalization of [F] (viz. unboundedness and bidirectionality).

Now suppose that the theory of autosegmental phonology was not independently motivated by tonal phenomena. It would then be possibile to argue that vowel harmony is segmental, but that we do not need language specific rules, because there is a universal convention which carries out the function of the mirror image iterative rule:

(29)



The autosegmental and the segmental approach are now equally simple: there is only one [+F] specification, one universal convention and no language-specific rule. The only problem that the segmental approach faces is that it is to a certain extent arbitrary to specify the first vowel as [+F] rather than some other vowel. In a toneless world this would provide us with one argument in favor of the autosegmental approach.

Clements (1976, 63) argues that, in addition, the autosegmental approach offers a better approach toward exceptions:

> Within the present framework, since vowel harmony is viewed as a consequence of general well-formedness conventions rather than as a set of language-particular rules, exceptions to harmony cannot be

> accounted for by [...] rule features. Rather, they must in all cases be built directly into the lexical representation of morphemes: vowels which invariably exhibit a given feature F are lexically bound to that feature, unless (as in the case of neutral vowels [...]) there is an independent explanation for their failure to show surface alternation.

Segments that are bound to an autosegment, before the association conventions (AC's) apply, are called **opaque**. Segments may be opaque on an item-to-item basis or predictably. An example of predictable opaqueness is found in Akan where the low vowel a is invariably linked to the autosegment [-ATR] (cf. Clements 1981). This fact is represented by linking all the occurrences of the low vowel to [-ATR] by a language-specific rule which takes precedence over the AC's:

```
(3Ø)                       -A
                            |
        [+low]    ->        -
```

This treatment of opaque segments explains a number of properties of such segments. They are not only exempted from undergoing a harmonic change, they also block the spreading of a harmonic feature to their left to segments to their right (and vice versa). Instead those segments become associated to the autosegment of the blocker. In short, opaque segments are **nonundergoers, blockers** and **spreaders** (cf. Clements and Sezer 1982 for more details). Consider the following example from Turkish, taken from the article just referred to:

```
(31)        -R    +R

            gEl   IyEr   Im

            -B    +B
```

The suffix /Iyor/ is disharmonic. Its second vowel does not harmonize to the value of the root. Observe that the autosegment of the root cannot spread further than the first vowel of the suffix. The second vowel then is opaque: it does not become associated to the autosegments of the root, it blocks propagation of both [-R] and [-B] and it finally spreads to the following suffix. A strictly segmental approach of this type of phenomenon requires

exception features of various types. Generally speaking it can be said that part of the autosegmental program is to eliminate exception features from the theory. The crucial point is that exceptionality in the autosegmental framework does not lead to the formulation of special (sub)rules or assigning special features. The irregular behaviour (being non-alternating) is encoded in the most straightforward way there is, given the autosegmental formalism.

It seems then that an autosegmental approach toward vowel harmony has several advantages and this would still be true, even if the crucial principles were established to explain this phenomenon only. But tone-languages exist and this implies that the autosegmental approach toward vowel harmony merely makes use of principles that have been independently motivated. The question should therefore not be: why should we treat vowel harmony autosegmentally? (as Ringen 1984 puts it), but rather: why should we continue to treat it segmentally?

Stewart (1983) proposes a segmental approach toward vowel harmony that is different from the two mentioned above in that use is made of word level wellformedness conditions (called word structure conditions) and rules (called Automatic rules, or A-rules) that specify how violations that may arise in the process of affixation are eliminated. Stewart applied his theory to Akan for which Clements (1981) had given an autosegmental analysis. Clements (1984) offers a critical assessment of Stewart's theory. It may be the case that Stewart's approach (and the somewhat similar approach offered in Crothers and Shibatani 198Ø) is the most preferred linear one, not facing the problem of stating the same generalization twice (i.e. as a morpheme structure rule and as a phonological rule) or the problem of using 'blanks' in phonological representations. A decision between the two types of treatments must then be made on the basis of their capacities to deal with complex sets of data in an explanatory way. At this point it is simply too early to say that either Stewart's approach or the autosegmental approach is more successful in this respect.

So far I have made use of a highly simplified (but essentially correct) picture of vowel harmony. I will now investigate in somewhat more detail the consequences of treating vowel harmony autosegmentally, adopting a slightly more critical perspective with respect to the claim that the principles used to explain vowel harmony and the principles used to explain tone are indeed the same. My intention here is to raise a few questions, rather than to provide answers.

In sections 1.3.1.-2 a number of reasons were discussed for treating tone autosegmentally. A sceptical student of harmony could argue now that by exploiting the autosegmental machinery to treat harmony we make a number of predictions that are not all borne out. The autosegmental approach toward harmony predicts that it is possible to find all the phenomena that we also find in the study of tone. If these phenomena are absent explanations for this absence must be given.

A striking difference between tonal and harmonic autosegments is the fact that whereas on the tonal tier we typically find "melodies", i.e. sequences of different tones, we **never** find melodies on the harmonic tier, excluding the cases where opaque segments are involved. That harmony always involves "degenerate melodies" (i.e. melodies consisting of one unit) has as a consequence that one-to-one **mapping** (as part of the universal set of AC's) is hardly relevant, whereas **spreading** is crucial. From this perspective tones and harmonic features appear to have little in common, considering the claim, discussed in the previous section, that spreading is not a universal convention in the area of tone. One might even go as far as to suggest that the theory of tone and the theory of harmony make use of **independent** principles. For tone the crucial convention is mapping. Spreading comes in as a language-particular rule (at least according to some phonologists). For harmony spreading is the essential universal convention since mapping is only required to link the harmonic feature to the leftmost vowel. As for the third possibility i.e. **dumping**, both areas are again very different. In vowel harmony systems it is **never** the case that two autosegments are associated to one P-bearing unit, i.e. multiple association is forbidden. This means that dumping is not possible, either as a universal convention or as a language-specific rule. On the other hand, one tone-bearing unit may be associated to two tones and this is typically the result of dumping rules. This fact even plays a crucial role in the argumentation in favor of the autosegmental theory of tone. Summing up, we arrive at the following picture:

(32)

		Tone	**Harmony**
a.	melodies	yes	no
b.	multiple ass.	yes	no
c.	mapping	yes	no
d.	dumping	yes	no
e.	spreading	?	yes

These five differences are not logically independent, of course, but that does not take away the impression that harmony is unlike tone in important

ways, despite the fact that we can exploit the same formalism (i.e. independent tiers and association lines) in both cases. The differences require an explanation, which autosegmentalists have not given so far.

In sections 1.3.2.-3 I discussed several diagnostic features for an autosegmental treatment. We have seen that some of these features (melodies, multiple association) are absent in the case of vowel harmony. Two other important diagnostic phenomena involved **defective morphemes** and **stability**. The question that naturally arises is whether or not we find these diagnostics in vowel harmony systems?

One type of defective morpheme has already been mentioned implicitly. Affixes that harmonize with roots can be represented as defective in the sense that they have no segment on the harmonic tier. Now do we also find suffixes consisting solely of the harmonic tier? One can think of several examples here that fit the description of such a type of defective morpheme.

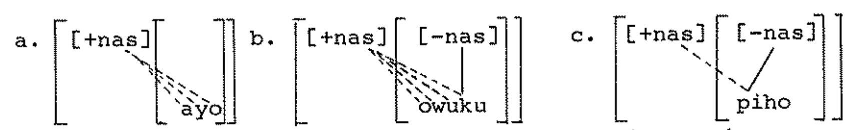
In their discussion of African vowel harmony systems Hall et al. (1974, 250) refer to:

> "... "Ablaut" ...a change of vowel series for which there is no overt conditioning factor - and "Reversed Category Shift" - the change of a [+ATR] vowel to a [-ATR] vowel. In both of these cases we believe that we are not dealing with autonomous morphophonemic processes but rather that these represent simply special cases of the Vowel Harmony rules which we have already seen. In the case of [...] "Ablaut" it is possible to speculate that historically there was a Dominant suffix present which has since been lost.

The "Dominant suffix" that is referred to can synchronically be analyzed as a suffix consisting solely of the autosegmental tier on which the feature [ATR] is represented.

A second example has been discussed in Van der Hulst and Smith (1982a, 22-23). In Terena, as described by Bendor-Samuel (1960), the first person singular of the verbal forms and the possessive of nouns is expressed by **nasalizing** all vowels and sonorant consonants from left to right up to the first obstruent, which appears as prenasalized. We are dealing here with a prefix consisting solely of the feature [+nasal]:

(33)



'my brother' 'my house' 'I went'

The example coming from Hall et al. (1974) also shows us the phenomenon of **stability** (in the diachronic sense), if Hall et al.'s speculation turns out to be correct. I know of no examples where stability plays a role in the synchronic derivation, i.e. no case in which for instance a vowel is deleted and its ATR value appears on another vowel. Stability, in the diachronic sense, is probably behind the following examples as well.

The first example is given by Clements (1981) in his analysis of Akan vowel harmony. A set of roots starting with a sequence consisting of one out of a specific set of consonants and the opaque low [-ATR] vowel a selects prefixes that are [+ATR]. The analysis of such roots offered by Clements is as follows:

(34)
$$\left[\begin{array}{llll} +A & & -A & \\ & & | & \\ & j^{w} & A & n\ I \end{array}\right]$$

What we find here is that an autosegment introduced by one morpheme is realized on another. Since two of the examples, discussed here, involve the feature [ATR] it is instructive that we can also give an example involving the feature [back]. In Hungarian we find backness harmony. Suffixes harmonize with roots, i.e. the system is **root-controlled**. The front unrounded vowels are neutral, i.e. they may cooccur in the same root with back and front rounded vowels. Roots that contain only neutral vowels normally take front suffixes. There is a set of roots, however, containing only neutral vowels that select suffixes with back vowels. We can account for the behaviour of these roots by giving them the following representation:

(35)
$$\left[\left[\begin{array}{l} +B \\ \\ vIz \end{array}\right] \begin{array}{l} \\ \\ nAk \end{array}\right]$$

I refer to Van der Hulst (1984) for a detailed discussion of Hungarian vowel harmony. The conclusion that we may draw from the discussion so far is twofold. Firstly, the autosegmental model is perfectly capable of handling the phenomenon of vowel (and consonant) harmony in both an elegant and explanatory fashion, so there is sufficient reason for adopting this theory, even ignoring the fact that it is (to some extent at least) independently motivated for the analysis of tone. Secondly, an autosegmental analysis entails certain predictions involving autosegmental

melodies, multiple linking and floating features. Not all of these predictions are borne out and this entails that at least some principles of autosegmental phonology are true for tone but not for harmony and vice versa.

I have ignored here several important and interesting aspects of the autosegmental approach toward vowel harmony, such as the proper treatment of neutral vowels or harmony systems in which root-control is absent (so called **dominant** harmony systems). The treatment of neutral segments is discussed in Van der Hulst (1984). I trust, however, that the present discussion is sufficiently detailed to give the reader a good idea of the principles of autosegmental phonology.

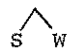
In the remainder of this book the focus will not be on the treatment of tone, nor harmony. Yet in many places reference will be made to the principles of autosegmental phonology, which justifies the foregoing discussion.

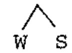
1.4. Metrical phonology

My sketch of metrical phonology will be short, because the principles of this theory will be discussed in great detail in the remaining chapters of this book.

In the broad sense metrical phonology is concerned with **phonological domains** and the **prominence relations** that hold within these domains. The theory of metrical phonology has arisen from Liberman's work on English stress and intonation (Liberman 1975). The treatment of English stress within this framework was elaborated in Liberman and Prince (1977), Selkirk (1980) and Hayes (1981, 1982). A general typology of stress systems, based on the metrical theory, was proposed in Halle and Vergnaud (1978) and Hayes (1981).

The basic idea behind metrical phonology is that prominence relations of an utterance can be characterized in terms of a constituent structure that is augmented with an S/W labelling. The S/W labelling expresses the fundamental claim that, within a particular constituent, one daughter is relatively strong with respect to her sister(s). A second, independent idea is that nodes in the constituent structure are maximally binary branching. Hence the S/W labelling indicates, for each pair of sister nodes, which one is more prominent. The basic building blocks of the theory are then:

(36) a. 

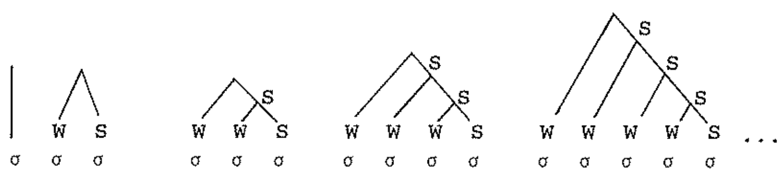
b. 

The labels S and W have no fixed phonetic interpretation. In this sense metrical trees are abstract and uninterpreted. It is a wellknown fact that prominence can be phonetically realized in a number of ways. For a typological survey of the ways in which prominence can be realized in natural languages I refer to Greenberg and Kaschube (1978).

Binary branching trees, thus labelled, have one and only one terminal element that is exclusively dominated by nodes that are labelled with S (excluding the top node). This property makes them suitable to express properties of speech units that occur at one place in these units only. One such **culminative** property is word stress (cf. Hyman 1977, Greenberg and Kaschube 1978). Suppose we want to say that in a language L all words have main stress on the final syllable. The labelled trees in (37b), taking syllables as their terminal elements express this fact adequately. The **stress rule** for L could be formulated as in (37a):

(37) a. Assign a uniformly right branching tree to each word
Label each right node with S and each left node with W

b.

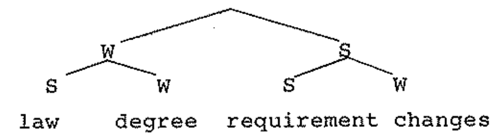


Monosyllabic words (i.e. the first case in 37b) receive a tree structure according to the rule in (37a), but we cannot assign a label S, because this label indicates **relative** strength. Within a constituent that has one daughter only, it makes no sense to say that this daughter has such a relational property. Yet, taking stress to imply the potential of being associated to an intonational pitch movement, monosyllables can be stressed. If they cannot be associated to a pitch moment they are **clitics**. This implies that metrical trees are interpreted according to the following rule:

(38) Within a constituent C main stress falls on the only syllable or on the syllable that is exclusively dominated by nodes labelled S

The idea of labelling nodes presupposes the presence of these nodes. Liberman's point of departure is that the constituent structure is given in the form of the morpho-syntactic constituent structure. This can be illustrated clearly with reference to compounds. On the assumption that the relevant constituent structure is the one that corresponds to the morphological structure the compound stress rule of English could consist of the following labelling rule:

(39) Label right node S iff it branches

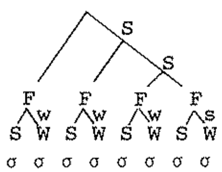


A very similar proposal was advanced in Rischel (1972), who uses the labels +/- instead of S/W. Rischel also points out that in certain cases the labelled tree must be restructured somewhat to arrive at a satisfying characterization of the stress pattern of compounds, a point that he discusses in more detail in Rischel (1983). This may be a reason to say that the hierarchical morphological structure of compounds is not so relevant at all. Below the compound level matters are slightly more complicated. Either we are dealing with words that have no morphological structure at all or the morphological structure is simply not the one that is required. I trust that the reader is familiar with the fact that in many languages one may distinguish between affixes that behave prosodically like stems, in which case the morphological structure can be used to assign the S/W labels to, and affixes that are integrated into the prosodic structure of their base, in which case the morphological structure appears to be irrelevant. The distinction will be discussed with reference to Dutch in section 2.2.4. The constituent structure that is to be labelled in complex words of the second type must be built up as part of the stress assignment procedure, as is the case when we are dealing with words that have no morphological structure at all. This is in fact what I did in the schematic example given above in (37).

But also above the compound level the syntactic structure is not the appropriate structure. It has been pointed out in various places that higher level prosodic tree structure is not isomorphic to the syntactic structure, although the former can be derived from the latter by means of a function. Nespor and Vogel (1982), following Selkirk (1982c) discuss this mapping function. They show that the constituent structure thus created not only provides a basis for assigning a relative prominence pattern to an utterance, but also functions as a theory of **phonological domains** to which phonological rules appear to be sensitive (cf. Selkirk 1980b). Rischel (1983) argues differently and claims that above the compound level, we do take the syntactic structure as a starting point. The resulting trees are labelled and then altered by transformational rules. A similar proposal is advanced in Giegerich (1983). It is clear that in both alternatives it is acknowledged that prosodic structure is not isomorphic to morphological or syntactic structure, but can be derived from it (directly or indirectly).

The Liberman and Prince theory embodies one other crucial innovation with regard to the treatment of stress. Prominence patterns typically involve more than just a single strong element surrounded by equally weak elements. If sufficient weak elements are present we will usually encounter a **rhythmical pattern**. Liberman and Prince propose two ways of dealing with rhythmical patterns. Within words such patterns arise by grouping syllables together into **feet**. A foot is defined as a relatively strong syllable followed or preceded by a sequence of relatively weak syllables. To designate the strongest syllable of the word we must now assume that feet rather than syllables are gathered in a uniformly branching tree:

(40)



To account for rhythmical patterns in phrases Liberman and Prince propose a different strategy, i.e. a procedure to create such patterns that does not depend on the binary branching constituent structure, but crucially involves another hierarchical structure, distinct from the tree, called the **grid**. A recent development of metrical phonology involves the claim that grid structure can be used to represent all aspects of prominence patterns and that one can do without binary branching trees and S/W labelling (Prince 1983, Selkirk 1984). In chapter 4 these variants of the metrical theory are discussed in great detail.

Just like the autosegmental theory, metrical theory, developed to deal with stress, has been extended to other phenomena. In particular it led to a revival of some traditional ideas about syllable structure. It will be evident that the metrical notation is adequate to represent the wellknown fact that for syllables it is also true that one element (usually a vowel) is

more prominent than all other elements within that same syllable. In chapter 2 I will discuss the various views on syllable structure that have been developed since.

1.4. Contents of this study

In the next four chapters I will be concerned with the theory of syllable structure and stress. With respect to both areas the strategy will be to discuss various competing theories and to argue in favor of particular variants. The variants that are adopted are then applied to Dutch. Chapters 2 and 3 deal with syllable structure, chapters 4 and 5 with stress.