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## Principles and parameters in prosodic phonology

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# Explanations for Language Universals

Edited by

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# Principles and parameters in prosodic phonology

GEERT E. BOOIJ

## 1. Introduction

In his well-known *Manual of Phonology* (1955), Charles Hockett writes that the phonological structure of an utterance is not just a linear sequence of segments but displays a hierarchical organization.<sup>1</sup> He assumes the following hierarchy:

- (1) macrosegment (= utterance minus intonation), microsegment (= phonological word), syllable, nucleus and margins, segment.

Haugen (1956) is of the same opinion. For Swedish he proposes the following hierarchy:

- (2) clause, phrase, measure (= phonological word), syllable, nucleus and margins, segment.

Comparing these two hierarchies, we see that Haugen adds a further differentiation of units above the level of the phonological word.

The idea of a phonological hierarchy is also present in the Firthian approach to phonology. For instance, Robins (1970: 192) writes,

- (3) 'We may thus speak of syllable prosodies, prosodies of syllable groups, phrase or sentence-part prosodies, and sentence-prosodies.'

That is, the linear sequence of segments is organized into higher-level units to which certain prosodies (i.e. suprasegmental phenomena) (such as tone, length, nasalization, etc.) may be assigned.

A fourth historical root of prosodic phonology can be found in the work of Kenneth L. Pike and his followers. For instance, McMahon (1967: 128) writes that the following phonological hierarchy must be assumed for Cora, a language of Mexico:

- (4) discourse-sentence-clause-phrase-foot-syllable-segment.

In standard generative phonology we do not find an explicit recognition

of a hierarchy of prosodic units. This can be illustrated by the way in which phonotactic constraints and stress are accounted for.

As for phonotactic constraints, they are mainly expressed in standard generative phonology by *morpheme* structure conditions (and partly also by phonological rules), but Hooper (1976) has shown that it is the syllable, not the morpheme, that gives us the most insightful and generalizing description of the phonotactics of a language. A sequence of segments is a well-formed phonological word if it can be exhaustively divided into one or more well-formed syllables. Moreover, for certain languages it is probably very unattractive to express phonotactic constraints by means of morpheme structure conditions. This holds for the Semitic languages, in which the identity of lexical morphemes is determined by so-called consonant skeletons, without vowels. These skeletons are unpronounceable, since the phonotaxis of these languages requires an alternation of consonants and vowels.

It is, in my opinion, a confusion of the *phonological* hierarchy and the *grammatical* hierarchy (segment-morpheme-word-phrase, etc.)<sup>2</sup> that led generative phonologists to consider the morpheme the relevant domain of phonotactic constraints. This confusion was probably furthered by the fact that these two hierarchies partially overlap. For instance, the segment occurs in both hierarchies, and in many cases a grammatical word is a phonological word as well. Moreover, in generative phonology there is no objection (and rightly so) to the use of grammatical information in a phonological description. But, of course, one should use grammatical information in the right way.

Pike (1962) already stressed the point that the two aforementioned hierarchies should be distinguished (see also Pike 1972: 409):

- (5) In our ordinary segmental material one finds the phonological units .... In addition, however, we have a lexical hierarchy with morpheme at the base. Morpheme sequences comprise words on a higher level of the same hierarchy, with further levels for phrases, clauses, sentences.... The interlocking of the phonology with the lexical and grammatical hierarchy is very important to the total language structure.

As for stress, it is again only the grammatical hierarchy that is recognized as relevant in standard-generative phonology. This is stated explicitly in Chomsky et al. (1956), in which the cyclic theory of stress rules is presented in embryonic form. In that paper, they defend *linear* phonology as the most restrictive phonological theory:

- (6) All suprasegmentals would then appear as features of phonemes, or as utterance-long or phrase-long components (i.e., contours). If similar

treatment is possible in the case of other languages, one can considerably simplify linguistic theory by restricting it to the consideration of linear systems.

However, things have changed as a result of the emergence of metrical phonology. In this theory, particularly in Selkirk (1978, 1980a, 1980b), we find an elaborated immediate constituent analysis of phonological structure. Selkirk assumes the following phonological hierarchy for English:

- (7) Utterance (U), Intonational Unit (I), Phrase ( $\phi$ ), Word ( $\omega$ ), Foot (F), Syllable ( $\sigma$ ), Segment.

In this paper, I will discuss certain aspects of this hierarchy. First, I will discuss the principles and parameters of syllable structure, presupposing that the introduction of the notion 'syllable' is well motivated. Second, I will discuss the role of the foot, the phonological word, and the phonological phrase in phonological description.

## 2. Principles and parameters of syllable structure

In the phonological literature, we find two approaches to the problem of how to define the canonical syllable structure of a language: the *distributional approach* and the *independent approach*. In the distributional approach, the class of possible onsets of a syllable in language L is equated with the class of possible word-initial consonants and consonant clusters of L, and the class of possible codas with the class of possible word-final consonants and consonant clusters.<sup>3</sup> In the independent approach, the syllable itself is the point of departure. It is evident that the latter approach must be preferred (although the distributional approach may have a heuristic function) since many languages have special restrictions for the word-initial and word-final positions that are not valid for every syllable onset and coda respectively. Some examples are the following:

- |                                       |                    |
|---------------------------------------|--------------------|
| (8) a. Word-final restrictions:       | Source:            |
| Japanese                              | Vennemann (1978)   |
| Huichol                               | Bell (1976)        |
| Timicua                               | Granberry (1956)   |
| Campa Arawak                          | Dirks (1953)       |
| Sierra Nahuat: no word-final [m]      | Key and Key (1953) |
| Arekuna Carib: no word-final [m], [n] | Edwards (1978)     |
| Spanish: no word-final [ns]           | Pulgram (1970)     |

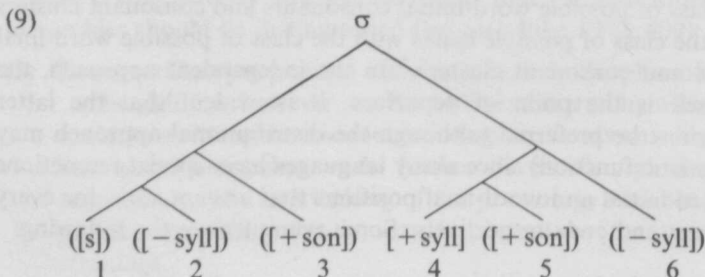
In all these examples, the restrictions apply only word-finally, but not syllable-finally.

- |        |  |                       |
|--------|--|-----------------------|
| (8) b. | Word-initial restrictions:                                   | Source:               |
|        | Tamil: no word-initial lateral segments                      | Fowler (1954)         |
|        | English: no word-initial [ʒ]                                 | Hooper (1976: 197)    |
|        | Marinahua: no word-initial consonant clusters                | Pike and Scott (1962) |
|        | Sierra Nahuat: no word initial [h], [g]                      | Key and Key (1953)    |
|        | Olgolo: no word-initial consonants (except certain prefixes) | Dixon (1970)          |
|        | Dutch: no word-initial [pj], [kj]                            | Booij (1981)          |
|        | Bamileke: no word-initial glottal stop                       | Hyman (1978)          |

The well-formedness conditions on syllable structure in a language can be expressed by means of a combination of (1) a syllable template, (2) the universal sonority hierarchy, (3) language-specific collocational restrictions, and (4) a possible appendix at the edges of the (phonological) word.

### 2.1. Syllable templates

The syllable template expresses the minimal and maximal number of segments which can be contained in a syllable and specifies certain necessary properties of these segments. For instance, the following template may be assumed for Dutch:



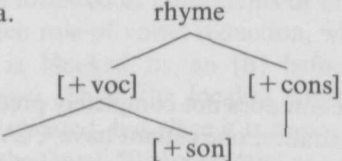
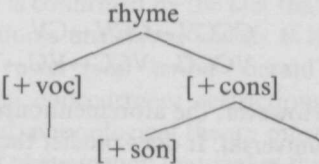
All terminal nodes are optional except one, the [+syllabic] segment. (Note that this syllable template presupposes as a separate parameter of syllable structure that it has already been defined which segments are [+syllabic].)

This geometrical approach to syllable structure has a certain attractiveness compared to the method of merely listing the possible syllable types of a language. For instance, assuming that in Dutch long vowels and diphthongs are represented as sequences of two syllabic segments, we

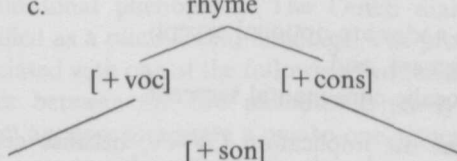
correctly predict by means of the template that long vowels and diphthongs do not admit more than one consonant in their codas, whereas short vowels admit two:<sup>4</sup>

- (10) [damp] but: \*[damp], \*[dɛimp]  
[baŋk] but: \*[baŋk], \*[beɪŋk]

A disadvantage of template (9) is that it claims for syllables with postvocalic consonant clusters (e.g. *damp*) that the vowel and the [+son] consonant have a stronger degree of cohesion than the [+son] consonant and the following consonant. This is not in conformity with the general observation that the restrictions between postvocalic consonants are stronger than those between the vowel and the following consonant(s). For instance, in Dutch a postvocalic nasal consonant must always be homorganic with a following tautosyllabic obstruent (with the exception of obstruents in the appendix, cf. section 2.4). This situation can be remedied by a proposal in Trommelen (1982: 310). She proposes two different templates for the rhymes of Dutch syllables,

- (11) a.  b. 

which can be collapsed into

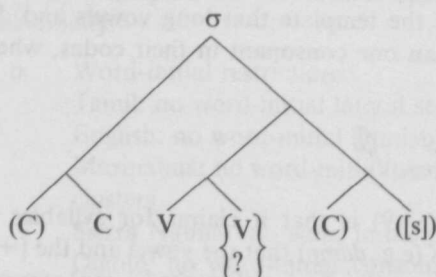
- (11) c. 

with a 'floating' feature [+son], which, by universal convention, can be connected with either the [+voc] node or the [+cons] node. The convention of feature percolation then determines whether the [+son] segment will be a vowel or a consonant.

A similar advantage of the geometrical approach shows up in the description of the canonical syllable structure of Sierra Popoluca (Vera Cruz, Mexico). The following syllable template can be assumed for this language:<sup>5</sup>



(12)



This template expresses the restriction that it is only after SHORT vowels that we may find a cluster of three consonants, the first of which has to be a glottal stop, and the third an [s] (Elson 1947: 14).

It should be noted furthermore that in the templates (9) and (12) only terminal nodes are optional. This is a well-motivated restriction on syllable templates. If we allowed for optional higher nodes as well, a language could have, for instance, the syllable types CCV and V, but not CV. This would conflict with the following implicational universal proposed by Greenberg et al. (1966: xxv):

- (13) CCCV → CCV → CV  
VCCC → VCC → VC → V

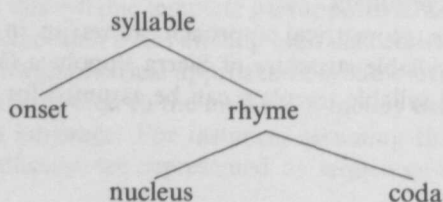
However, the aforementioned restriction does not completely predict this universal. It does predict that, for instance, one cannot have CCV and V without also having CV, but it does not predict that only one C-node before the [+syllabic] segment can be obligatory. Thus, to cover Greenberg's universal, the constraint should be reformulated as follows:

- (14) All and only terminal nodes are optional except  
a. the [+syllabic] segment, and  
b. optionally a prevocalic consonantal segment.

Greenberg explicitly excludes the implication CV → V, because certain languages, such as Sierra Popoluca (cf. 12) require at least one prevocalic consonant.

The proposed syllable templates (9) and (12) reflect the onset-rhyme distinction within the syllable:

(15)



It has been frequently noted (e.g. in Hockett 1955: 150; Pike 1972: 386–387) that while there are usually no cooccurrence restrictions between onset consonants and vowels, such restrictions do exist between the vowels and the coda consonants. By assuming that syllables have a hierarchical structure and that cooccurrence restrictions are local, this asymmetry in the restrictions between vowels and consonants is explained. Furthermore, it is predicted that restrictions between onsets and codas do not exist.

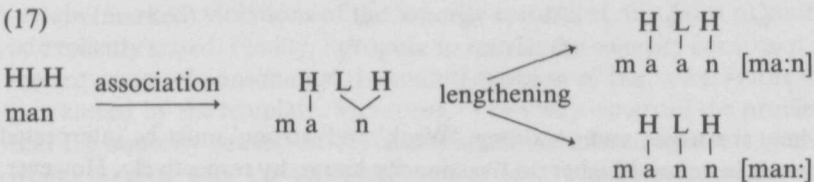
Note, however, that these assumptions do not exclude restrictions between the onset and the whole rhyme. We find such a restriction in Dutch where the following patterns occur or are excluded:

- (16) a. \*[l] — long vowel — [l]    c. [r] — long vowel — [r]  
 b. [l] — short vowel — [l]    d. \*[r] — short vowel — [r]

In the cases (16a–d) it is clearly the whole rhyme that is incompatible with the consonant in the onset, since syllables with [l] + long vowel or [r] + short vowel are well formed.

However, restrictions between the onset and the vowel of the rhyme do exist. For instance in Dutch the sequence \*[hə] is forbidden, whether the schwa is followed by consonants or not. This is confirmed by the fact that the Dutch rule of vowel reduction, which reduces unstressed vowels to a schwa, is blocked by an [h] before the vowel (e.g. *heráut* ‘herald’ → \**həraut*). Thus, the locality constraint on cooccurrence restrictions may be violated, but since it is normally valid, phonological theory must qualify the Dutch \*[hə] constraint as a marked phenomenon that makes the grammar more complicated than the restrictions in (16).

The onset-rhyme division is also relevant for an adequate account of certain tonal phenomena. The Dutch dialect of Maasbracht can be qualified as a pitch-accent language. The prominent syllable of a word is associated with one of the following two tonal melodies: HLH or HL. The choice between the two melodies is partly lexically determined. This dialect appears to require a one-to-one association between the tones and the [+sonorant] segments in the *rhyme* of the maximally prominent syllable. For instance, the word *man* ‘man’ has a HLH melody. Although this word contains three sonorant segments, a process of lengthening still has to apply, adding another sonorant segment, since the relevant domain, the rhyme, contains only two sonorant segments:





This shows that the [+son] segment in the onset does not count, since otherwise lengthening of the short vowel or the consonant would not be necessary (cf. Hermans 1982).

## 2.2. The sonority hierarchy

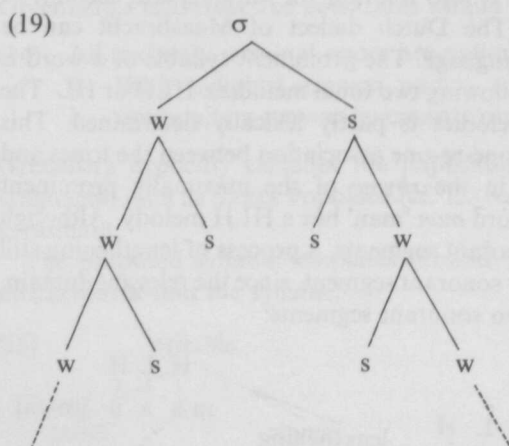
A second general principle of syllable structure is that the sonority of the segments of a syllable must decrease in the direction of the edges. We assume the following sonority hierarchy:

- (18) vowels–glides–liquids–nasals–fricatives–plosives  
 →  
 decreasing sonority

For instance, if position 5 in template (9) is occupied by the [r], position (6) can be filled by a nasal (e.g. *arm* 'arm'), but if position 5 is occupied by a nasal, position 6 can be occupied only by an obstruent.

The sonority constraint should again be considered an unmarked principle. In certain languages it can be violated, as template (9) shows: this template admits a fricative, [s], before plosives and fricatives, creating clusters such as [sp-], [st-] and [sx-]. Some languages admit clusters of consonants with the same degree of sonority (e.g. Greek *pt-*, *mn-*), again violating the constraint.<sup>6</sup>

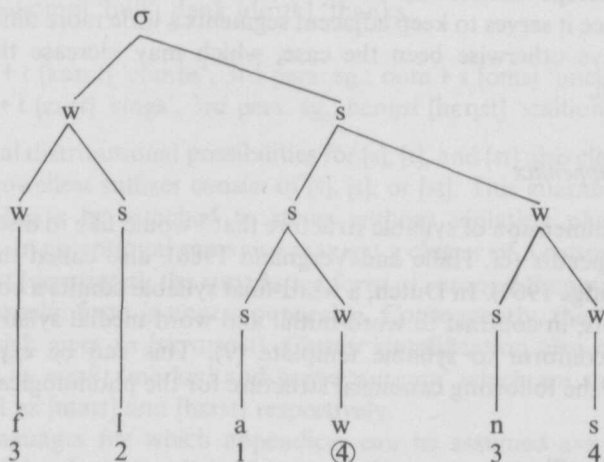
Kiparsky (1979: 432) proposed to integrate the sonority constraint into metrical phonology by assuming the following universal syllable template:



where w = *weak*, and s = *strong*. 'Weak' and 'strong' must be interpreted here as lower and higher on the sonority hierarchy respectively. However,

the templates (9) and (12) do not conform to the general structure (19), since they contain a branching nucleus. That is, structure (19) does not admit the generalizations we would like to make. Selkirk (1980a), who also uses the *w/s* notation for the sonority hierarchy, assumes the following representation for the word *flounce* [flaʊns], WITH a branching nucleus:

(20)



But this is no improvement, because this structure appears to predict that the right branch of the nucleus must be weaker than the following consonant, which is clearly incorrect. (This prediction can be checked by applying the algorithm proposed by Liberman and Prince 1977 to the syllable tree: the second part of the nucleus receives a '4'). Moreover, for many languages it is attractive to represent long vowels as sequences of two IDENTICAL segments, in order to express phonotactic constraints, as we saw above (cf. [9], [12]), or to uniformly qualify heavy syllables as syllables with branching rhymes (cf. Hayes 1981).

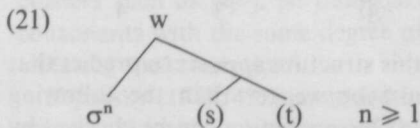
Thus, I prefer not to extend the strong-weak relationship to the internal structure of the syllable. I will consider the sonority constraint as an additional constraint on the linear sequences of terminal nodes in the syllable template. Consequently, no special provision has to be made for the [s] in position 1 in template (9). Furthermore, if a language admits certain (marked) violations of the sonority constraint, this must of course be explicitly stated. Finally, I propose to restrict the sonority constraint to the sequences of consonants: the central position of the vowel is already guaranteed by the template. Moreover, in this way we avoid the problem that the sonority constraint excludes adjacent identical segments, which would conflict with the representation of long vowels as two identical segments.

## 2.3. Collocational restrictions

In addition to a syllable template and the sonority constraint, a language may impose further restrictions on the types of syllable which it admits. These restrictions are called 'collocational restrictions' in Fudge (1969). Dutch, for instance, does not accept plosive-fricative or fricative-plosive clusters, except clusters with *s*. This restriction has a functional 'explanation', since it serves to keep adjacent segments a little more different than would have otherwise been the case, which may increase the ease of perception.

## 2.4. The appendix

The next dimension of syllable structure that I would like to discuss is that of the appendix (cf. Halle and Vergnaud 1980), also called the 'termination' (Fudge 1969). In Dutch, a word-final syllable admits a coda of four consonants, in contrast to word-initial and word-medial syllables, which have to conform to syllable template (9). This can be expressed by assuming the following canonical structure for the phonological words of Dutch:



On the phonetic level, these appendices [s], [t], and [st] have to be integrated into the final syllable, because the phonological rules that apply within a syllable also apply to word-final syllables plus appendix. The following words exhibit such appendices:

- (22) a. Simplex words:  
       markt 'market'; links 'left'; herfst 'autumn'  
       naakt 'nude'; laars 'boot'; ernst 'seriousness'
- b. Complex words:  
       warm + t 'heats', 3rd pers. sg.; (iets) arm + s 'something poor';  
       dank + t 'thanks', 3rd pers. sg.; (iets) goor + s 'something filthy';  
       vond + st 'finding'  
       erg + st 'worst'

There are at least three arguments for an appendix interpretation of s, t, and st in Dutch:

1. it explains why codas of three and four consonants occur only word-finally;

2. it explains why coda clusters of three and four consonants do not obey the sonority constraint on syllable structure;

3. it explains why consonant clusters in *-st* are exceptions to the rule that nasals are always homorganic with a following tautosyllabic obstruent. Compare:

- (23) damp [damp] 'vapor'; bank [bɑŋk] 'bench'  
 romp [rɔmp] 'hull'; dank [dɑŋk] 'thanks'  
 but:  
 kam + t [kamt] 'combs', 3rd pers. sg.; oom + s [oms] 'uncles'  
 zing + t [zɪŋt] 'sings', 3rd pers. sg.; hengst [hɛŋst] 'stallion'

These special distributional possibilities for [s], [t], and [st] also clarify why all Dutch vowelless suffixes consist of [s], [t], or [st]. This guarantees that they can always be attached to stems without violating phonotactic constraints. In exceptional cases one may get a cluster of 5 consonants as in *verarmdst* [verarmstst], the superlative form of *verarmd* 'impoverished', but this phonetic form is unpronounceable. Consequently, the first [t] is deleted, which gives us [verarmst]. Cluster simplification also occurs in words such as *markt* 'market' and *herfst* 'autumn' which are sometimes pronounced as [mart] and [herst] respectively.

Other languages for which appendices can be assumed are English, German, Malayalam, Swedish, Berber, and Zoque. Fudge (1969) proposes a syllable constituent 'termination' (T, st, θ) for English, Moulton (1956) proposes the assumption of an appendix of three coronal obstruents for German (e.g. in [*des*] *Herbsts*, gen. sg. of *Herbst* 'autumn'), and for Malayalam Halle and Vergnaud (1980: 98) assume the appendices [m] and [n], since in this language rhymes normally consist of vowels or syllabic [r] only, but word-final rhymes may contain an [m] or [n] as well.

In Tamazight Berber (Saib 1978: 101 ff.) consonant clusters occur only in word-final syllables. Moreover, some of these clusters violate the sonority constraint, such as the word-final clusters in *iffɾ* 'wing', *asy* 'to take', *izm* 'lion'. Tamazight Berber also has obstruent + nasal sequences in inflected verbs and nouns. Thus, the assumption of a consonantal appendix for this language seems to be well motivated.

In Swedish one finds word-final codas with up to six consonants (Sigurd 1965), e.g. *svenskt*, *närmsts*, *skälmskts*, whereas word-internally a coda consists of at most two consonants. These long clusters mainly occur in inflected or derived words. These facts can be accounted for by assuming the appendix (*s*) (*k*) (*t*) (*s*) for Swedish. Again, the appendix interpretation also explains why these clusters violate the sonority constraint: this constraint holds for (phonological) syllables, not for appendices.

The final language that I want to discuss here is Zoque. According to

Wonderly (1951), syllable onsets consist of at most two consonants, but word-initially we may find three, e.g.,<sup>7</sup>

- (24) ηgyenba 'you look'  
mbyokspa 'you sit'

The (homorganic) word-initial nasals are prefixes. For this language we may therefore postulate a word-initial nasal appendix because this relates the fact that clusters of three consonants occur only word-initially, and the fact that these clusters violate the sonority constraint since the nasal consonant precedes an obstruent. The difference between Zoque and the languages mentioned before is that Zoque has a word-INITIAL appendix.<sup>8</sup>

### 2.5. *Residual questions*

In the preceding sections I have tried to show which principles and parameters must be assumed for syllable structure. However, it should be realized that there is a second dimension of syllable structure that has not been discussed so far: the principles of syllabification for each language. Three questions emerge here: (1) which are the general principles of syllabification (for instance, can we assume a universal 'maximal onset principle'?); (2) on which level in the phonological derivation do syllabification rules apply; and (3) what happens to a syllabified string after the application of a phonological or morphological rule that changes the segmental composition of that string, i.e. which are the principles of resyllabification? Although these questions lie outside the scope of this paper, they should be mentioned here in order to get a complete picture of the issues involved in syllable structure. They are discussed in Pulgram (1970), Kahn (1976), Selkirk (1980a, 1980b), and Booij (1981).

### 3. The foot

The necessity of assuming a foot level in the prosodic hierarchy emerged in the course of the development of the metrical theory of stress. Therefore, I will first introduce the elementary principles of this theory.

Lehiste (1970: 2) mentions two fundamental properties of stress which distinguish this phenomenon from the inherent properties of segments. First, stress is, like pitch and quantity, a secondary, superimposed function of inherent properties: suprasegmental properties involve the manipulation of phonetic factors which are present anyway. Second, stress is a syntagmatic property: it is a property of a unit in relation to

other units to which it stands in a syntagmatic relation. That is, stress is a relational property.

Generative phonology, however, has tried to reduce stress to an inherent feature by means of the cyclic theory of stress rules. A first version of this theory was presented in Chomsky, Halle, and Lukoff. They motivate their theory as follows (1956: 79):

All suprasegmentals would then appear as features of phonemes, or as utterance-long or phrase-long components (i.e. contours). If similar treatment is possible in the case of other languages, one can considerably simplify linguistic theory by restricting it to the consideration of linear systems.

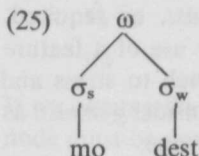
They do acknowledge the relevance of constituent structure to phonology, but the constituent structure they use is the morphological-syntactic structure which is present on the underlying phonological level. The phonetic representation of an utterance is linear: 'The elements of the transcription T are segmental phonemes, junctures and a single accent element' (1956: 66).

The treatment of stress in a linear framework suffers from two serious drawbacks (cf. Liberman and Prince 1977):

1. a linear representation of stress does not do justice to its relational, syntagmatic nature; and
2. the representation of stress by means of an inherent feature involves a considerable enrichment of the descriptive power of phonological theory that is motivated only for stress rules.

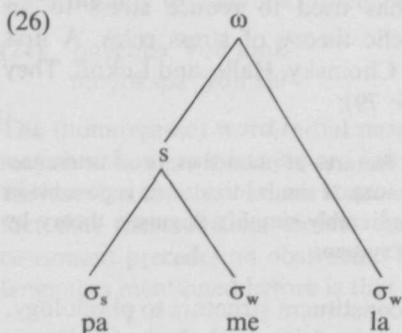
For instance, the *SPE* theory of stress requires the cyclic application of stress rules, and a stress subordination convention.<sup>9</sup> Moreover, it also implies the use of variables in the structural description of stress rules, and consequently stress rules become nonlocal, in contrast with other phonological rules, i.e. they skip potentially relevant segments, thereby violating the relevancy condition ('Only irrelevant segments may intervene between the focus and the determinant in phonological rules'; Jensen and Stong-Jensen 1979).

These problems are overcome in the metrical theory of stress developed in Liberman (1975, ch. 4) and Liberman and Prince (1977). The prominence of the first syllable of *modest* with respect to the second can be represented as in (25):<sup>10</sup>





where *s* = strong, and *w* = weak. Similarly, the word *Pamela* receives the representation (26):



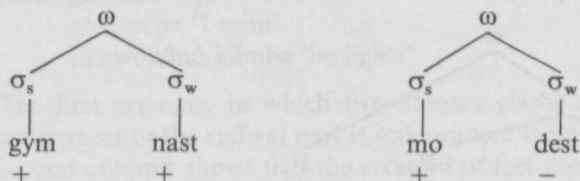
The essential well-formedness condition on metrical trees is that if there is a node labeled *s*, there must be a sister node labeled *w*, and vice versa. In this way, the relational nature of stress is formally expressed. Consequently, prosodic trees are always binary-branching at those levels where strong-weak relations are defined. The syllable of a word which is dominated only by *s*-nodes bears the main stress of that word. The degree of stress of the syllables dominated by at least one *w*-node is provided by the following algorithm:

If a terminal node *t* is labelled *w*, its stress number is equal to the number of nodes that dominate it, plus one. If a terminal node *t* is labelled *s*, its stress number is equal to the number of nodes that dominates the lowest *w* dominating *t*, plus one (Lieberman and Prince 1977: 259).

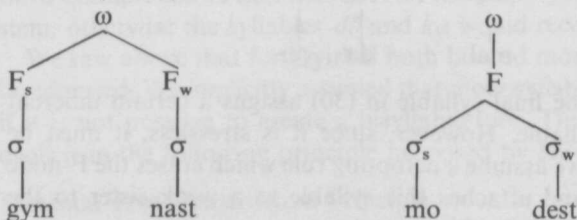
Thus, the stress pattern 132 is derived for *Pamela*.

As I mentioned above, Selkirk (1980a) proposed an additional foot level between the level of the syllable and the level of the phonological word. One of her arguments for this additional level is that it enables us to account for the difference between *modest* and *gymnast* without the use of an inherent feature [stress]. In *gymnast* the vowel of the second syllable cannot reduce, but in *modest* it can. Therefore, Liberman and Prince assigned the feature [−stress] to the vowel in the second syllable of *modest*, and the feature [+stress] to the vowel in the second syllable of *gymnast*. Since vowel reduction is considered to apply only to unstressed vowels, the reduction rule will be blocked in *gymnast*, as required. However, Selkirk (1980a) convincingly argues that the use of a feature [stress] is a residue of the linear, paradigmatic approach to stress and should therefore be avoided. Selkirk's alternative is to consider *gymnast* as consisting of two feet, and *modest* as consisting of only one:

Lieberman and Prince (1977):



Selkirk (1980a):



If vowel reduction is formulated as applying to weak syllables only, reduction will be blocked in *gymnast*.

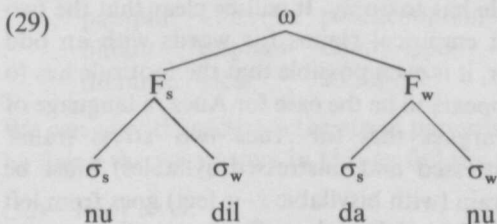
There is yet another, much more general reason for the introduction of a foot level: the foot is the descriptive mechanism par excellence for the many languages in which words show an alternation of stressed and unstressed syllables.<sup>11</sup> An example of such a language is Dyirbal. In Dyirbal every odd syllable receives stress, except a word-final one (Dixon 1972: 274–276). This is illustrated by the following forms of the verb *nudil* 'to cut':

(27) *núdin, núdilman, núdildánu, núdilmáldanu*

Let us assume that Dyirbal has the following stress rules:

- (28) a. Create iteratively bisyllabic *s w* feet, from left to right.  
b. On the word level, the nodes are labeled *s w*.

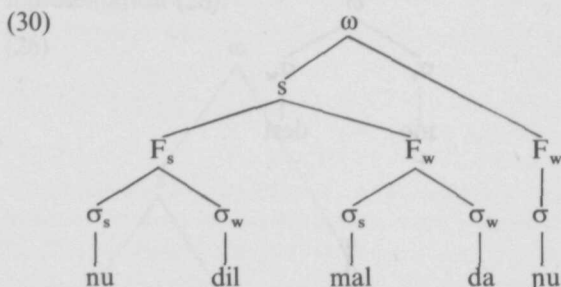
These rules create the following representation for *nudildanu*:<sup>12</sup>



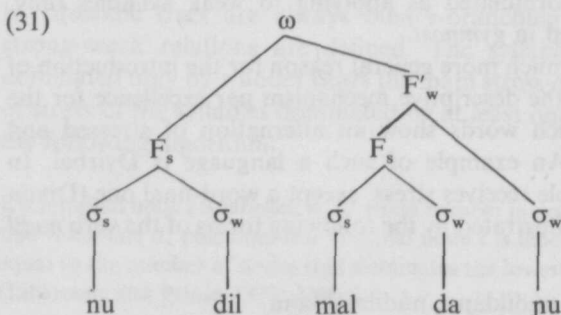
If we assume the prosodic well-formedness condition that every syllable node must be dominated by a foot node, this implies that Dyirbal words



with an odd number of syllables end in a monosyllabic foot, as (30) shows:



The foot status of the final syllable in (30) assigns a certain inherent prominence to this syllable. However, since it is stressless, it must be 'defooted'. Therefore, we assume a defooting rule which erases the F-node of monosyllabic feet and attaches this syllable as a weak sister to the preceding foot. This results in (31):



It would be wrong to assume trisyllabic feet on the underlying level, since then we could not predict that a word of, for instance, six syllables must be divided into three bisyllabic feet, not into two trisyllabic feet.

In describing the stress patterns of languages with an alternation of stressed and unstressed syllables, it is important also to specify the direction in which the foot rule has to apply. It will be clear that the two directions will make different empirical claims for words with an odd number of syllables. Moreover, it is even possible that the foot rule has to apply from both sides. This appears to be the case for Auca, a language of Ecuador (Pike 1972). Pike argues that for Auca two 'stress trains' (sequences of alternately stressed and unstressed syllables) must be assumed. In Auca the stress train (with bisyllabic *s-w* feet) goes from left to right in the stem and from right to left in the suffixal part of a complex word. The examples in (32) illustrate this (the dot indicates the boundary between stem and suffixal part):

- (32) gó.bópa 'I go'  
 gó.tabópa 'I went'  
 tíkawódōnó.kāmba 'he lights'

The first example, in which two stresses clash, shows that the stress assignment in the suffixal part is independent from that in the stem. The second example shows that the creation of feet goes from right to left in the suffixal part, since otherwise the syllable *ta* would be stressed. The third example shows that the foot rule must apply from left to right in the stem: otherwise the syllables *dō* and *ka* would receive stress.

We saw above that for Dyirbal both bi- and monosyllabic feet have to be admitted. We implicitly assumed that monosyllabic feet are created only if it is not possible to create a bisyllabic foot. This assumption is made explicit in the following principle proposed by Hayes (1981: 9):

#### Maximal Tree Construction Principle

Metrical rules construct the largest tree compatible with their conditions.

This principle guarantees a maximal alternation of stressed and unstressed syllables.

Summarizing, the following parameters for the metrical structures of words have been proposed:<sup>13</sup>

- (33) Foot level:  
 a. What is the maximal number of syllables in a foot?  
 b. Is the labeling *s-w* or *w-s*?  
 c. Does the foot rule apply from left to right, or from right to left?  
 Word level:  
 Is the labeling *s-w* or *w-s*?

Another example of a language with an alternation of stressed and unstressed syllables is Dutch, as the following words show:

- (34) kànapée 'couch'    èncyclòpedie 'encyclopedia'  
 pàraplú 'umbrella'    pàrallèllográm 'parallelogram'  
 ólifànt 'elephant'    ònomàtopée 'onomatopoeia'  
 dóminée 'vicar'    sòciologie 'sociology'

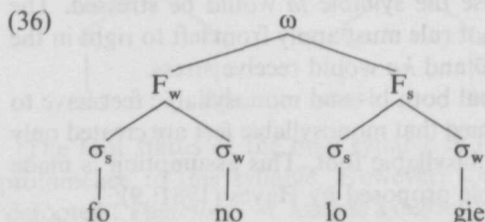
We can now characterize the stress patterns of these (nonderived) words by fixing the parameters in (33) as follows for Dutch:<sup>14</sup>

- (35) Foot level:  
 a. A foot consists of at most two syllables.  
 b. The labeling is *s-w*.  
 c. The foot rule applies from left to right.

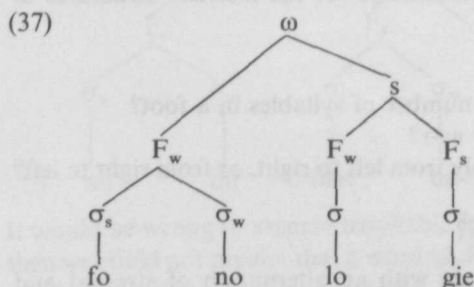
Word level:

Native words:  $s-w$ ; non-native words:  $w-s$ <sup>15</sup>

This system seems to derive wrong metrical structures for words such as *fônologie* 'phonology' and *ànologie* 'analogy', in which main stress falls on the final syllable, whereas the rules (35) would assign main stress to the third syllable, as (36) illustrates:



This problem is easily solved by the assumption that, before the general foot rule applies, a special rule creates one foot at the right edge of non-native words. This foot is monosyllabic for words such as *fonologie*. After the application of this special rule, the general foot rule applies iteratively, and thus we derive the correct metrical structure (37) for *fonologie*:



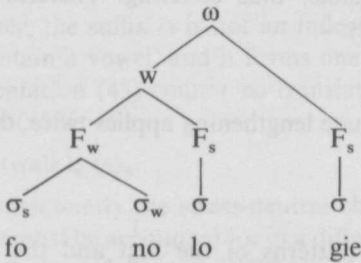
Since Dutch has a rule of vowel reduction which reduces a vowel in weak syllables to a schwa, structure (37) correctly predicts that the vowel of the second syllable can be reduced: [fonəloyi].<sup>16</sup>

The prominence relations among the syllables in *fonologie* also confirm the hypothesis that there is a correlation between dominance and branching: if on a certain level the left node is dominant (strong), the tree is left-branching; if the right node is dominant, the tree is right-branching. This correlation follows from the following principle proposed by Hayes (1981: 47):

- (38) Recessive nodes may not branch  
[where 'recessive' = 'weak', at least in the unmarked case].

Suppose, for instance, that we construct the following tree for *fonologie*:

(39)



This tree which violates principle (38) wrongly qualifies the third syllable of *fonologie* as more prominent than the first one, whereas the reverse is in fact the case (cf. van Zonneveld 1980: 186). This hypothesis is also confirmed by Italian (Nespor and Vogel 1981) and Winnebago (Hale and White Eagle 1980).

#### 4. The phonological word

In many cases we find a simple one-to-one correspondence between grammatical and phonological words, and consequently a syllable boundary will coincide with each word boundary. However, in certain cases a grammatical word corresponds to more than one phonological word, and, inversely, one phonological word may correspond with more than one grammatical word. Below, I will illustrate both cases.

In several languages we find two types of affix, 'cohering' and 'noncohering' affixes. Cohering affixes fuse with their stems into one phonological word, noncohering affixes do not, and form an independent phonological word. For instance, Dixon (1977: 90 ff.) distinguishes cohering and noncohering affixes for Yidin<sup>y</sup>. Cohering affixes are monosyllabic, noncohering affixes are bisyllabic. Yidin<sup>y</sup> has the following rule of penultimate vowel lengthening (Dixon 1977: 43):

- (40) In a word with an odd number of syllables, the vowel of the penultimate syllable is lengthened.

Consider now the following underlying form:

- (41) /gumari + | daga + | nu / 'to redden, past'  
       'red'       | INCHOATIVE | PAST

If we consider (41) as one phonological word, rule (40) does not apply, since (41) contains an even number of syllables. But *-daga* is a bisyllabic,

noncohering suffix and forms an independent phonological word. The past tense suffix *-nu* is monosyllabic, thus cohering. Therefore, (41) consists of two phonological words:

(41') (gumari)<sub>ω</sub> (dagapu)<sub>ω</sub>

Consequently, the rule of penultimate lengthening applies twice, deriving the correct phonetic form (41'')

(41'') [gumá:ri dagá:nu]

As predicted by (41') the stress patterns of the first and the second sequence of three syllables in *gumaridagapu* must be determined separately. Although we normally find an alternation of stressed and unstressed syllables in Yidin' words, in this case two unstressed syllables occur between two stressed ones.

In Dutch the members of compounds and certain affixes are independent phonological words. This appears from the syllabification patterns of these complex words, e.g.:

(42)	[[vlees] <sub>N</sub> [eter] <sub>N</sub> ] <sub>N</sub>	(vlees) <sub>σ</sub> (e) <sub>σ</sub> (ter) <sub>σ</sub>
	lit. meat eater 'carnivore'	not: *(vle) <sub>σ</sub> (se) <sub>σ</sub> (ter) <sub>σ</sub>
	[[rood] <sub>A</sub> achtig] <sub>A</sub>	(rood) <sub>σ</sub> (ach) <sub>σ</sub> (tig) <sub>σ</sub>
	lit. red-like 'reddish'	not: *(ro) <sub>σ</sub> (dach) <sub>σ</sub> (tig) <sub>σ</sub>

In standard generative phonology the difference between cohering and noncohering affixes can be expressed by assigning the morpheme boundary + to cohering affixes, and the word boundary # to noncohering affixes. The members of a compound can be assumed to be separated by #. In the *SPE* theory a #, but not a +, blocks the application of a phonological rule, unless it is mentioned in the context of that rule. Thus, it can correctly be predicted that in Dutch compounds and derived words with # affixes, a syllable boundary will always coincide with the internal morphological boundary, since the syllabification rules for Dutch do not apply across word boundaries in careful pronunciation.

In the theory of prosodic phonology, grammatical boundaries can be dispensed with in phonological representations. The only thing we need is an algorithm for mapping grammatical words onto phonological words in which the special character of compounds and derived words with noncohering affixes is taken into account. This is not just a notational variant of the boundary theory in *SPE*, since it is more restrictive. In *SPE* the # can be arbitrarily used to block the application of a rule. For instance, *SPE* accounts for the stress-neutral character of the English inflectional suffixes by means of a word-boundary insertion convention that inserts a # before the inflectional suffix, as shown in (43) for *walks*:

- (43) [ $\#$  [ $\#$ walk $\#$ ]<sub>v</sub> s $\#$ ]<sub>v</sub>

However, the suffix *-s* is not an independent phonological word: it does not contain a vowel, and it forms one syllable with the stem. Therefore, representation (43) cannot be translated into a prosodic representation such as (43'):

- (43') (walk)<sub>σ</sub> (s)<sub>σ</sub>

and consequently the stress-neutral character of the English inflectional suffixes must be accounted for in a different way (for instance, by means of rule ordering; cf. Strauss 1979).<sup>17</sup>

The status of independent phonological words for members of compounds and certain affixes in Dutch is confirmed by deletion phenomena below the level of the grammatical word, illustrated in (44):<sup>18</sup>

- (44) [[land]<sub>N</sub>[bouw]<sub>N</sub>]<sub>N</sub> en [[tuin]<sub>N</sub>[bouw]<sub>N</sub>]<sub>N</sub>  
 'agriculture and horticulture'  
 [[storm]<sub>N</sub>achtig]<sub>A</sub> en [[regen]<sub>N</sub>achtig]<sub>A</sub>  
 'stormy and rainy'  
 [[zwanger]<sub>A</sub>schap]<sub>N</sub> en [[moeder]<sub>N</sub>schap]<sub>N</sub>  
 'pregnancy and motherhood'  
 ↓  
 land- en tuinbouw  
 storm- en regenachtig  
 zwanger- en moederschap

An essential condition on this type of deletion is that only constituents which form at least one independent phonological word can be deleted. This explains why the deletions in (45) are impossible:

- (45) [[rod]<sub>A</sub>ig]<sub>A</sub> of [[groen]<sub>A</sub>ig]<sub>A</sub>  
 'reddish or greenish' \*rod- of groenig  
 [[rok]<sub>ver</sub>]<sub>N</sub> en [[drink]<sub>ver</sub>]<sub>N</sub>  
 'smoker and drinker' \*rok- en drinker

Since the suffixes *-ig* and *-er* are not independent phonological words, deletion is impossible. The cohering nature of these affixes is confirmed by syllabification patterns such as (ro)<sub>σ</sub> (dig)<sub>σ</sub> and (ro)<sub>σ</sub> (ker)<sub>σ</sub>.

Note that this deletion rule does not violate the 'lexical integrity hypothesis' (Brame 1978) which says that 'syntactic rules are not allowed to refer to, and hence cannot directly modify, the internal morphological structure of words' (Lapointe 1979: 222), since this deletion rule does not apply to grammatical structure but to prosodic structure. This, again, stresses the importance of distinguishing a grammatical and a phonological hierarchy.<sup>19</sup>



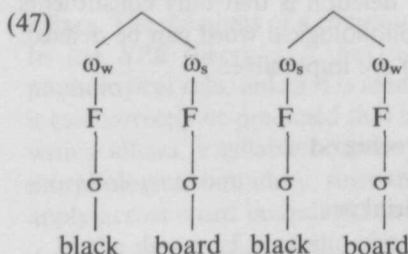
The one-to-one correspondence between grammatical and phonological words is also violated in cases where one phonological word corresponds with more than one grammatical word. Classical examples are the Latin conjunctions *-que* and *-ve* and the question particle *-ne* (Matthews 1974: 31). Generally, clitics can be considered independent grammatical words, but phonologically dependent on an adjacent word. In particular, grammatical words (articles, pronouns, prepositions, etc.) very often exhibit this phonological behavior.

A second type of deviation from the one-to-one correspondence between grammatical and phonological words is found in French where the boundaries between grammatical words within a phrase (or 'breath group'; cf. Pulgram 1965) are systematically obliterated: syllabification applies across the grammatical word boundaries, as illustrated in (46):

- (46) vers cinq heures      (vɛr)<sub>σ</sub> (sɛ)<sub>σ</sub> (kœr)<sub>σ</sub>  
       'at about 5 o'clock'  
       belle Hélène        (bɛ)<sub>σ</sub> (le)<sub>σ</sub> (lɛ:n)<sub>σ</sub>  
       'beautiful Helena'

Therefore, we may characterize French as a language in which each phonological phrase consists of only one phonological word. I will come back to this in section 6.

Like the syllable, the phonological word has three functions. First, it is a bearer of prominence relations, as shown in (47) for the NP *bläck bóard* and the compound *bläckbòard*:



Second, it is a domain of application of phonological rules; and finally, it is also a domain of phonotactic restrictions. The phonotactic function has already been demonstrated in section 2, where it was shown that we have to assume word-structure conditions in addition to syllable-structure conditions, and also that certain languages have appendices at the edges of phonological words.

Another example of the phonotactic function of the phonological word is that, in both Dyirbal and Yidin' (Dixon 1972, 1977), a phonological word consists of at least two syllables (except for certain exclamations).

Thus, we can predict that monosyllabic affixes in Yidin<sup>y</sup> are cohering since they cannot form an independent phonological word.

### 5. The phonological phrase

In this section I will give only a short illustration of the relevance of the phonological phrase in the prosodic hierarchy. The reader is referred to Selkirk (1978) and Nespor and Vogel (1981) for a more extensive analysis of the prosodic categories above the level of the word.

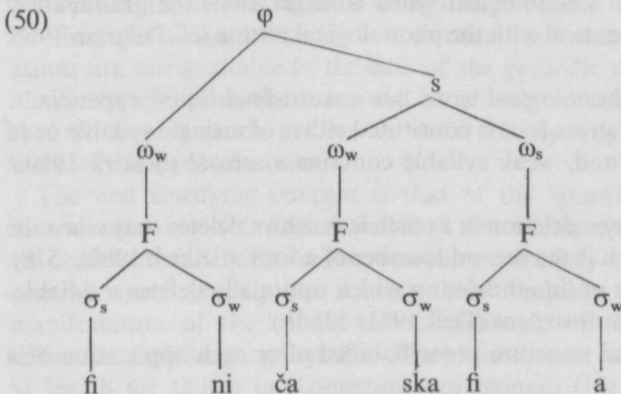
According to Pike and Scott (1962), in Marinahua, a language of Peru, each vowel has four different lengths, dependent on its position in the sentence. The following sentences illustrate this:

- (48) a. fi:ni ča.ška fi:a  
man achioté bought  
'the man bought achioté'  
b. yo:ra ra.fi si:oa  
people two whistled  
'two people whistled'

(one dot after the vowel means 'long' [3 long], two dots mean 'extra long' [2 long], and three dots mean 'extra extra long' [1 long]. If we consider this length variation as a manifestation of prominence relations, the length differences can be predicted by assuming the following metrical principles for Marinahua:

- (49) foot level/word level: s w  
phrase level:<sup>20</sup> w s

Thus we get the following prosodic structure for sentence (48a)





The vowels in the weak syllables are short; the vowels in the strong syllables are long. The vowel in the strong syllable that is only dominated by *s* nodes is [1 long], the degree of length of the other vowels in *s* syllables is identical to the number of nodes above the syllable, counting from the first *w* node.

Note that it is crucial that the tree is right-branching on the phrase level, in conformity with the principle that weak nodes may not branch. Otherwise, it would be wrongly predicted that the long vowel in the first word is shorter than that in the second word.

## 6. A case study: schwa deletion in French

In this section it will be illustrated how the enriched conception of phonological structure proposed in prosodic phonology and outlined above enables us to account for seemingly complicated phonological data by means of very simple phonological rules.

In Dell (1981: 31) the following data concerning the pronunciation of the French schwa are mentioned:

- |      |    |                  |                          |
|------|----|------------------|--------------------------|
| (51) | a. | quelle table?    | [kɛltabl] or [kɛltab]    |
|      |    | ['which table']  |                          |
|      | b. | table carrée     | [tabləkare] or [tabkare] |
|      |    | ['square table'] |                          |
|      | c. | quelle arbre?    | [kɛlarbr] or [kɛlarb]    |
|      |    | ['which tree']   |                          |
|      | d. | (il) parle       | [parl], *[par]           |
|      |    | (he) speaks'     |                          |

These data can be accounted for by the following assumptions and rules:

1. In French the phonological word is larger than the grammatical word; in fact it is identical with the phonological phrase (cf. Pulgram 1965: 138).
2. The French phonological word has a word-final liquid appendix.
3. '[I]n French a stress foot is constituted either of a single syllable or of two, where the second, weak syllable contains a schwa' (Selkirk 1980a: 578).
4. The rule of schwa deletion in French is 'a schwa deletes only when the syllable containing it is the second member of a foot' (Selkirk 1980a: 578).
5. There is a rule of liquid deletion which optionally deletes a syllable-final liquid after an obstruent (Dell 1981: 32).<sup>21</sup>
6. A phonological structure is resyllabified after each application of a phonological rule.

7. The output of the phonological rule component is filtered out if it does not conform to the canonical prosodic structure of French.

Let us now see how these assumptions and rules account for the data in (51). In *quelle table* the schwa can be deleted. The resulting word-final cluster *-bl* is unexpected since it violates the sonority constraint. However, the [l] can be considered a word-final appendix, and therefore [kɛltabl] is not filtered out. The situation in *table carrée* is different. If the schwa is deleted, we get [tablkare], a prosodically ill-formed phonetic form, since no proper syllabification can be made: neither *-bl* nor *-lk* is a well-formed cluster. In this case we do not have the possibility of interpreting the [l] as an appendix, since it does not occur word-finally: *table carrée* is one phonological word. However, if liquid deletion is applied we get a well-formed phonetic form, [tabkare]. In this way we explain why liquid deletion is obligatory in *table carrée*, once schwa deletion has applied, whereas it is optional in *quelle table* and *quelle arbre*.

This analysis also explains why no liquid deletion applies to *pauvre ami* 'poor friend'. After schwa deletion and resyllabification, we have the syllable sequence (po)<sub>σ</sub> (vra)<sub>σ</sub> (mi)<sub>σ</sub>. Here no syllable-final liquid is present, and thus liquid deletion does not apply, and we do not get \*[povami]. We now also understand why in Dell (1973: 226), where syllable structure was not taken into account, the rule of liquid deletion required a word-initial consonant to follow the liquid.

## 7. External explanation of prosodic universals?

For certain language universals it may be possible to provide an external explanation. For instance, the restriction on the number of possible tone levels (at most 4 to 5) may be explained by the restrictions on the perceptual abilities of human beings with respect to tone differences (Collier, this volume). As far as I can see, such causal external explanations are not available in the case of the prosodic universals discussed above. Nevertheless, there are two other, related modes of explanation that do not so much predict as rather clarify why languages have a hierarchy of prosodic units.

The first clarifying concept is that of the 'grammaticalization of a natural tendency' (cf. Anderson 1981). For example, in many languages we observe a tendency to reduce vowels, particularly unstressed ones, to a neutral vowel (mainly the schwa). This tendency may be seen as a manifestation of the (nonlinguistic) principle of minimal effort that influences each language system. This phenomenon has been investigated at length for Dutch in Koopmans-van Beinum (1980). It appears that

vowel reduction occurs in both stressed and unstressed syllables, in all styles of speech. Yet, as argued in Booij (1982), we have to assume an optional rule of vowel reduction, with several phonological conditions, as a part of the phonological system of Dutch. That is, the natural tendency of vowel reduction does not predict which form a rule of vowel reduction will take in a certain language, but it makes the existence of such a rule understandable.

A similar clarification of the existence of the syllable as a unit of prosody may be possible: the speaker needs certain units for the planning of muscular gestures. Ladefoged puts it as follows (Ladefoged 1971: 81):

Although there is no single muscular gesture marking each syllable, there is evidence that speakers organize the sequences of complex muscular events that make up utterances in terms of a hierarchy of units, one of which is the size of a syllable.

That is, we may interpret the existence of the prosodic unit 'syllable' as a grammaticalization of one of the planning units for the coordination of muscular gestures.

Similarly, the foot can be seen as a manifestation of the general human tendency to assign rhythmic patterns to sound sequences. But again, for each language this general rhythmic tendency is grammaticalized into particular phonological rules of foot construction.

The second mode of explanation that may clarify the existence of prosodic units is that of functional explanation. Again, this type of explanation is not an explanation with predictive value, since the structure of a system is not predictable from its functions, but it can help to make understandable why languages are as they are.

The function of the phonological word and the prosodic units above it (phonological phrase, phonological clause, etc.) can be qualified as a delimitative one: these prosodic domains indicate the syntactic structure of an utterance. For instance, if we hear in French a sequence obstruent + liquid at the end of a syllable, we can infer that we have arrived at the end of a phonological word, i.e. at the end of a syntactic phrase. Generally, phonological phenomena that occur at the edges of a certain domain indicate the boundaries of that domain, and consequently the boundaries of its grammatical correlate. This has already been pointed out in Trubetzkoy's well-known '*Abgrenzungslehre*' (Trubetzkoy 1939: 241 ff.). Trubetzkoy also remarks that this delimitative function is not strictly necessary: the hearer has nonphonological means at his disposal to discover the words and phrases in an utterance, but the phonological juncture phenomena are useful aids.<sup>22</sup> The fact that, in French, grammat-

ical word boundaries are usually obliterated phonologically confirms once more that juncture phenomena are not necessary for the perceptibility of words in an utterance.

Not only juncture phenomena are indications of the grammatical structure of an utterance. The rhythmic patterns may also help to sort out the words in an utterance. For instance, in a language with bisyllabic feet each word exhibits an alternation of stressed and unstressed syllables. In a sequence of two words, however, we may get two adjacent stressed syllables. Thus, a 'stress clash' can serve to indicate the boundary between two words.<sup>23</sup> Yet, in Auca (cf. section 3), stress clashes occur *within* a word, and English sometimes avoids stress clash (as in *thirteen mén* → *thirteen mén*; cf. Liberman and Prince 1977). This again illustrates that functional explanations do not predict necessary features of natural languages.

Finally, it should be noted that it remains an open empirical issue which of the available prosodic cues for grammatical structure are used by the hearer and how they are used. Cooper and Paccia-Cooper (1980: 213) point out that there is evidence that the hearer can detect certain prosodic cues, such as vowel lengthening at the end of a phrase. 'However, work is only beginning to be directed at the more important question of whether listeners *typically* use this information in decoding constituents' (1980: 213–214).

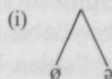
In conclusion, it will always remain necessary to postulate an independent language faculty, many properties of which cannot be predicted on language-external grounds. The principles of prosodic phonology outlined above partly characterize this language faculty, while the parameters express some of its possibilities of variation.

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## Notes

1. Hockett (1955: 43): 'Ultimate phonological constituents do not occur in an utterance as the individual bricks occur in a row of bricks. Rather, they occur in clusterings, these occur in still larger clusterings, and so on, up to the level of the whole utterance. That is, the phonological structure of the utterance shows a hierarchic organization.'
2. Of course, the segment itself is not a grammatical constituent, but by also mentioning the segment in the grammatical hierarchy we can express the fact that segments are organized in two ways, in a phonological and in a grammatical hierarchy.

3. An example of the distributional approach is Pulgram 1970.
4. In Dutch, the short vowel 'schwa' often behaves distributionally like long vowels and diphthongs. For example, the schwa admits only one consonant in the coda. Therefore, Trommelen (1982) proposes to represent the schwa as a branching node, just like long vowels/diphthongs, but with one of the terminal nodes empty:



If one does not want to admit empty terminal nodes, no generalization is possible here, which implies that this restriction must be expressed by a collocational restriction (cf. section 2.3).

5. I do not use features here, because I do not want to go into the problem of how to characterize the class of vowels and glottal stop by means of features. Note that a similar position for the glottal stop is claimed by Safir (1979) for Capanahua.
6. In many African languages we find nasals before plosives in onsets. However, usually no independent status is assigned to these nasal segments, and sequences such as *mb*, *nd* are qualified as monosegmental, prenasalized plosives. If this is correct, there is no violation of the sonority constraint involved here.
7. Wonderly also gives two examples of word-initial clusters of four consonants: *nglyenta* 'my client', *mbrweba* 'my test', but it is evident that here the stems are borrowings from Spanish.
8. Of course, the two anomalies of Zoque discussed here would also disappear if the sequence *ng-* and *mb-* could be considered prenasalized plosives. However, since Wonderly (1951) qualifies these sequences as clusters, I prefer the appendix interpretation for these words.
9. In metrical phonology the cyclic application of stress rules, at least from the level of the phonological word onward, is not an independent principle, but follows from the relational character of stress. Cyclic application of stress rules below the level of the word is problematical, however, since the traditional cyclic application of stress rules on this level makes use of the internal *morphological* structure of words, which is no longer available in metrical stress rules.
10. I have made an expository simplification here, since Liberman and Prince use the symbol *M* instead of  $\omega$ , and do not use the  $\sigma$ .
11. Examples of such languages are Finnish and Estonian (Lehiste 1970: 138, 163), Wishram Chynook (Dyk and Hymes 1956), Auca (Pike 1972), Dyirbal and Yidin<sup>y</sup> (Dixon 1972, 1977), Southern Paiute, Tübatulabal, and St. Lawrence Eskimo (Anderson 1974), Warao (Osborn 1966), Dutch (Booij 1981), Surinam Arawak (Pet 1979), Tenango Otomi (Blight and Pike 1976), and Arekuna Carib (Edwards 1978). See also Trubetzkoy (1939: 253).
12. I assume that in Dyirbal the first syllable of a word receives primary stress, hence the pattern *s-w* at both the foot and the word level. However, Dixon (1972: 275) remarks that there is no direct evidence that native speakers of Dyirbal distinguish different degrees of stress. Hayes (1981: 56, 60) proposes that such languages do not have phonological words. But this solution does not work for Dyirbal since the level of the phonological word is necessary anyway for a proper account of assimilation: assimilation processes apply only within phonological words (Dixon 1972: 269). Dixon also points out that a differentiation of degrees of stress would be useful for the description of certain allomorphy phenomena (1972: 275). Note also Dixon's remark (1980: 128) that in Australian languages it is usually the first syllable that bears primary stress.



13. Hayes (1981) also mentions the following parameters: (i) the construction of feet may be sensitive to the phonological composition of the syllable, i.e. sensitive to syllable quantity; (ii) the foot rule may or may not apply iteratively; (iii) the level of the phonological word may be absent (but see the preceding note).

As for parameter (33i), Hayes defends the position that languages have either binary or unbounded feet (apart from the degenerated, monosyllabic feet).

14. In words such as *Gröningen*, *Batàvia*, and *gymnàsium* the final syllable does not bear secondary stress, contrary to what is predicted by (35). Word-final syllables ending in -ə(C), -a, -um, etc., can be defined as extrametrical syllables that do not count in the construction of feet. In a later stage of the derivation they are integrated in the final foot, and thus we get word-final ternary feet.

In words such as *banáan* 'banana' two monosyllabic feet are created. The word-initial foot may be defooted, however, and in that case the vowel can be reduced to schwa: [bənan].

15. Native words are understood here as words of Germanic origin and words of Romance or foreign origin which have been adapted to the Germanic, word-initial stress pattern.
16. In a very casual style of speech, the vowel of the third syllable can be reduced as well. This can be accounted for by the defooting rule which defoots monosyllabic, non-word-final feet.
17. In Booij (1977) the distinction between # affixes and + affixes is explicitly based on the syllabification patterns of complex words, and therefore each # affix in that analysis of Dutch may be considered an independent phonological word.
18. Examples from Bakker (1968).
19. Lehiste (1978: 79) points out that Estonian is another example of a language in which the members of compounds and certain affixes are independent phonological words.
20. Compare the following statement in Pike and Scott (1962: 4): 'The nucleus of the phonological clause is the nuclear syllable of the last phonological word.'

It might be hypothesized, furthermore, that the right-branching nature of the prosodic tree on the  $\phi$  level is a reflection of the right-branching nature of the syntactic structure of Auca, as in  $[s_{[NP]fini}]_{NP} [v_{[VP]NP} \text{čaška}]_{NP} [v \text{fia}]_{VP}$ ]. This presupposes that *rafi* in (48b) is to be interpreted as a constituent of the VP, not as a numeral in postposition.

21. Compare Dell (1973: 226), where liquid deletion is an obligatory rule that only applies if the following word begins with a consonant. This rule cannot account for [keltab].
22. Trubetzkoy (1939: 241, 242): 'Dagegen ist die äußere Abgrenzung der bedeutungsgeladenen Schallkomplexe gar nicht unbedingt notwendig. ... Die Möglichkeit von Mißverständnissen ist meistens recht gering, besonders weil man gewöhnlich bei der Wahrnehmung jeder sprachlichen Äußerung von vornherein auf eine bestimmte, eng begrenzte Begriffssphäre eingestellt ist und nur jene lexikalischen Elemente, die zu dieser Sphäre gehören, zu berücksichtigen braucht. Wenn trotzdem jede Sprache gewisse spezielle phonologische Mittel besitzt, die das Vorhandensein oder das Nichtvorhandensein einer Satz-, Wort- oder Morphemgrenze an einem bestimmten Punkt des kontinuierlichen Schallstromes signalisiert, so sind diese Mittel als solche nur Hilfsmittel.'
23. Trubetzkoy (1939: 253): '... jede Störung dieser rhythmischen Inertie, die immer das Ende eines Wortes und den Anfang eines anderen signalisiert, gewinnt dadurch eine besondere Prägnanz.'

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