THE PHONOLOGICAL SYLLABLE WITH SPECIAL REFERENCE TO DANISH

Hans Basbøll

1.   Introduction

The present paper[1] is divided into three main parts.
In the first of these (section 2) it will be argued that the
syllable must be recognized as an important linguistic unit in
any adequate phonology of Standard Danish. In section 3 I shall
discuss the status of the syllable in a generative phonology,
including such questions as the functions of the syllable in
phonological rules, phonetic vs. phonological syllable, and
the principles of syllabification. In section 4, finally, the
nature of the syllable will be discussed in more general terms,
and a distinction between what I call "hierarchical" and "cross-
classificatory" distinctive features will be proposed. It
will be shown that the hierarchy of phonological features can
explain nearly all order relations among Danish consonants.
These considerations have bearing on what the feature [syllabic]
may actually mean.

Although the language material discussed in the present
paper is taken almost exclusively from Standard Danish, the
conclusions arrived at in sections 3 and 4 seem to be relevant
to general phonological theory. The paper is thus not only
meant to be a contribution to the phonological description of
one language, viz. Standard Danish; it is intended to be a con-
tribution to phonological theory as well.

---

1) This is an enlarged version of a paper entitled "Stavelsen i
   dansk fonologi" ('The syllable in Danish phonology') which I
read at the Meeting of Nordic Linguists at Kungälv, March 30 -
31, 1974. I am indebted to Niels Davidsen-Nielsen for stylistic
suggestions.

2. Arguments to the effect that any adequate phonology of Danish must include the syllable as a phonological unit

2.1. Allophonic variation of short /o/ and /a/

Since I have discussed the allophonic variation of the short /o/ and /a/ phonemes in Danish and their dependency upon syllabification elsewhere, I shall here only give a brief summary of what appear to be the main facts (see further Basbøll 1972a,p. 187-190).

The vowels [u:, u], [o:, ɔ] and [ɔ:, ʌ] have generally been taken to be manifestations of /u:, u/, /o:, o/ and /ɔ:, ɔ/ respectively (e.g. Ege 1965). However, the vowel [o] also occurs, partly as shortened /o:/ (in positions where the other long vowels are shortened too), partly in some foreign words like foto [fótˢo]. The vowel [ɔ] also appears in foreign words, e.g. tundra, centrum [tˢɔ́ndʁa, sɛntʁ̥ɔm]. It has been pointed out (Basbøll 1969, p. 44) that the short vowels [o] and [ɔ] both occur posttonally in complementary distribution, [o] occurring in open syllables and [ɔ] in closed ones. This principle generalizes to all occurrences of [o] and [ɔ] not derived from long vowels. Such a principle of course presupposes a syllabification, and this syllabification turns out to be identical with the one which is presupposed by the other phonological rules examined here, and which is stated explicitly in section 3.4.1 below. (The distribution of short [o] and [ɔ] in French is in part due to similar principles, e.g. sot, sotte [so, sɔt].)

The short /a/ phoneme in Danish is pronounced as a back vowel in the environment of /r/, as a front vowel ([a]) before zero and dentals, and as a mid or back vowel ([ɶ] or [ɑ]) before velars and (in most language usages) labials. The fact

that the first vowel of words like Amerika, akademi, tapir
is pronounced [a] as opposed to the first vowel of e.g.
amfiteater, Absalon, akkeleje suggests that this manifesta-
tion rule applies with the syllable rather than the word as
its domain. The syllabification presupposed for this purpose
is identical to that presupposed for the prediction of the
manifestation of /o/ and of the consonant gradation phenomena
mentioned below in section 2.2 (according to these principles
a single intervocalic consonant goes to the preceding syllable
if the following vowel is shwa, but to the following syllable
if its vowel is a "full vowel", i.e. non-shwa, see section
3.4.1 below).

Particularly suggestive of an explanation in terms of
syllables are alternative pronunciation patterns like the
following. Amerikaner is either pronounced [ameʁikʰǽ:ʔnʌ,
ameɹikʰǽ:ʔnʌ], where the first /a/ is followed by /m/, which
again is followed by the full vowel /e/, i.e. /a/ occurs in
an open syllable and is thus pronounced [a]; or it is pro-
nounced [ɑmʁikʰǽ:ʔnʌ], where the second vowel is dropped
(possibly via a reduction to shwa), and consequently the first
/a/ occurs in a closed syllable ending in a labial, and it is
thus pronounced [ɑ] (or [ɑ]). Forms of the stem abbed like
abbed, abbeder, abbedisse can be pronounced as [ábeð,
ábe(:)ðʌ, abedísə], where the second vowel is the full vowel
/e/ (which can even be long in abbeder), and /a/ thus occurs
in an open syllable and is pronounced [a]; or it can be pro-
nounced as [ɑ́bəð, ɑ́bəðʌ ɑbedísə], where the second vowel
reduces to shwa, and the /b/ therefore belongs to the first
syllable with the effect of retracting the vowel /a/.

2.2. Consonant gradation[1]

The term "Consonant gradation" is used here in accord-
ance with Rischel 1970a. It covers a number of morphological
alternations among which are the following (alternation (i)
is mentioned by Uldall 1936, (ii) by Rischel 1970a, (iii) by
Basbøll 1972a, (iv) by Hjelmslev 1951, and (v) by Rischel
1969):[2]

(i) Word-final unaspirated plosive alternates with aspirated
plosive before a stressed vowel. Among the examples are
a number of derived verbs in -ere, e.g. galopere, vattere,
lakere [galop^{h}é:?ʌ, vat^{s}é:?ʌ, lak^{h}é:?ʌ], derived from
galop, vat, lak [galʌb, vad, lɑg]. Note particularly the
last example where the /a/ is pronounced [ɑ] before the
word-final and hence syllable-final /k/, whereas in
lakere /k/ belongs to the following syllable, /a/ thus
being pronounced [a].

---

1) For reasons of space, it is impossible to treat this very
complicated subject in any detail here. I have discussed
the "Consonant gradation"-phenomena extensively in my ditto'ed
notes (in Danish) Konsonanter I-II (87 p., unfinished). (These
notes, which will be continued, also include a chapter (46 p.)
on the diphthongs.)

2) When I use formulations like "word-final X alternates with
Y before Z" it does not imply that all instances of word-
final X alternate with Y before Z, nor does it mean, of course,
that all occurrences of Y before Z alternate with word-final X
(notice that I do not use the word "alternates" in a "process"
sense: the only implication here is that X before word boundary
and Y before Z are in a relation of alternation, cf. Rischel
1974, p. 320ff). E.g. in (i) below it is said that word-final
[b d g] alternate with [p^h t^s k^h] before stressed vowel, but
alternations like klaustrofob-klaustrofobi [klɑysdʁofó:?b,
-fobí:?] show that some instances of word-final [b] alternate
with [b] and not [p^h] before stressed vowels. And in (iv) below
there are examples like dyr, dyrisk [dyʁ?/dy:?ʁ, dý:?ʁisg/
dý:?ʁisg/dýʁ?isg] which exhibit no alternation [ʁ] ∽ [ʁd]
(where the latter should occur before the derivative ending
-isk). In most of the other cases, the alternations are general
in the sense that the mentioned word-final sound types do not
alternate with other sound types in the said context than those
mentioned. It should be added that alternations (i)-(iii) and
(v) are limited to "learned" derivations, cf. section 3.4.1 below.

(ii) Word-final voiced non-labial continuant consonant alter-
      nates with unaspirated plosive before stressed vowel.
      Examples are foreign words like perfidí, pædagogik
      [pʰæn̥fidí:ʔ, pʰɛdagogíg], derived from perfid, pædagog
      [pʰæn̥fí:ʔð, pʰɛdagó:ʔɣ].

(iii) Word-final [ŋ] alternates with [ŋg] before a stressed
      vowel. There is at least one example of this alterna-
      tion, viz. (di-, mono-, poly- etc.)-ftongere
      [(di)ftʌŋgé:ʔʌ], derived from (di- etc.)-ftong [(di)ft˥ʌ̃ŋ].

(iv) Word-final [nʔ, lʔ, n̥ʔ] alternate with [nd, ld, n̥d] be-
      fore derivative endings like -ig, isk. Examples are
      mandig, skyldig, jordisk [mándi, sgýldi, jón̥disg], de-
      rived from [manʔ, sgylʔ, jon̥ʔ/jo:ʔn̥] (in words with
      -rd, conservative usages have a long vowel in the un-
      derived word but the corresponding short one in the
      derived form).

(v)   Word-final [n̥] alternates with [ʁ] before stressed
      vowels. Examples are kontorist, professorat [kɔntˢoʁísd,
      pʁɔfɛsoʁɑ́:ʔd], derived from kontor, professor [kɔntˢón̥ʔ,
      pʁɔfɛ́sʌ].

     Now it is very interesting that all these alternations
can be subsumed under a single principle, viz. the well-known
one of consonant weakening in syllable final position. Accord-
ing to this principle the phonemes /p t k d g r/ are mani-
fested as [pʰ tˢ kʰ d g ʁ] in syllable initial position
and as [b d g ð ɣ n̥] in syllable final position (where [ɣ] is
in younger standards substituted by [i̯], [u̯] or zero). It
should be added that in utterance-final position, i.e. before
pause, any final consonant can be followed by an [h]-sound,
and that /t/ can be manifested [tˢ], i.e. affricated (whereas

final [b g] followed by [h] are not discernable from [p^h k^h]).
It should also be mentioned that syllable-initial /p t k/ in
word-internal position before an <u>unstressed</u> vowel can be pro-
nounced [b d g], especially in non-distinct pronunciations,
that [ɣ], but not [g], is dropped after nasals, and that [ð]
is dropped after sonorants. (There are certain complications
in accounting for the syllable-final pronunciations of the
labial obstruents /b v/, which may also be weakened as com-
pared with the syllable-initial manifestations [b v], but
these cannot be treated here for reasons of space; the reader
is referred to the notes referred to in footnote 1 on p. 42
for further information.)

The above-mentioned principle accounts not only for a
great number of morphological alternations (as (i)-(v) above),
but also explains (in a weak sense) quite a few distributional
gaps like the following: [ð ɣ ŋ] occur only before #, conso-
nants and shwa, never before full vowels; /h/ only occurs
before full vowels, etc.

As already mentioned, it is, for reasons of space,
impossible in this paper to fully discuss or even survey the
very complicated phenomena connected with "Consonant grada-
tion". However, it is clear that the value of the above-
mentioned principle depends on whether there can be given
<u>explicit</u> (and not unnatural) principles of the location of
syllable boundaries that can account for all of the above-
mentioned phenomena without giving rise to complications else-
where in the phonology. This will be attempted in section
3.4.1 below.

By way of conclusion of this section it should be men-
tioned that there exists one explicit proposal for the de-
limitation of the consonant manifestations here called
"syllable initial" and "syllable final" which does <u>not</u> include

the syllable as a theoretical unit, viz. Rischel 1970a,
p. 462. In order to show that the syllable is a <u>necessary</u>
<u>prerequisite</u> for correctly accounting for the mentioned
consonant phenomena, we must therefore demonstrate that
Rischel's proposal is unsatisfactory. Rischel gives the
following "working definition" for two positions, viz. "strong"
and "weak", which "here will be taken as essentially synonymous
with (syllable-)initial and (syllable-)final position":

    "A consonant is in strong position if it fulfils the
following two requirements: (1) it is preceded by juncture
(morpheme border) or by a segment that is (phonemically)
voiced; (2) it is followed by a full vowel (i.e., not shwa)
with or without an intervening voiced consonant but without
an intervening juncture. Examples are: [g] in [gliːðə]
'glide', [b, g] in [lomˈbæːgo] 'lumbago'.

    Otherwise a consonant is in weak position. Examples
are: [ɣ, ð] in [tɔːɣəðə] 'foggy' (plur.), [ð, g] in [jøːðisg]
'jewish' (the latter word has a morpheme border between [ð]
and [i]), and [ð] in [feðmə] 'fatness'."

    It follows from Rischel's definition that a consonant
is in weak position if it fulfils at least one of the follow-
ing three requirements: (i) it is preceded by a (phonemically)
voiceless segment belonging to the same morpheme; (ii) it is
followed by a juncture; (iii) it is followed by a shwa, with
a possible intervening consonant. (The alternations mentioned
at the outset of this section show, in agreement with Rischel's
note on p. 464, that "juncture" cannot simply mean "morpheme
border" as the definition suggests, see section 3.4.1 below.)

    In conservative varieties of Standard Danish there are
certain counter-examples to implication (iii) of Rischel's
definition. E.g. words like <u>kæntre</u>, <u>ændre</u> need not rhyme,
and <u>verden</u>, <u>værten</u> can be distinguished: <u>kæntre</u> and <u>værten</u> can

be pronounced with unvoiced /r/ ([kɛntʃə, væʃtən]), which is never possible in ændre, verden, and in some usages, where the possibility of unvoiced /r/ in one or both of these examples does not exist, a distinction of length can be made in the non-syllabic sonorant so that /n, r/ etc. can be shorter before (written) p, t, k than before b, d, g (see Fischer-Jørgensen 1973, p. 146f).

Of course it can be argued that the proposed definition should only cover (younger) standards where these distinctions are not made, but I find it highly significant that the only way to account for these distinctions by means of "strong vs. weak position" is to claim that the obstruents in question are in strong and not weak position as they would be according to Rischel's definition; and this agrees well with the fact that [ð] is excluded in such positions, and that there is also a possible contrast between [p] and [b] (e.g. jambe, lampe [jɑm(.)bə, lɑmbə(lɑmpə)]. If Rischel's definition should be amended to cover these facts, it becomes even more complicated and unnatural. This brings me to my other point.

Rischel is, of course, well aware of the striking arbitrariness of his definition as shown e.g. by his term "working definition". It seems clear, to me at least, that if the [b] of [lom'bæ:go] is in strong position, it is not because it follows a phonemically voiced segment, viz. [m]; rather the voicedness (or better: sonority) of the preceding segment is a factor influencing the location of the syllable border, i.e. [b] is "strong" because it is syllable initial.

2.3. The stød

The stød has traditionally been considered to be a phonologically suprasegmental entity characterizing a syllable, although its place has generally been indicated as phonetically

concurrent with a vowel or a consonant. Among the arguments
that can be given for this phonological analysis are the
following (cf. Basbøll 1972b, p. 6f): unlike most segments
the stød can be lost under certain accentual and grammatical
conditions, its place within the syllable is completely
predictable (there is at most one stød which falls "on" the
vowel if this is phonemically long, otherwise "on" the fol-
lowing consonant which in this situation is a sonorant), and
the stød can be moved from a sonorant consonant to the follow-
ing sonorant consonant without ever changing the identity of
the word (Hjelmslev's (1951, p. 17) example jar'l = jarl').

However, the notational conventions used in what might
be termed orthodox generative phonology (as codified in SPE)
give no way to represent the stød as a characteristic of the
syllable. Instead, the stød has been considered a feature
characterizing the segment where it was normally said to
occur phonetically (e.g. Austin 1971). Let us briefly con-
sider some consequences of this latter stød-notation, con-
trasting it with the more traditional prosodic stød-descrip-
tion, which may be rephrased like this: The stød character-
izes certain syllables (which syllables is, at least in part,
predictable from grammatical and phonological information,
but this is of no concern to us here). If the stød-syllable con-
tains a long vowel, the stød is manifested on the vowel;
if it contains a short vowel immediately followed by a sonorant
consonant, then the stød is on this consonant. It might be
added that if it contains a short vowel followed by an obstruent
(such a combination is normally said to be unable to receive
the stød), then the stød is not manifested (compare alternative
pronunciations like pust [puːʔsd/pusd]) except by a "stød-
like" intonation in certain Western varieties of Standard
Danish; this amounts to considering an abstract stød ("Accent
1"), falling on syllables which never have stød phonetically

but which occur in a morphological context normally implying
stød (e.g. prefixed verbs, cf. <u>beflitte</u>, <u>bestille</u> [beflídə,
besdél?ə]), further see Rischel 1970b, p. 128f, and Basbøll
1972b, p. 30.

Before the oral non-lateral non-syllabic sonorants
([ð̩, i̥, u̥, ɹ̩] manifesting /d, g, g/v, r/ syllable-finally)
a stød-vowel can be shortened and the stød "moved" to the
following sonorant, where it is normally placed (e.g. [fo:?ð/
foð?, dæ:?i̥/dæi̥?, sgɛ:?u̥/sgɛu̥?, sbi:?ɹ̩/sbiɹ̩?]). Phonetically,
it is quite possible that there is no "stød-movement" (i.e.
change of the location of the stød) at all, the stød occurring
at (roughly) the same place <u>in the syllable</u> (cf. Riber-
Petersen 1973 and references cited there). If this is correct,
a prosodic treatment of the stød would seem to present itself,
but let us, for the sake of the argument, accept the segmental
location of the stød (in the output) as traditionally given
in phonetic notation and taken over by Austin. A non-syllabic
treatment of the stød would then seem to need a phonological
transformation like the following:

$$
(i) \quad
\begin{bmatrix} V \\ +\text{long} \\ +\text{stød} \end{bmatrix}_1
\begin{bmatrix} C \\ +\text{son} \\ -\text{nas} \\ -\text{lat} \end{bmatrix}_2
\xRightarrow{\text{OPT}}
\begin{bmatrix} 1 \\ -\text{long} \\ -\text{stød} \end{bmatrix}
\begin{bmatrix} 2 \\ +\text{stød} \end{bmatrix}
$$

However, this is clearly inadequate because part of the trans-
formation states that the vowel is shortened before certain
consonants, e.g. [ð], and a phonological rule with exactly
this effect is needed since the shortening also occurs in
words without stød (although less frequently), e.g. <u>bide</u>
[bi:ðə/biðə]. We may then change the phonological transforma-
tion to the following, in order to avoid the duplication of

the vowel-shortening rule (which it must follow in the
ordering):

$$
(ii) \quad
\overset{\text{V}}{\begin{bmatrix} -\text{long} \\ +\text{stød} \end{bmatrix}}
\overset{\text{C}}{\begin{bmatrix} \alpha\text{son} \end{bmatrix}}
\underset{\text{OBL}}{\Longrightarrow}
\overset{1}{\begin{bmatrix} -\text{stød} \end{bmatrix}}
\overset{2}{\begin{bmatrix} \alpha\text{stød} \end{bmatrix}}
$$

The point to be emphasized is that this transformation (of
a dubious formal status) is completely superfluous with a
syllabic treatment of the stød, whereas it is, as far as I
can see, indispensable in an orthodox generative framework.

Another type of stød-rule where a non-syllabic treat-
ment seems hopelessly inadequate is constituted by rules
ascribing stød to certain stressed syllables (e.g. ultimates
and antepenultimates in foreign words). If an ad hoc trans-
formation like (ii) is not recognized, it must in a non-
syllabic framework be formulated as two processes, one con-
cerning vowels and one concerning consonants, although it is
clearly the same phenomenon which is involved. Such a rule
will be explicitly formulated in section 3.1 below.

3.   The syllable in a generative phonology

In the preceding section we have presented a number of
facts taken from the phonology of Danish, the correct de-
scription of which seemed to presuppose, so we claimed, that
the syllable should be included in phonological theory. But
so far we have said next to nothing about the precise way in
which the syllable should be included in phonology. In the
following we shall discuss a number of different functions
the syllable can have in phonological rules. We shall for

this purpose accept the general framework of (non-orthodox)
generative phonology (in section 4 the perspective will be
widened). Since the most detailed and explicit discussion
in print which I know of on the functions of the syllable
within the framework of generative phonology is Hooper 1972,
I shall mainly refer to her paper in section 3, and postpone
the inclusion of some non-generative literature on the syl-
lable until section 4.

3.1. The syllable as a unit in the structural description of phonological rules

Consider how a very simple stress rule (like the one
in Polish) placing stress on the penultimate syllable of
polysyllabic words and stressing monosyllables too would be
formulated within an orthodox generative framework:

(i) $\qquad V \longrightarrow [+stress] / \underline{\qquad} C_o (V) C_o \#$

or (ii) $V \longrightarrow [+stress] / \underline{\qquad} C_o (V C_o) \#$

or (iii) $V \longrightarrow [+stress] / \underline{\qquad} (C_o V) C_o \#$

The notational distinction between the three ways of parenthes-
izing the last syllable apparently does not correspond to
anything empirically; this, of course, is a shortcoming of
the notation. Another drawback is the fact that one has to
state two instances of C_o in the structural description of a
rule. Now, what does C_o mean? C_o means that it is _irrelevant_
for the application of the rule whether there are any consonants
after the vowels mentioned in the structural description or not.
Of course, the over-all principle of what ought to be mentioned
in the structural description of a rule is that only what is

relevant for the application should be included in the nota-
tion. But in the case under discussion here it is the nota-
tional convention that stress cannot be ascribed to syllables
which forces one to state the irrelevant consonants. Compare
how the rule can be formulated when stress is ascribed to
the syllable (the S-symbol) (cf. McCawley 1968, p. 36):

(iv) $S \longrightarrow [+\text{stress}] / \underline{\hspace{1cm}} (S) \#$

Rule (iv) avoids all the difficulties of rules (i)-(iii).

As mentioned in section 2.3 above, the basic principle
governing the occurrence of the Danish stød in foreign words
of a Latin-Greek type as well as the traditional school
pronunciation of these languages (according to which the main
stress is placed in agreement with the target language, where-
as the other features of pronunciation have in general no
connection with the classical languages) is the following:
if stress is on the ultimate or the antepenultimate syllable,
the stressed syllable has stød if it has "stød-basis" (i.e.
contains a long vowel and/or a postvocalic sonorant), whereas
a stressed penultimate syllable does not have stød (the rela-
tion between non-main stresses and stød is more complicated
and can be ignored for the present purpose).

If the notation does not allow one to ascribe the stød
to a syllable, then either one must rely on the ad hoc-trans-
formation (ii) of section 2.3, or the rule in question must be
split up into two parts, viz.:

(v) $\begin{bmatrix} V \\ +\text{long} \\ +\text{stress} \end{bmatrix} \longrightarrow [+\text{stød}] / \underline{\hspace{1cm}} C_o (VC_o VC_o) \#$

or (vi) $\begin{bmatrix} V \\ +\text{long} \\ +\text{stress} \end{bmatrix} \longrightarrow [+\text{stød}] / \underline{\hspace{1cm}} (C_o VC_o V) C_o \#$

or (vii) $\begin{bmatrix} V \\ +\text{long} \\ +\text{stress} \end{bmatrix} \longrightarrow [+\text{stød}] / \_\_C_o(VC_oV)C_o \#$

and (viii) $\begin{bmatrix} C \\ +\text{sonorant} \end{bmatrix} \longrightarrow [+\text{stød}] / \begin{bmatrix} V \\ -\text{long} \\ +\text{stress} \end{bmatrix} \_\_C_o(VC_oVC_o) \#$

or (ix) $\begin{bmatrix} C \\ +\text{sonorant} \end{bmatrix} \longrightarrow [+\text{stød}] / \begin{bmatrix} V \\ -\text{long} \\ +\text{stress} \end{bmatrix} \_\_(C_oVC_oV)C_o \#$

or (x) $\begin{bmatrix} C \\ +\text{sonorant} \end{bmatrix} \longrightarrow [+\text{stød}] / \begin{bmatrix} V \\ -\text{long} \\ +\text{stress} \end{bmatrix} \_\_C_o(VC_oV)C_o \#$

Notice that rules (v)-(vii) as compared to rules (viii)-(x) are notationally quite different: in (v)-(vii) the vowel is the affected segment (i.e. the segment which is changed by the rule), in (viii)-(x) it is the consonant; in (v)-(vii) the affected segment is stressed, which is not the case in (viii)-(x); and in (viii)-(x) the environment to the left is relevant which is not the case in (v)-(vii). I shall argue that all these differences have nothing to do with the rule itself. Furthermore, there is a notational ambiguity in the parenthesizing of the environment to the right which has no empirical content.

Quite independently of the phenomena under discussion here, there are good arguments for a general "stød-manifestation principle" according to which stød is manifested on the vowel if this is phonemically long, on the consonant immediately following the vowel if this consonant is a sonorant, and not manifested as a stød in the normal phonetic sense (but eventually by a "stød-like" intonation, at least in certain Western varieties of Standard Danish) if the short vowel is immediately followed by an obstruent (see section 2.3).

Granted this stød manifestation principle, the rule in question can be formulated quite simply in a syllabic framework:

$$(xi) \qquad \begin{bmatrix} S \\ +stress \end{bmatrix} \longrightarrow [+stød] / \underline{\hspace{1cm}} (SS) \#$$

The phonological behaviour of the Danish stød thus strengthens the traditional concept of the syllable as bearer of prosodic features like stress and tone.

It should be added that the recognition of the syllable as a possible unit (S) in the structural description of phonological rules as recently used e.g. by Hooper (1972) in no way implies that one is forced to accept Hooper's definition of this symbol as "a sequence of segments between two syllable boundaries" (p. 537), see section 4.1 below.

3.2. Syllable boundaries in the structural description of phonological rules

There is no doubt that phonological theory should allow the notation of a syllable boundary ($) in the structural description of phonological rules. This is typically the case when $ constitutes the left-hand side or right-hand side environment of the segment affected by the rule, i.e. when the rule expresses a process taking place in absolute syllable-initial or absolute syllable-final position. (I use the quali-fication "absolute" to resolve the ambiguity of e.g. "syllable-final position" as meaning either the final segment (perhaps the final consonant) of the syllable (i.e. "absolute syllable-final position"), or a segment (perhaps a consonant) in the final part of the syllable, i.e. occurring after the syllabic peak.) Examples of such processes, which should be stated by means of the syllable boundary symbol $ in their structural

description, are strengthening of glides (in Spanish) in
absolute syllable-initial position (cf. Hooper p. 528, where
the environment is given as / $___) and tensening of non-low
stressed vowels (in Castilian) in open syllables, i.e. in
absolute syllable-final position (cf. Hooper p. 530, where
the environment is given as / ___$).

    However, Hooper mentions the $-symbol in a much wider
range of phonological rules than those referred to above,
and in most of these other cases I find that her use of $ in
the structural description of phonological rules is unjusti-
fied and in fact obscures the nature of the processes. This
is the case with several assimilation rules which, according
to her statements, apply only across $. We shall now devote
some attention to a typical example of this sort, viz. the
place-of-articulation assimilation of nasals before consonants
in Spanish (in "Allegretto" speech style, p. 525f).

    The problem to account for is that nasals assimilate
to obstruents both within words (e.g. campo, ganga [-mp-,
-ŋg-]) and across word boundaries (e.g. un beso, un gato
[-mb-, -ŋg-]). Before glides ([j, w]), on the other hand,
the assimilation occurs only across word boundaries (e.g.
un hielo, un huevo [-ɲj-, -ŋw-]), not within words (e.g.
miel, nieto, muevo, nuevo [mj-, nj-, mw-, nw-]). Hooper
writes:

    "With the syllable boundaries included in the strings,
the solution to the problem becomes obvious. Nasal assimila-
tion occurs before a consonant or a glide only if a $-boundary
intervenes. Thus one rule generates the desired output for
all cases:

(1) $[+nasal] \rightarrow \begin{bmatrix} \alpha coronal \\ \beta anterior \\ \gamma back \\ \delta distributed \end{bmatrix} / \_\_\$ \begin{bmatrix} \alpha coronal \\ \beta anterior \\ \gamma back \\ \delta distributed \end{bmatrix}$

Rule 1 accomplishes all that is required of a phonological
rule: it generates all instances of nasal assimilation; it
states the constraints on nasals followed by non-vowels;
and it provides an explanation of the facts. Using $-
boundaries, the difference between the glides of [uñ$yeḷo]
and [nyeto] can be stated formally: the first [y] begins a
syllable and thus is functioning as a non-syllabic segment,
while the second is part of the syllable nucleus. Rule 1
states the appropriate generalization, that nasals assimilate
only before segments that begin syllables, i.e. segments
in a non-syllabic function." (p. 526; my italics.)

The first thing to be noted in the passage quoted
is that Hooper's "explanation" (which even "can be stated
formally") does not follow from her rule formulation, but
that it presupposes an additional axiom like the following:
a glide which begins a syllable is a non-syllabic segment
as opposed to a glide which does not begin a syllable. If
this is not in plain contradiction to other passages of hers,
e.g. "two contiguous syllabic segments form separate syllables.
This rule applies to Spanish ..." (p. 534), at best her termi-
nology is confusing (the word "syllabic" apparently meaning
"part of the syllable nucleus" while the feature name
"[syllabic]" seems to mean "constitutes the peak of a syllable";
see section 4.5 below). Anyhow, the "explanation" is based
upon a dubious distinction between those prevocalic glides
which do and those which do not form part of the syllable
nucleus, and I find this far from convincing (it should be
noted that in the speech style discussed here, the glides in
absolute syllable-initial position are not strengthened to
obstruents, p. 528).

But if her explanation in the text is not connected
with her rule formulation and in itself unconvincing, let us
then take a look at her notation. The rule in fact states

that the assimilation takes place _only_ if the segment to be
assimilated is separated from the segment causing the assimi-
lation by a $-boundary. But to me it is unbelievable that
it is the occurrence of a boundary which conditions the
assimilation. I suggest the universal principle that if a
certain assimilation under certain conditions takes place
across a certain boundary, then the same assimilation under
the same conditions will also take place in the absence of
this boundary (and in the presence as well as absence of a
weaker boundary).

    This is, of course, not to deny the observational
adequacy of Hooper's assimilation rule, but I think the
explanation should be sought in a different direction, al-
though within the same basic framework, viz. that the _syllable_
plays a crucial role for the assimilation. Even though the
function of the glides in un hielo and nieto is the same, as
I suggest is the case, the function of the nasals in the two
examples is quite different. In the final part of the syllable
there is no contrast of place-of-articulation among nasals,
and - with the Prague School terminology - there is thus only
one nasal archiphoneme syllable-finally, whereas syllable-
initially there is a three-way contrast between labial, dental,
and palatal nasals (similarly the contrast between dental and
palatal laterals is neutralized in syllable-final position).
These neutralizations in syllable-final position are only one
manifestation of a more wide-spread phenomenon: that syllable-
final consonants are "weaker" than their initial counterparts
in a number of respects: they are shorter, have a laxer arti-
culation, and are much more susceptible to assimilatory phe-
nomena (cf. Grammont 1933, p. 184ff). Whatever the correct
formulation of the rule may be, I think this is the heart of
the matter. Notice that Hooper must claim that her rule

"states the constraints on nasals followed by non-vowels"
in such a way that if a nasal should be followed by a word-
final obstruent, the former would not necessarily be homorganic
with the latter. Such a word-final cluster does not, of
course, occur in normal Spanish words, but it seems improbable
that a nasal preceding e.g. a word-final /p/ could be any-
thing but [m].

According to Hooper, "these assimilation rules are
two examples of generalizations that cannot be stated without
the $-boundary" (p. 526; my italics). This assertion can
only be due to lack of imagination, and I shall just sketch
two alternative ways of accounting for the nasal assimilation
in what seems to me a more insightful way. I have at present
no strong arguments in favour of one or the other of these
two proposals, and I do not believe that they are completely
independent of each other.

One possibility is to re-include the notion of the
archiphoneme in phonology, in the sense that a rule can refer
to a segment which is not fully specified, i.e. which has
zero as its coefficient for one or more features. Further-
more, the place-of-articulation assimilation expressed by the
rule is obviously not a simultaneous but independent assimila-
tion of four distinct features: [coronal, anterior, back,
distributed], as the formulation suggests. If we therefore
use one multi-valued feature [place-of-articulation] (abbre-
viated [art]) (cf. Ladefoged 1971, p. 42ff) [1], the rule can

---

1) By the term "multi-valued" I mean that the feature can take
   a finite number larger than two (but in practice a small
number) of coefficients. Schane (1973, p. 96) apparently con-
siders "multi-valued" equivalent to "scalar" in the sense that
multi-valued features (i.e. features on a late, "phonetic"
level of representation within his framework) can specify fine
phonetic distinctions, e.g. between different languages, within
a certain "scale". I should emphasize that this implication

be formulated as follows:

$$\begin{bmatrix} +\text{nasal} \\ \emptyset \ \text{art} \end{bmatrix} \longrightarrow [\alpha \ \text{art}] \ / \_\_\_ \begin{bmatrix} C \\ \alpha \ \text{art} \end{bmatrix}$$

This rule expresses the generalization that the nasal archi-
phoneme is assimilated as regards place-of-articulation to a
following consonant, whereas a fully specified nasal is un-
changed by the rule; this explanation also holds true for
the lateral assimilation. (This statement in terms of archi-
phonemes may be interesting in view of evidence from speech
error analysis discovered by Niels Davidsen-Nielsen (forth-
coming) which points to an encoding of sp-, st-, sk- as /s/
followed by a stop archiphoneme unspecified as regards the
feature(s) distinguishing /ptk/ from /bdg/.)

Another possible solution would be that [-syllabic]
segments are subcategorized into [+final] and [-final]. Thus
the underlying forms could be - but need not be - sequences
of syllables, each syllable consisting of an unordered set
of segments which would then have to become a sequence by a
process of linearization in accordance with the syllabic
hierarchy, see section 4 below. This idea of linearization

---

1) (cont.) (due to the orthodox generative (Jakobsonian)
unwillingness to recognize non-binary features on the
phonological level) does not apply to my use of "multi-valued"
(which is in agreement with Ladefoged). Ladefoged, however,
uses "scalar" synonymously with "linearly ordered" (as opposed
to "independent"), i.e. a ternary feature can be scalar ac-
cording to him. I think this terminology should be refined
so that "scalar" means "continuously varying within certain
limits" (this is in fact a normal property of a "scale"), in
agreement with Schane's use of the word, whereas "a multi-
valued linearly ordered feature" can take only a finite
number of values on a certain "scale". Whatever terminology
is chosen, the distinctions mentioned above all seem necessary,
i.e. both Schane's and Ladefoged's terminologies are too crude.

has evident parallels in higher parts of the grammar (cf. Chafe 1970, p. 250ff). Thus the assimilation rule could·be stated like this:

$$\begin{bmatrix} +\text{nasal} \\ +\text{final} \end{bmatrix} \longrightarrow [\alpha\text{art}] / \underline{\quad} \begin{bmatrix} C \\ \alpha\text{art} \end{bmatrix}$$

In favour of a solution along these lines would be the fact that for a large number of assimilation processes the segment affected could be defined as being [+final], and this is true also in cases where there is no neutralization in final position, as in the voicing assimilation rule which Hooper states (p. 530) in the following way:

$$[\quad\quad] \longrightarrow [+\text{voice}] / \underline{\quad}\$ \quad [+\text{voice}].$$

3.3. The syllable as a domain for phonological rules

At the outset of section 3.2 we mentioned certain types of phonological rules where it seemed to be the best solution to mention the $-boundary in the structural description, viz. mainly processes applying to segments in absolute syllable-initial and absolute syllable-final position (there are maybe some others as well, cf. Hooper p. 531). We claimed, however, that in a number of cases this was not the correct solution. In this section we shall discuss some further phonological rules where the syllable seems to play a crucial role although not the one ascribed to it by Hooper.

The $-boundary is, of course, not the only boundary in phonology which can constitute the left or the right-hand side limit of a rule environment. For example, special processes can occur phrase-finally (aspiration (and affrication in the case of /t/) in Danish is such an example), and such rules

must contain the boundary symbol in their structural description (devoicing before $\#$ or $\#\#$ in many languages is another well-known example).

It must be emphasized that such cases by no means illustrate the only function of boundaries in phonology; they do not even constitute the most important one. This is not the place for a general discussion of grammatical boundaries in phonology (cf. Basbøll (forthcoming) for an extensive discussion of (particularly word-internal) boundaries in French phonology). However, in order to place syllable boundaries in their proper perspective, I find it useful very briefly to discuss the function of the boundaries in SPE and to compare it with the proposals of McCawley (1968, p. 55ff).

Let us begin with the conceptually simpler proposal, viz. that of McCawley. He suggests that the grammatical boundaries in phonology (junctures) in a given language can be arranged in a unique rank order B_1, B_2, ... B_n, in the sense that B_1 is the weakest (of lowest rank), then comes B_2, etc. (B_1 is the morpheme boundary, B_n the pause.) The main function of the boundaries is to define the domain of phonological rules in the following way: Each phonological rule has a certain rank expressed in terms of a specific boundary, e.g. $[B_3]$; when an input string to a rule of the rank $[B_3]$ is scanned to see whether it matches the structural description of the rule, the string is divided into chunks in such a way that each chunk is limited on both sides by a boundary of rank 3 or a higher rank (i.e. B_3^n), and that the only boundaries that occur within each chunk are of a rank lower than 3 (i.e. B_1^2); each such chunk is thus separately matched to the structural description of the rule, ignoring those internal lower rank boundaries (i.e. B_1^2) in the input string which are not mentioned in the structural description of the rule.

(According to McCawley, a rule of rank B_n is higher valued than a similar rule of a lower rank.) Although the proposal is in need of precision as to the restrictions on the inventory of possible boundaries, it is conceptually very satisfying.

The same can scarcely be said about the use of boundaries in SPE. First of all, boundaries (which are [-segment]) are cross-classified by means of distinctive features, just like vowels and consonants ([+segment]). This is a very powerful principle (the inclusion of which in the phonology of boundaries seems by and large unmotivated). Chomsky and Halle use three different intra-phrase boundary symbols, viz. + ("morpheme boundary", i.e. [-segment, +formative boundary, -word boundary]), # ("word boundary", i.e. [-segment, -formative boundary, +word boundary]), and = ([-segment, -formative boundary, -word boundary]). This latter boundary, forming separate natural classes together with + ([-segment, -word boundary] defining = and +) and # ([-segment, -formative boundary] defining = and #), destroys the hierarchical principle inherent in McCawley's proposal, but since it is limited to certain quite specific non-native formations (SPE p. 94f), we shall ignore it here. Boundaries stronger than # are in SPE represented by sequences of # , which in fact approaches the idea of a hierarchy of boundaries; e.g. a rule applying in the environment /___# will also necessarily apply in the environment /___## , but not inversely.

Now, what is the function of the boundaries + and # in rules? According to SPE, the distribution of the boundary + is irrelevant to the application of phonological rules unless their structural description explicitly mentions a

+-boundary.[1] A $\#$, on the other hand, prevents the application of a phonological rule which does not mention a $\#$ -boundary at the indicated place in its structural description. This is empirically equivalent to saying that a phonological rule which does not mention any boundaries in its structural description only applies if the string of segments matching the structural description does not contain any instances of $\#$. For non-cyclical rules, this amounts to saying that their domain of application is the maximal string between two successive $\#$ -boundaries unless boundaries occur in the structural description. And, in fact, also the maximal string between two successive +-boundaries containing no internal boundaries defines a rule domain, viz. the domain for morpheme structure rules or morpheme structure conditions.

The point I wish to make by this digression is the following: despite the great differences between the boundary theories of McCawley and SPE, they in fact agree that a main function of boundaries in phonology is to define the domain of rules. This follows from the fact that boundaries can block the application of rules where the sequences of segments

---

1) The condition expressed in the last clause does not seem very well motivated. Jørgen Rischel has suggested that the distinction between the boundaries $\#$ and + should be, simply, that $\#$ can have phonological effects, whereas the distribution of the boundary + in phonological strings is irrelevant to the application of phonological rules, i.e. neither the presence nor the absence of + can be presupposed for the application of a phonological rule. This hypothesis is a way of formulating the well-known insight that certain grammatical boundaries, but not all, have phonological consequences, cf. Rischel 1972, p. 226 (notice that the argument above does not apply to morpheme structure rules or -conditions). However, compare Kiparsky 1973, p. 57ff.

match the structural description (the occurrence of + blocks a morpheme structure rule, and the occurrence of other junctures can block phonological rules).

Now, if this is true of grammatical boundaries let us then examine the possibility that also syllable boundaries can block certain phonological rules, or that the syllable could be a domain of phonological rules. Apparently this possibility is not considered by Hooper (who seems implicitly to assign the same junctural status to the $-boundary as to the +-boundary, i.e., that if a $ occurs in the structural description, then the rule applies only to input strings containing $ at the indicated place, whereas rules not mentioning $ apply regardless of the distribution of $; in an SPE-framework, this seems in fact to be the only possibility). A case in point is the following example:

"Many P-rules in Akan depend upon syllable shape and thus syllable boundaries [...] For example, consider the nasalization of high vowels which occurs before a nasal consonant in the same syllable. (Note that this environment is extremely common for vowel nasalization - it occurs in French for all vowels in just such an environment.) It is possible to avoid the mention of 'syllable' in formally stating the rule, by recognizing two environments: before a nasal before another consonant, and before a morpheme-final nasal:

$$(15) \quad \begin{bmatrix} V \\ +high \end{bmatrix} \longrightarrow [+nasal] \ / \underline{\quad} \ [+nasal] \ \begin{Bmatrix} C \\ \# \end{Bmatrix}$$

It is simpler, however, to state the environment in terms of $-boundaries:

$$(16) \quad \begin{bmatrix} V \\ +high \end{bmatrix} \longrightarrow [+nasal] \ / \underline{\quad} \ [+nasal] \quad \$$$

Note that Rule 16 is NOT an abbreviation of 15. Rule 16
is the <u>real</u> statement of the environment, while Rule 15 is
merely an <u>ad-hoc contrivance that produces the same results</u>"
(Hooper, p. 533; my italics).

The point to be emphasized is that the two formulations
<u>do not in all cases produce the same results</u>, but that the
"ad-hoc contrivance" gives the right output, whereas her
rule 16 often gives the wrong output. For example, French
words like <u>cent</u>, <u>sans</u> [sã] (I use examples from French where
I know the data) in their underlying forms end in obstruents
(cf. <u>centaine</u>, <u>centenaire</u> [sãtɛn, sãt(ə)nɛ:ʁ] and <u>sans amour</u>
[sã z amu:ʁ]). The latter example suggests that the phono-
logical $-boundary should occur after the /z/ at the point
of the derivation where the vowel is nasalized, since this
is the place of the word boundary (according to Hooper, one
should not expect a readjustment of the $-boundary to the
place before /z/ until /z/ is intervocalic, i.e. after the
nasal has dropped, see p. 527, 537). This conclusion seems
strengthened by the observation that a word like <u>sens</u> [sã:s]
has a nasalized vowel before a word-final <u>pronounced</u> obstruent
(in certain varieties of French, at least, there is no under-
lying shwa in such words). A further argument for the posi-
tion that nasalization of vowels in French can occur also
before·nasals that are not in absolute syllable-final position
comes from words like <u>pente</u> [pã:t] in which the vowel is
nasalized before a pronounced obstruent followed by pause.
Such words end in an underlying shwa , and it might be claimed
that the /t/ is syllable-initial at the point of the deriva-
tion where the vowel is nasalized. However, this does not
agree with the fact that in a word like <u>étiquette</u> [etikɛt]
(which is underlying /#etikətə#/, cf. <u>étiqueter</u> [etikte]),
the phonological syllable border must go <u>after</u> the final /t/

since the /ə/ is converted to ε, see Dell 1973, p. 198ff and
Basbøll, forthcoming. Although each of these arguments
taken alone is not irrefutable, they nevertheless give a
certain implausibility to Hooper's formulation. And at any
rate, it is certain that the two formulations are not equi-
valent in all cases; and I find it hard to accept a notation
in which every form /VN$/ is nasalized, but no form /VNC$/.

   We therefore claim that the nasal consonant in these
examples does not occur immediately before the $ which Hooper's
formulation demands. In order to make her rule 16 work, it
should be changed to (for the French material):

(i) $V \rightarrow$ [+nasal] /___ [+nasal] $C_o$$

But this is only one more example where one is forced to
state in the rule what is irrelevant for the application of
it, viz. C_o.

   How should this rule, then, be formulated? In the text
Hooper in fact gives the correct condition, viz. "before a
nasal consonant in the same syllable". Thus it is irrelevant
whether the $-boundary occurs immediately after the nasal
or not, what counts is that it does not occur between the
vowel and the nasal consonant. If we recognize the possibili-
ty that a rule can have the syllable as its domain, or can
have the $-boundary as its rank, or can be blocked by the
occurrence of a $-boundary within its structural description
(all these formulations here being equivalent), then the rule
can be formulated like this:

(ii) $V \rightarrow$ [+nasal] /___ [+nasal]

where it should be a property of the rule, but not of its
structural description, that it has the syllable as its domain.

(If it cannot be deduced from the process itself that the syllable is the domain of the rule, this must be given as an index of the rule, as McCawley must state the rank of rules with smaller domains than the string occurring between two pauses; however, as far as I know, it is the normal case for rules assigning consonant features to vowels, as well as for rules coalescing a vowel and a following consonant, that they do not apply across syllable boundaries.)

Let us now turn to a rule from Danish in which there is absolutely no way out of mentioning C_o in the structural description if we are to accept Hooper's framework. I have in mind the rule for the manifestation of short /a/ (see section 2.1 above). The colouring of /a/ by the following homosyllabic consonant is quite independent of any additional final consonants, e.g. the /a/ in samt [ˈsɑmʔd] is pronounced exactly like the /a/ in Sam [ˈsɑmʔ]. Consequently Hooper would have to formulate the rule like this:

(iii)   a $\longrightarrow$ [+back] /___   [-cor] C_o \$

(Notice that in the SPE-framework of distinctive features used by Hooper, there is no way to capture the assimilatory nature of the process in question, because what is alike in the vowel and the consonant is not articulatorily defined, see below.)

However, I argue that the domain of the rule is the syllable, and that its correct formulation is the following:

(iv)   a $\longrightarrow$ [+grave] /___   [+grave]   (domain: syllable)

This rule too is a case where a feature of a consonant (viz. the acoustically-auditorily defined feature [+grave] characterizing labials and velars, cf. Ladefoged 1971, p. 44) is ascribed to a preceding homosyllabic vowel.

Of course, I do not claim that the syllable is the only domain for phonological rules, not even that it is the most important one. Some other domains of phonological rules in Danish will be briefly mentioned below.

It is clear from the discussion of grammatical boundaries in phonology at the outset of the present section that according to the notational conventions of SPE, non-cyclical rules which do not include any boundary symbol in their structural description have the maximal string between two consecutive #-boundaries as their domain. The rule [-son] ⟶ [-voi]/___ [-voi] in Danish is such an example. This rule turns an underlying voiced obstruent, i.e. b, d, g, v, ʁ, into its voiceless counterpart, i.e. p, t, k, f, x̣, in the position before a voiceless obstruent not separated from the preceding segment by any #-boundary (on this rule, see the notes referred to in footnote 1 on p. 42).

The compound stress rule in Danish seems to have the word as its domain: it is characteristic that the stress pattern which is typical of ordinary Danish compounds never applies to more than one word (cf. Rischel 1972). Finally, certain assimilation rules have larger domains, in part depending on stylistic factors, and so on.

It is an urgent need in phonology to find the relations which undoubtedly exist between the nature of a phonological process and its domain. I suggested above that rules which assign consonant features to a preceding vowel normally have the syllable as their domain. However, this relation is probably not a universal law, since certain rules seem able to change their domain. Such conditions of rules changing their domain ought to be investigated; for example, rule (iii) above seems to be in the process of enlarging its domain by younger speakers, so that words like papir, akademiker are now often pronounced [pʰɑpʰíʁ̩ʔ, ɑkʰadéːʔmigʌ] (the pronunciation [pʰ, kʰ] suggests that it is not the syllable boundary which has been moved).

3.4. Syllabification

By "syllabification" I understand the division of a
phonological string (consisting of phonological segments and
boundaries) into consecutive syllables. "Syllabification" is
thus roughly equivalent to "placement of syllable boundaries";
and it therefore concerns the border between contiguous syl-
lables, and not their internal structure in terms of peak,
nucleus, margin, and the like (see further section 4).

As to the cases where the syllable functions as a unit in
phonological rules (i.e. typically in rules concerning prosodic
features like stress, tone, and stød, cf. sections 2.3 and 3.1
above), syllabification is not required for the correct applica-
tion of the rules: what is necessary is only that the number of
syllables be known, and this information can possibly be given
with an identification of the syllabic peaks. The consequences
of this fact for the formal definition of the syllable will be
taken up in section 4.1 below.

Obviously, if a syllable boundary occurs in the structural
description of a phonological rule (section 3.2 above), the
input string to this rule must be syllabified. Similarly, re-
garding the rules having the syllable as their domain (section
3.3 above), their input strings also appear to presuppose a
previous syllabification.

However, on this point I would like to claim that phono-
logical syllable boundaries can be partly indeterminate, i.e.
they need not always be fully determined. In a great number of
cases where the syllable plays a role in determining phonological
processes, the only relevant distinction is one between open and
closed syllables, whereas a distinction between syllables ending
in one, two, or three consonants does not matter. This is the
case e.g. with the stress rule in classical Latin and with the
rule predicting the manifestation of Danish short /o/ (section
2.1 above).

Let me briefly discuss a third example of this sort, viz. the rule E-Adjustment in French which in certain contexts (which can tentatively be defined as "in closed syllables") converts an /e/ or /ə/ into /ɛ/ (see Basbøll, forthcoming, for a discussion of this rule in connection with syllabificational problems). Examples like genevois, jetterons [ʒənvwa,ʒɛtɤɔ̃], derived from /# ʒənəv+uaz# , #ʒət+ə+r+ɔN# z #/, show that an intervocalic consonant between two unstressed shwas belongs to the following vowel if no morpheme boundary intervenes between it and the consonant, otherwise to the preceding vowel. But where does the syllable boundary occur in an example like sévrerons [sɛvɤəɤɔ̃], derived from /# səvr+ə+r+ɔN# z #/ (cf. sevrer [səvɤe] /# səvr+ə+r #/)? If we say that the syllable boundary coincides with the morpheme boundary, then the first syllable ends in the otherwise unknown final consonant combination /vr/ (see below); but if we say that the syllable boundary occurs between /v/ and /r/, then we must recognize that the factor determining the syllable boundary, viz. the morpheme boundary, occurs at a different place, i.e. that it can only retract the syllable boundary one place, and this sounds somewhat mysterious to me. In fact I think the choice between the two mentioned locations of the syllable boundary is a pseudo-problem which only arises in a theory forcing one to state one unique inter-segmental location of every syllable boundary. A more realistic solution is to define the notions open and closed syllable formally in such a way that the first shwa in sévrerons will occur in a closed syllable, but without commitment to the choice between several locations which will in any context under any circumstances give the same result.

Before we turn to the discussion of several factors which can influence the syllabification of phonological strings, a word should be added about the level at which syllabification applies.

First of all, I do not think it makes much sense to
speak of syllables and syllabification at very abstract
levels of representation (cf. Fudge 1969). Of course, one
can claim (Hooper 1972, p. 538) that Spanish estable is de-
rived from /stable$/ via (by an e-epenthesis rule followed
by a resyllabification) /estable/, but I fail to see why
there must be $-boundaries (before /s/) in the abstract string
/stable$/. Similarly, she notes that Spanish pan is derived
from /pane$/ via (by an e-deletion rule followed by a re-
syllabification) /pan/. In fact, I think that the only
arguments for abstract syllable boundaries different from the
phonetic ones are the impact of such boundaries on the applica-
tion of phonological rules. There is thus no reason to
postulate an "abstract syllable boundary" between /a/ and /n/
in pan if this boundary can have no phonological effect what-
ever and, of course, no phonetic existence at all (this is
in line with our proposal above that phonological syllable
boundaries are in some cases partly indeterminate). Notice
that the present discussion concerns the level of description,
i.e., I do not intend to exclude an abstract syllabification
/pane$/ if this word-internal syllable boundary could be
phonologically justified in other forms with e-deletion; but
a phonological syllabification applying before a certain rule
P should be excluded in principle if the syllabification in
question can have no effects on the application of P or of
any phonological rule ordered before P.[1]

At the other end of the abstractness scale there is
ample evidence for the existence of phonetic syllables and
phonetic syllable boundaries. At the phonetic level the
postulation of a syllable boundary should, of course, be justi-
fied on purely phonetic (i.e. non-phonological) grounds, in-
cluding the distinction between syllable initial- and syllable-

---

1) The rule order involved here is descriptive order, i.e.
   priority is concerned, not time (e.g. in a psychological
sense), see Rischel 1974, p. 311ff.

final extrinsic allophones, etc. The postulation of phonetic
syllable boundaries can thus be confirmed or disconfirmed by
experimental-phonetic evidence, as opposed to phonological
syllable boundaries which are merely "descriptive devices"
in cases where they differ from the phonetic ones. Since the
subject of the present paper is the phonological and not the
phonetic syllable, I shall leave the purely phonetic questions
here (but cf. section 4), and turn to the relation between
phonological and phonetic syllable boundaries.

"The claim made here is that Rule 22 [which inserts syl-
lable boundaries in certain contexts defined in terms of seg-
ments; HB] represents the _universal_ definition of the _phono-_
logical syllable, and that languages may or may not have
additional late rules that define a _language-specific_, _phonetic_
syllable" (Hooper 1972, p. 536; my italics). Cf. the following
quotation: "We have been assuming that it is always possible
to assign a non-arbitrary syllable division in any word; this
assumption is justified on the grounds that we are referring
to the phonological syllable, not to the phonetic syllable"
(ibid.). Hooper refers to Hoard 1971 who shows that stress
influences syllabification (which is not predicted by her
Rule 22) in English. Apparently Hooper here confuses two
issues; what is specific to English is _not_, as Hooper suggests
it is, that "a stressed syllable attracts a maximum number of
segments to it" (ibid.), but rather the fact that English is
a language which has heavily stressed syllables contiguous
to unstressed ones, as well as (naturally) the regularities
and irregularities of the location of the stresses.

In fact, I think that the relation between phonetic and
phonological syllable boundaries is just the opposite of what
Hooper believes (cf. Basbøll 1972a, p. 193[1]). It is highly

---

1) I have permitted myself to restate some of the points I made
   in Basbøll 1972a, since Hooper's article had not appeared
at the time I published my paper, and I could therefore not
take into consideration her partly similar, partly deviant
proposals on that occasion.

significant that the <u>universals</u> concerning syllable types in different languages, possible consonant clusters and their division by syllable boundaries, etc. which have been signalled in the literature (cf. e.g. Jakobson 1941, Greenberg 1965, and Cairns 1969) all apply at a <u>phonetic</u> or a "<u>classical</u>" <u>phonemic</u> level, but <u>not</u> at an <u>abstract phonological</u> (morpho-phonemic) level. This suggests that an abstract phonological syllable may be more or less language-specific (although there is also here a high degree of convergence between the syllabificational criteria used by different languages, e.g. as to the specific role of the unstressed shwa in both French and Danish); phonetically, on the other hand, languages seem to agree, and I suggest that the <u>universally unmarked way to syllabify a given sound chain is the phonetic syllabification</u> (but it depends, of course, on a number of language-specific factors, such as the distribution of stresses (and maybe junctures, see below), a dependence which is probably not language-specific). As a hypothesis, I think it has much more inherent plausibility than Hooper's, and it seems to be supported by observations like the following:

In Danish, <u>phonological</u> criteria clearly point to a syllable division <u>after</u> [ð] in words like <u>bade</u> [bæ:ðə] (e.g., [ð] never occurs word-initially, and it alternates with [d] before stressed vowels as in <u>abbed</u>, <u>abbedisse</u> [ábeð, abedísə]), but both <u>phonetically</u> and <u>psychologically</u> (see below) it seems to occur <u>before</u> [ð], which is in agreement with the tendency towards CV-syllables, especially when the vowel is long (note that in this example there is no question about segments being inserted or deleted, or changing their coefficient for the feature [syllabic], which could motivate a resyllabification within Hooper's framework).

As for the <u>psychological</u> reality of syllable boundaries, the only thing that can be said here is that the problem of

determining whether such psychologically real syllable boundaries exist, and if so, where they are, is empirically quite distinct from determining both the phonetic and the phonological syllable boundaries. This question should be enlightened by means of psychological test methods, but its interwovenness with orthography will probably make the issue extremely difficult to settle.

Let us now return to the phonological syllable boundaries. Below I shall discuss briefly a number of factors which can influence the location of the phonological syllable boundaries, viz. the following: grammatical boundaries; the existence of initial and final segment combinations in the utterance and/or the word and/or the morpheme; stress; the surrounding vowels; and the sequences of consonants. It should be emphasized that these do not represent a number of alternative principles of syllabification of which every language chooses one; on the contrary, those principles interact in different ways in different languages. In section 3.4.1 below I shall state briefly how Danish uses these different criteria in an ordered fashion to form a set of principles of phonological syllabification.

<u>Sensitivity of syllable boundaries to grammatical boundaries</u>. It has always been recognized that grammatical boundaries can determine the place of syllable boundaries in such a way that the latter must coincide with the former (cf. Hooper 1972, p. 527, 537). For example, it seems to be true for a great number of languages that boundaries between words are also phonological syllable boundaries, if the latter are relevant at all.

The relation between intra-word grammatical boundaries and syllable boundaries is more complex. If the hypothesis

sketched in the footnote on p. 62 can be upheld, viz. that the distinction between the boundaries # and + is that the former but not the latter can play a role for the application of phonological rules, then the hypothesis suggests itself that the boundary # always coincides with the syllable boundary (this hypothesis seems by and large valid for the Danish and French material I have investigated with regard to syllabification); however, the general examination of it is an enormous task because the junctural structure of the language in question must be established independently of syllabificational phenomena if the reasoning shall avoid circularity (see Basbøll, forthcoming).

The last problem I shall mention concerning the relation between grammatical and syllabic boundaries is the well-known fact that, in general, Germanic languages as opposed to Romance languages exhibit a phonetic syllabification which is sensitive to word boundaries (compare the fact that in German word-initial vowels have a glottal attack, e.g. ein Esel [ʔɑin ʔéːzɫ], with the liaison- and enchaînement-phenomena in French, e.g. en avril [ɑ̃ n avʁíl]). In my view, this casts doubt on the existence of a phonological rule of universal applicability that erases all grammatical boundaries at the end of the phonological component. An alternative would be that (intra-phrase?) grammatical boundaries are erased at an earlier point of the derivation in French than in German, or maybe that they are not erased in German at all but manifested phonetically in various ways. This issue has scarcely been investigated at all.

<u>Sensitivity of syllable boundaries to the existence of</u>
<u>initial and final segment combinations in the utterance and/or</u>
<u>the word and/or the morpheme</u>. It is a traditional insight that
there is generally a high correlation between the possible
initial and final consonants in a syllable on one hand and in
grammatical units like the utterance, the word or the morpheme
on the other, in the sense that an intervocalic consonant
cluster can be partitioned on different syllables so that the
syllable final cluster is also found finally in the grammatical
unit in question, and that the syllable initial cluster is
also found initially in the grammatical unit.

As for the grammatical unit used for the comparison, I
think most can be said in favour of <u>the word</u>, which is in fact
also the traditional choice. In general, there seem to be no
<u>phonological</u> restrictions determining which words can be com-
bined in utterances, can occur utterance initially or -finally,
etc. (of the type "words with three initial consonants never
start utterances"), this of course being related to the fact
that the word is the "minimal free form". Thus the word will
give the same results as the utterance for this purpose, and
is of a more manageable size (there may be methodological
reasons for preferring one or the other frame of reference
within different linguistic schools, but this can be ignored
here). On the other hand, there can be <u>phonological</u> restric-
tions on the combination of morphemes into words (for a Danish
example, cf. Basbøll 1973, p. 129f) and, furthermore, one
morpheme often has several alternants differing with respect
to consonant combinations (i.e. with different phonological
rules being applied in different contexts), and this makes the
consonant combinations less well defined. A Danish example
showing the difficulty in using the morpheme as frame of ref-
erence is mentioned in section 3.4.1 below.

Within generative phonology, a similarity between initial
and final consonant combinations in the syllable and in the
morpheme has often been pointed to (e.g. Hooper 1972, p. 535f).
The interest of this comparison within the orthodox generative
framework is no doubt due to the fact that the concept "pos-
sible morpheme initial (final) cluster" can be given a well
defined theoretical status by means of the morpheme structure
rules or -conditions applying in the lexicon (cf. Stanley
1967). But it should be emphasized that these morphemes are
generally taken to be very abstract entities, and in cases
where the initial or final clusters of these morphemes are
changed by phonological rules, they do not play any role for
syllabificational phenomena, as far as I know. The dangers in
using abstract morphemes as frame of reference for syllabifi-
cational phenomena can be seen in the following quotation from
Hooper:

"In Spanish the division is /s$l/, as in is$la, but in
English it is /$sl/. Again the constraints for syllable-
initial position correspond to the constraint for word-initial
position.

To account for such exceptions [viz. to the general
principle that the syllable boundary occurs before the obstruent
in an obstruent-liquid sequence; HB] formally, I propose that,
in addition to the general rule for inserting $-boundaries, the
metatheory provide a list of possible exceptions [...] The
choice of exceptions applicable in a given language is deter-
mined by the morpheme structure conditions of that language
[...] The fact that such a relation obtains may bear on the
question of the existence of $-boundaries in the lexicon."
(p. 535f; my italics).

Hooper jumps easily from the similarity between the
syllable-initial constraint and the word-initial constraint of
/sl/ in Spanish (which is real), to an imaginary similarity

between the syllable-initial constraint and the morpheme-structure constraint which is in flagrant contradiction to her underlying forms on p. 538 like /slabo/ which has an initial /sl-/. The correct conclusion is, of course, that there is no relation between clusters in abstract morphemes and syllabification, unless these abstract clusters are also found at more concrete levels of representation.

This conclusion agrees well with one of the claims made at the outset of section 3.4, namely that phonological syllable boundaries are merely descriptive devices in cases where they differ from the phonetic syllable boundaries, and that it is unjustified to speak of phonological syllable boundaries on more abstract levels than those on which they are used by phonological rules. It follows, then, that the comparison between word-initial (or -final) and syllable-initial (or -final) clusters cannot be made on such abstract levels.

However, the comparison in question cannot always be made on the phonetic level either, since the clusters to be compared may differ in ways which have no bearing on the validity of the comparison. E.g., if final voiceless stops in a given language are aspirated in word-final position but not in syllable-final position within the word, then it seems reasonable to disregard this difference in aspiration when comparing a certain postulated syllable-final cluster to the set of word-final clusters to see whether one of these matches it. A level appropriate for this comparison would be something like a phonemic level in the pre-generative sense, and this has in fact been used for distributional descriptions by many authors, e.g. Sigurd 1965 and Vestergaard 1968. However, within orthodox generative phonology no such intermediate level between the systematic phonemic and the systematic phonetic level has been given any theoretical status (cf. Chomsky 1964). If the genera-

tive model is not expanded to include one or more theoretical levels of this sort (which it probably should, cf. Rischel 1974, p. 361ff), then the distributional description - including the comparison between word-initial (or -final) and syllable-initial (or -final) clusters - can, at any rate, be given at an intermediate level defined by the rules which have, respectively have not, applied at that level (cf. Basbøll 1973 for a distributional description of Danish consonants at such a level, and Basbøll 1974 for a partly similar description of Italian).

It should also be said that the relation discussed in these lines obtains between syllable-initial and -final clusters on the one hand, and possible word-initial and -final clusters on the other, not necessarily registered clusters in a given corpus (i.e. clusters which are accidentally missing should be included in the material). It is of course a moot question how to define the distinction between structurally missing and accidentally missing clusters (cf. Spang-Hanssen 1959 and chapter VI of Fischer-Jørgensen 1952), and it has both statistical, psychological, and, above all, purely phonological aspects of the sort discussed in section 4.3 below. E.g., a Danish word like lingvist [leŋgvísd] should be syllabified before /gv/ despite the non-occurrence of word-initial /gv/, [g] being the syllable-initial allophone of /g/. That the non-occurrence of word-initial /gv/ may be regarded as accidental is seen from the existence of word-initial [sgv] as found in skvat [sgvad], etc. (the interpretation of [sg-] as /sk-/, suggested by Uldall 1936 and taken over by Vestergaard 1968, is not only far-fetched phonetically, but also at variance with the unanimously accepted interpretation of [sv-] as /sv-/ and not /sf-/).

There are at least two principal difficulties which arise when we try to evaluate the importance of the syllabificational

criterion under discussion here. First: we argue for a certain intra-word syllable boundary by saying that alternative locations of it would lead to a syllable-initial (or -final) cluster which is structurally impossible as a word-initial (or -final) cluster. However, it will in general be possible to get (roughly) the same results by defining the location of the syllable boundary in terms of the sequence of intervocalic consonants instead, without reference to the set of structurally possible clusters in the word. This difficulty arises in Danish, and it will therefore be discussed in section 3.4.1 below.

The other principal difficulty is the following: When a certain constraint is valid both for syllable-initial (or -final) clusters within the word and for word-initial (or -final) clusters, then it is no simple matter to decide which constraint is the basic one and which is the derived one, if they are not both consequences of a more general principle. It is rather evident that the set of word-initial and word-final clusters are primary data in a way in which intra-word (phonological) syllable boundaries are not, and in the language analysis the word-initial and -final clusters have therefore generally been taken as primary, and the intra-word syllable-initial and -final clusters as secondary. But in the final language description model (in the synthesis, if you like), it is not so clear what to do. Within the descriptive framework advocated in section 4 below, according to which most phonotactic information can be derived from a general model of "maximal syllabic structure", the constraints for word-initial and word-final consonant clusters are a consequence of the fact that these clusters are by necessity also initial, respectively final, in the syllable.

(An approach to syllabificational phenomena relying heavily on the relation to initial and final clusters is found in Anderson and Jones 1974.)

Sensitivity of syllable boundaries to stress. As already
mentioned, Hoard 1971 contains a detailed discussion of the
influence of stress in English on the occurrence of syllable
boundaries (see the beginning of this section). The general
principle seems to be that a stressed syllable attracts a
maximum number of segments to it.

In Danish, this principle is not very important for the
phonological syllabification (but the unstressed vowel shwa
plays a great role, see section 3.4.1 below). I shall, however,
mention one type of example where its influence can be clearly
seen. A word like eskorte is nearly always pronounced with an
unaspirated [g]: [ɛsgɔ̃:də]. The derived verb eskortere, on
the other hand, is often pronounced with an aspirated [k^h], i.e.
with the /k/ in syllable-initial position not occurring after a
homosyllabic /s/: [ɛsk^{h}ɒt^{s}é:ʔʌ/ɛsgɒt^{s}é:ʔʌ]. The only relevant
difference between the two occurrences of /s/ + velar stop is
that in eskortere, both surrounding vowels are unstressed,
whereas in eskorte, the following vowel is stressed and it thus
obligatorily attracts both preceding obstruents to it.

Sensitivity of syllable boundaries to the surrounding
vowels. It has been pointed out in Basbøll 1972a that the
distinction between the shwa-vowel and all other vowels (i.e.
"full vowels") plays a major role for phonological syllabifica-
tion in Danish; e.g. a single intervocalic consonant, as well
as a /g/ preceded by a sonorant, belongs to the preceding syl-
lable if the following vowel is shwa, but to the following syl-
lable if its vowel is a "full vowel". It is of course not
accidental that it is exactly the vowel shwa which occupies such
a unique place with regard to syllabification: The distinction
between shwa and full vowels is also essential to the descrip-
tion of stress (cf. Rischel 1970b), of the Danish "word types"
(Poul Andersen 1955 and later works), and of the creation of

syllabic consonants and other assimilatory phenomena in un-
stressed syllables (see section 4.6 below).

The importance of the vowel shwa for syllabificational
phenomena is also suggested by the fact that the "consonant
gradation"-phenomena (section 2.2 above), i.e. the consonant
weakening in syllable-final position, are peculiar to Danish
as opposed to e.g. Swedish, in which there is a contrast
/a/:/e/ in unstressed position, corresponding to the one Danish
vowel shwa (cf. Danish gade, Swedish gata [gæːðə, gɑːta]
'street').

Finally, it is interesting to notice that the unstressed
vowel shwa in French plays a role for phonological syllabifica-
tion very much as in Danish. For example, an intervocalic
consonant as well as an obstruent-liquid cluster belongs to
the following syllable if its vowel is a "full vowel" (this
term denoting all other vowels than shwa, as well as the under-
lying shwas which receive the word stress, e.g. appel [apɛl]
/# apəl#/, cf. appeler [apl̥e] /#apəl+ə+r#/), but to the
preceding syllable if its vowel is a full vowel and the follow-
ing vowel is an unstressed shwa. If both surrounding vowels
are unstressed shwas, then the preceding syllable is open
unless there is a morpheme boundary between the post-vocalic
consonant and the following shwa (cf. genevois, appellerons
[ʒənvwa, apɛlʁɔ̃] /#ʒənəv+uaz#, # apəl+ə+r+ɔN# z# /) as men-
tioned above in the present section. Also in French there is,
of course, ample evidence for the special phonological role
played by the unstressed shwa, both with regard to the word
stress-rule (a word-final shwa in a polysyllable being the
only final vowel which does not bear the word stress) and to
the vowel deletion rules (where unstressed shwas regularly drop
in most contexts, as opposed to all other vowels with a couple
of quite isolated exceptions like the /a/ of /la/).

Sensitivity of syllable boundaries to the sequences of
consonants.   It is a well-known fact that different types of
consonant clusters can have different effects on syllabifica-
tion. E.g., in many languages, like Latin, Italian, and French,
and to some degree also in Germanic languages, a sequence
obstruent-liquid "counts as" one single consonant with regard
to the principles of syllabification (it should be added, how-
ever, that in the Romance languages mentioned above it is a
condition that the obstruent be non-sibilant). Also the
clusters of /s/ plus a stop can in certain cases in Germanic
languages, but generally not in Romance, act as single conso-
nants with respect to syllabification (see Davidsen-Nielsen
1974 for a phonetic analysis of some English material in this
respect). Since this type of conditioning on syllabification
has been discussed extensively by others, e.g. Hooper 1972, I
shall limit myself to the above remarks on this matter.

3.4.1 Some principles of phonological syllabification in Danish

As an illustrative appendix to the more general discussion
in the preceding section, I shall here briefly survey some
principles which seem, by and large, to account for the phono-
logical syllabification in Danish (I have discussed these prin-
ciples in greater detail in the notes mentioned in footnote 1
on page 42).

It is probably superfluous to emphasize that the principles
to be presented below constitute only one out of several possible
ways to account for the phonological syllabification in Danish,
and that the formulations are highly sketchy. As pointed out
above, it is very difficult to determine the interaction between
two of the principles to be mentioned below, namely (ii) (on the
relation between clusters in the syllable and in the word), and

(iii) (on the sensitivity of syllable boundaries to the sur-
rounding segments), and it is not even certain that principle
(ii) will be indispensable in the final analysis. The following
section should thus be taken as exemplifying the preceding
discussion rather than explaining the location of every phono-
logical syllable boundary in Danish.

The practical difficulties in effectively testing such
principles (as well as phonological rules in general) for
observational adequacy should be evident. I would therefore
like to mention that Kjeld Kristensen and the author of these
lines are at present engaged in computer testing of a part of
a Danish phonology which includes a phonological syllabifica-
tion of Danish words, as well as a number of phonological rules
(both categorial and variable). This work in progress is
planned to be reported in the forthcoming volume of ARIPUC.[1]

I shall now discuss one model for determining the place
of the phonological syllable boundaries in Danish, containing
the following three types of factors (it should be borne in
mind that (ii) below may turn out to be dispensable in the
final analysis, presupposing a certain elaboration of (iii)):
(i) grammatical boundaries, (ii) the relation between initial
and final consonant combinations in the syllable and in the
word, and (iii) the sequences of segments in question (both
concerning vowels and consonants). The principles apply in
a hierarchical fashion so that (ii) only applies if (i) has
not decided the location of the syllable boundary, and (iii)
only if (ii) has not (i.e., the principles (i)-(ii)-(iii) are
disjunctively ordered). It is presupposed that the chain of
segments to be syllabified is fully specified as to the feature
[syllabic], i.e. it is known which segments form a syllabic
peak and which do not ("vowels" and "consonants", respectively,
in a somewhat loose terminology, see below), cf. sections 4.1
and 4.5 below.

---

1) A preliminary account is given in the present volume of
   ARIPUC.

The function of the principles can be illustrated by means of the following (somewhat metaphorical) description: The first time a phonological string is input to a rule which either has the syllable as its domain or which mentions a syllable boundary in its structural description, it is syllabified. Every boundary of a certain "rank" occurring between two [+syllabic]-segments is concurrent with a syllable boundary (see below). In the cases where there is no such boundary between two [+syllabic]-segments (possibly with intervening [-syllabic]-segments), all the places a syllable boundary can occur without giving rise to a syllable-final cluster which is impossible word-finally, or a syllable-initial cluster which is impossible word-initially, are marked off (ii). If there is only one such place, then the syllable boundary occurs there (there will always be at least one). If there are several such places, then the syllable boundary is placed at one of these, according to the principles (iii) which are sensitive to sequences of segments.

(i) The syllable boundary coincides with certain grammatical boundaries. This seems true of the boundaries between words, the intra-word boundaries before stems, and the boundaries before stressed native suffixes like -inde and -agtig. It thus seems possible to define the occurrence of these grammatical boundaries only in terms of what follows; viz. if what follows is a word, a stem (i.e., roughly, a major lexical category: N, V or A), or a stressed native suffix, or if nothing follows, then the grammatical boundary is obligatorily a syllable boundary too. Notice that both words, stems, and native stressed suffixes contain at least one [+syllabic]-segment, i.e. the principle suggested above can give rise to at most one syllable boundary between two [+syllabic]-segments (which is, of course, necessary in order for the definition "to work").

I leave the question open whether the syllable boundaries in these cases could or should be defined by means of junctures, or whether they have to refer directly to notions like "stem", "suffix", etc.

Concerning the grammatical boundary before stems, it will place the correct syllable boundaries between prefixes or "small words" (prepositions etc.) and stems, e.g. medgørlig [mɛðgǿ ɳʔli], as well as between stems, i.e. between the two parts of a compound, e.g. mados [máð(ʔ)ò:ʔs] (in this connection it may be interesting to notice that in French as well, the grammatical boundaries before stems are always syllable boundaries too, which is not the case for all grammatical boundaries after stems, cf. Basbøll, forthcoming).

Concerning the syllable boundary before native stressed suffixes like -inde, -agtig, -dom, -hed, it should be emphasized that "stressed" covers main stress as well as the reduced main stress typically found in second parts of compounds (e.g. violinistinde, barnagtig, sølvagtig, guddom, guddommelig, godhed [violinisdénə, bɑ:nɑ́gdi, sǿlɑ̀gdi, gúðdʌmʔ, guðdʌ́mʔəli, góðhèð?]). (To account for the distribution of main vs. reduced stresses is in many cases difficult, and non-pertinent for our purpose.)

The qualification "native" of the stressed suffixes in question is necessary in view of the many foreign (Greek-Latin type) stressed suffixes like -at, -ist, -i, -isse which are preceded by syllable-initial consonant allophones (e.g. doktorat, kontorist, perfidi, abbedisse [dʌgtˢoʁɑ̀:ʔd, kʰɔntˢoʁɪ́sd, pʰæɳfidí:ʔ, abedɪ́sə], cf. doktor, kontor, perfid, abbed [dʌ́gdʌ, kʰɔntˢóɳʔ, pʰæɳfíð?, ábeð]). Another fact which points to the foreignness of these suffixes, as opposed to -agtig, -dom, etc., is that they have never reduced main stress which is in general characteristic of typically native formations.

The special role of the boundary before stressed native suffixes agrees well with the vague hypothesis advanced in Basbøll 1972a (p. 194) that the intuitively transparent morpheme boundaries are also syllable boundaries. This amounts to postulating that native derivative formations like professorinde are more easily analysable for the native speaker than learned forms like professorat.

Finally it should be said that morphemically complex words can be lexicalized in the sense that their internal (phonologically relevant) grammatical boundaries are erased, with the consequence that they are treated phonologically as if they were monomorphemic. E.g. when the word rødspætte [ʁæsbɛdə] is pronounced without [ð], it is in accordance with the general constriction on monomorphemic words that [ð] does not occur before [s] (which it does in compounds etc.). This agrees well with the semantics of the word in question, which means 'plaice', whereas its second "constituent" in isolation can only mean 'woodpecker' (cf. Basbøll 1973, p. 122ff). Similarly, several names of Danish islands ending in -ø ('island') are pronounced as if they were not compounded: Ærø, Thurø [ɛ:ʁæ̀:ʔ, tˢú:ʁæ̀:ʔ] (cf. Færøerne [fɛɒ:ʔʌnə]), while others have alternating pronunciations corresponding to forms with and without the grammatical boundary (e.g. Rømø, Femø [ʁœ́mæ̀:ʔ, fɛ́mæ̀:ʔ] and [ʁæ̀:mæ̀:ʔ, fɛ:mæ̀:ʔ]).

(ii) The location of syllable boundaries as decided by the possibility of word-final and word-initial clusters. As already mentioned, phonological syllable boundaries in Danish, as well as in many other languages (not in all, e.g. not in Classical Greek), can always be - and, in fact, also are - placed in such a way that the syllable-final cluster does not violate any general restrictions holding for word-final clusters, and so that the syllable-initial cluster does not violate any general restrictions holding for word-initial clusters

(I deliberately avoid the formulation that "syllable-final clusters should also occur word-finally" or the like, in order to stress the fact that the issue concerns structurally pos-sible clusters, see above).

Examples which clearly demonstrate the necessity of having recourse to such a principle for the location of phono-logical syllable boundaries in Danish are not easy to find. One could mention words like angre(r), buldre(r) [aŋʁʌ, bulʁʌ], where the manifestation of /r/ is the one elsewhere found in syllable-initial position, but what these examples in fact show is only that the morpheme boundary and the syllable boundary need not coincide (in both words the morpheme boundary occurs after /r/). Whether the explanation for this syllabifi-cation is that neither /-ŋr/ nor /-lr/ are structurally possible word-final consonant clusters, or that the syllable boundary in an intervocalic sequence of two sonorant consonants always separates these consonants, is an open question.

The use of this criterion in the present model for phono-logical syllabification in Danish depends on a previous phono-tactic description allowing one to distinguish between (struc-turally) excluded and accidentally non-occurring clusters in the beginning and end of the word (cf. Basbøll 1973). This criterion has been used here in order to permit as simple and general a formulation of principle (iii) below as possible.

(iii) The location of syllable boundaries as a function of the sequence of segments. When the location of a syllable boundary between two syllabic peaks with intervening [-syllabic]-segments must be determined by principle (iii), the primary distinction is whether the following syllabic peak is a "full vowel" or a "weak syllabic peak". The basic generalization is, then, that the syllable border is situated in the leftmost position indicated by principle (ii) if the following syllabic

peak is a full vowel, otherwise in the rightmost position with
one reservation (see below). In other (and vaguer) words:
the "stronger" of the two syllabic peaks attracts the conso-
nants (cf. the influence of stress briefly mentioned in the
preceding section), but when the vowels are of equal "strength"
(i.e. with respect to the distinction full vowel:weak syllabic
peak), then the following syllabic peak is the decisive one
(thus the syllable boundary goes "to the left" between two full
vowels, but "to the right" between two weak syllabic peaks).

First, let us define the distinction between full vowels
and weak syllabic peaks on the phonetic surface (but it should
be remembered that it is used at an earlier point of the deri-
vation, cf. below). The latter comprise all occurrences of
the vowel [ə] and of all syllabic consonants[1] (i.e. [ð̥, l̥, m̥,
n̥, ŋ̥], of which [m̥, ŋ̥] only occur after labials and velars,
respectively, where they are in free variation with [n̥], see
Basbøll 1969, p. 44f). Certain occurrences of the unstressed
vowels [i, e, ʌ] are weak syllabic peaks, too. This is always
true for the vowels of the (unstressed native) derivational
suffixes ig, ing (and the rare ik), e.g. dydig, madding(,maddik)
[dý:ði, máðeŋ (,máð?ig)]. Also all unstressed [ʌ]s which are
derived from one of the sequences /ər, rər, rə/ or from /ə/
preceded by /r/ (e.g. kuer=kurer=kure, angre [ku:ʌ, aŋʁʌ], cf.
Rischel 1969, p. 196ff) count as weak syllabic peaks. The vowel
of the derivational suffix isk in some words counts as a weak
syllabic peak (e.g. metodisk, pædagogisk [met^S ó:?ðisg, pɛda-
gó:?(ɣ)isg]), in others as a full vowel (erotisk, parodisk
[eʁó:?t^S isg/eʁó:?disg, paʁó:?disg]), cf. Rischel 1970b, p. 133f.
All other syllabic peaks are full vowels (i.e. all stressed
vowels, all unstressed vowels different from [i, e, ʌ, ə], and
all instances of unstressed [i, e, ʌ] which do not satisfy the
(mainly non-phonological) conditions stated above).

---

1) I here follow the traditional use of the term "consonant", but
   in section 4.2 below [ð] will be defined as a vocoid.

When viewed on the phonetic level, the distinction be-
tween full vowels and weak syllabic peaks may look cumbersome
and unnnatural. But it should be remembered that the phono-
logical syllabification under discussion takes place at an
intermediate level of· the phonological component, and on that
level the distinction turns out to be much more natural.
First of all, the phonological processes deriving unstressed
[ʌ][1] from a number of different inputs all containing shwa
(discussed by Rischel 1969, p. 196ff) have not yet applied,
and all syllables with a weak syllabic peak and which phonetic-
ally contain [ʌ] thus have shwa as their vowel when the phono-
logical syllabification applies. Furthermore, syllabic con-
sonants are generally created by a process of shwa-assimilation
(see section 4.6 below) which is a late one and thus applies
after phonological syllabification (it will be considered in
section 4.5 below whether underlying syllabic consonants should
be postulated, but at any event there is a general relation of
equivalence between pronunciations with [ə] and a non-syllabic

---

1) My transcription differs from most of the earlier IPA-
    transcriptions of Standard Danish used in ARIPUC in that I
identify the unstressed vowel derived from /ə/ in certain
/r/-contexts with the stressed vowel in kom! [kʰʌm], and not
with (the quality of) the stressed vowel in hård [hɒ:ʔ]. From
a purely phonetic (in the sense of 'non-phonemic') point of
view the former identification is clearly superior to the latter
for the majority of Standard Danish usages; but if each pho-
netic symbol is taken to represent a certain range of different
pronunciations within the norm, then a new symbol (i.e. a symbol
not identical with any stressed Danish vowel symbol) is probably
needed for this unstressed vowel: the unstressed vowel in
damers can be identical to that of Amos, but also less rounded;
the unstressed vowel of Amors, on the other hand, can be identi-
cal to that of Amos (and thus also to that of one of the pos-
sible pronunciations of damers), but also more rounded and
back/low. All these pronunciations can even occur in the speech
of one individual (e.g. my own).

consonant (in more formal styles etc.), and pronunciations
with syllabic consonants). Finally, an assimilation rule has
been proposed with the effect of raising a /ə/ in /əng, əg,
ək (əsk)/ to i (Basbøll 1972a, p. 201):

$$\text{ə} \longrightarrow [+\text{high}]/\underline{\hspace{1cm}} \quad ([+\text{cor}]) \begin{bmatrix} C \\ +\text{high} \end{bmatrix}$$

thus accounting for the fact that the vowels of the derivation-
al suffixes ing (where i is regularly lowered before a nasal),
ig, ik (and possibly, for purely descriptive reasons, certain
occurrences of isk, namely those which seem to have a weak
syllabic peak) count as weak syllabic peaks, the reason being
that their vowel is an underlying shwa. With the possible
exception of the derivational suffix isk, the set of syllables
with weak syllabic peaks is thus identical to the set of syl-
lables whose vowel is shwa at the point of the derivation where
phonological syllabification applies.

There is one exception to the general principle that the
syllable boundary goes to the left before a full vowel but to
the right before a shwa, viz. when a consonant cluster which
contains a stop other than /g/ preceded by either a (under-
lyingly) voiced continuant or a nasal occurs before shwa.
In that case the syllable boundary goes before the stop (see
section 2.2 above):

$\quad$ kæn\$tre, æn\$dre [(kʰɛntɤʌ/)kʰɛndʁʌ, ɛn(.)dʁʌ];

$\quad$ lam\$pe, jam\$be [(lɑmpʰə/)lɑmbə, jɑm(.)bə];

$\quad$ vær\$ten, ver\$den [(væɤtˢən/væɤdən/)væ�dən, væ̞(.)dən];

$\quad$ mal\$ke, alg\$e [(malkʰə/)malgə, al(.)ɣə];

$\quad$ vær\$ke, værg\$e, ærg\$re [(væɤkʰə/væɤgə/)væ̞gə, væ̞(.)ɣə,

$\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ æ̞(.)ɣʁʌ];

van$te (sb.), ban$de (sb.), van$dig [(vant^{S}ə/)vandə,
ban(.)də, van(.)di].[1]

There is overwhelming evidence that a single intervocalic
consonant before a shwa belongs to the preceding syllable (Bas-
bøll 1972a), e.g. bade, koge [bæ:ðə, kɔ:ɣə]. Examples showing
the location of the syllable boundary before full vowels are
ek$stra, a$ttrap, O$ta [ɛgsdʁɑ, at^{S}ɣɑ́b, ó:t^{S}a] (that /s/ belongs
to the preceding syllable in eksport [ɛgsp^{h}ɔ́:d] is in accordance
with principle (i) above since its stem is port, cf. import
[emp^{h}ɔ́:d]). As already mentioned, the location of the syllable
boundary can be dependent on stress as shown by certain clusters
of /s/ plus stop.

---

1) I thus no longer believe (as in Basbøll 1972a, p. 199) that
    the syllable boundary in /CVndə, CVldə/ regularly goes to
the right of the /d/, cf. bande (sb.) and see section 2.2 above.
(The fact that /d/ is deleted (possibly via a lenition to ð) in
vande, skylde, jorde, etc., is thus not a consequence of the
location of the syllable boundary, but of an earlier rule which
seems to obey the proposed universal condition (Kiparsky 1973,
p. 65ff) that (non-automatic?) neutralization processes only
apply to derived forms (i.e. not to the underlying form of one
morpheme); the underlying logic is, not surprisingly, that if
they applied to the non-derived forms, too, a word like bande
(sb.) could then have no possible use for its underlying /d/
since it would be deleted in all contexts.) This change in the
earlier syllabification principles has the desirable consequence
of turning the class of "exceptions" (1972a, p. 201f) vandig,
skyldig, etc., into regular consequences of the principles. The
main argument for the location of the syllable boundaries pro-
posed here is that they permit the most general statement possible
on the manifestation of /p t k/ vs. /b d g/: the distinction is
one of aspiration when they occur initially in a syllable with a
full vowel, the distinction is most often neutralized, in favour
of the unaspirated stops, when they occur initially in a syllable
with a weak syllabic peak (whereas Conservative usages in that
position can make a distinction in the length of the preceding
consonant), and /d g/ are regularly manifested as voiced continu-
ants when they occur syllable finally (for details, see my notes
referred to above).

4. The structure of the syllable and the hierarchy of distinctive features

The theoretical framework used in the preceding sections was that of (non-orthodox) generative phonology.[1] In this section we shall take a more general view of the phonological syllable. It is, of course, impossible here to survey all the different theories of the syllable which have been proposed in the literature (Kloster Jensen 1963 gives a good overview of the subject; cf. also Malmberg 1965). Our main concern will be to discuss the sonority structure of the syllable in terms of currently used phonological distinctive features and to define a syllabic hierarchy of these features (sections 4.2 - 4.4).

Before this central part of section 4 (on the structure of the syllable), a word will be said on how to define the phonological syllable (i.e. on the nature of the syllable) (section 4.1), and we will conclude by discussing the feature [syllabic] (section 4.5) and a rule which changes the coefficient for this feature (section 4.6).

---

1) It should be emphasized that I consider this generative framework a purely descriptive model (which, in my view, is a useful complementary tool to structuralist methods of analysis emphasizing the notions of contrast etc. (cf. also Rischel 1974)), and I thus do not share the commonly held belief among generativists that their phonologies are (ideally) models of the psychological language mechanism of the (ideal) speaker-hearer. See Linell 1974 and (particularly) Derwing 1973 for recent critical discussions of the psychological implications of generative phonology and syntax.

4.1 On the nature of the phonological syllable

Hooper (1972, p. 537) defines the syllable (S) in the following way:

$$X \longrightarrow S \: / \: \$ \underline{\hspace{1.5cm}} \$$$

Condition: X contains no $.

I.e., according to Hooper, a syllable is <u>defined</u> as the maximal string between two consecutive syllable boundaries ($). This seems to me a poor definition. It is well known that the number of syllables as well as the location of their peaks can very often be indicated - by the native speaker as well as by the linguist - even in cases where the precise location of their borders is indeterminate. Hooper's definition makes it impossible to speak about e.g. bisyllabic words without being able to indicate the precise location of the border between the syllables. This is to me suggestive of a weakness in her theory (recall that I do not agree with Hooper's claim that <u>phonological</u> syllable boundaries (as opposed to phonetic ones) are always, by necessity, uniquely defined, cf. section 3.4 above).

It is, of course, true that if the location of all syllable boundaries in a given phonological string is known, then the extension of each syllable of that string is, <u>ipso facto</u>, also known; but the <u>peaks</u> of each syllable are <u>not</u> determined by the boundaries. If the location of all syllabic peaks in a given phonological string are known, on the other hand, then the <u>number</u> of syllables is also known, but <u>not</u> the location of their boundaries. Thus the syllabic peaks give some information on the syllable that cannot be derived from the location of the syllable boundaries, <u>and vice versa</u>. This means that the syllable is crucially characterized by both of these concepts, and a satisfactory general definition of the syllable ought thus to include both types of information, cf. Kloster Jensen's conclusion (1963, p. 34): "Es ist dringend notwendig, dass man sich klar macht,

was für eine Hybride die Silbe ist. Sie hat einen phonetischen
Kern und phonemisch und distributionell bestimmte Grenzen".
In the following we shall briefly survey a couple of definitions
which in different ways make reference to the "phonetic kernel"
of the syllable.

One such approach to defining the phonological syllable
is that exemplified by Haugen 1956 (cf. also O'Connor and Trim
1953), who defines the syllable as "the smallest unit of re-
current phonemic sequences. We will then have to include not
only the segmental phonemes, but also the prosodic ones like
stress, tone, length, and juncture. Any or all of these occur
in sequence with each other, and the syllable is that stretch
of phonemes which makes it possible to state their relative
distribution most economically" (p. 216). Haugen thus indirect-
ly refers to both the peak and the boundaries of the syllable:
the peak is characterized by means of "prosodic phonemes" like
stress and tone, the boundaries by the segmental phonemes. This
certainly makes sense as an operational definition within pho-
nemic theory, but from our point of view the definition is not
entirely satisfactory. For one thing, it is not quite clear
that the meaning of the phrase "to state their relative distribu-
tion [i.e. of the phonemes] most economically" can be made ex-
plicit, and if so, there is no reason to believe that the syllable
is in all languages the most satisfactory frame of reference for
the phonotactic description (for some evidence bearing on this
question, see Pike 1947, e.g. p. 144ff, 174ff; Basbøll 1974
argues that the word is the preferable frame of reference for the
distributional description of Italian consonants). It is also
problematic in Haugen's definition what "recurrent phonemic
sequences" means in cases where there are great differences
between the phonemic inventory and/or structure of e.g. "stressed
and unstressed syllables" (cf. Fischer-Jørgensen 1952, p. 17).

I thus see Haugen's definition as a practical way of trying to solve the problem of the (phonemic) syllable within an American structuralist framework, but with results which are not quite satisfactory from other points of view.

The difficulty met with above, i.e. that two types of syllables (e.g. "strong" and "weak", of which only the "strong" ones occur as one-syllable utterances) may differ structurally, also shows up in Eli Fischer-Jørgensen's definition (1952, p. 16ff) as she herself notes. She defines the "syllabic base" as "<u>the class</u> of the <u>smallest</u> units, of which <u>each</u> (in connection with stress, tone, and intonation, if such units are distinctive in the language in question) is capable of constituting an utterance by itself" (my italics). The difficulty in question cannot, of course, be avoided by changing "<u>each</u>" to "<u>some</u>" in the definition, since segments (i.e. vowels and consonants) will then fulfil this definition in a language in which a vowel alone can form a "strong" syllable and thus also an utterance.

To Hjelmslev (1939), the essential feature of the syllable is its being a unit consisting both of a syllabic theme and <u>a distinctive accent</u>. This leads to the well known terminological absurdities that French does not have syllables, and that Finnish vocoids and contoids are not vowels and consonants, respectively, in the structural sense, cf. Fischer-Jørgensen ibid. (Hjelmslev therefore defines the notion pseudo-syllable, which is a unit consisting of a pseudo-vowel (capable of constituting an utterance by itself) and pseudo-consonants, to be applied in languages without distinctive accent, e.g. French; the pseudo-syllable is close to Fischer-Jørgensen's definition of the syllabic theme.) According to Hjelmslev, the vowels (in the structural sense) <u>are presupposed</u> by the consonants (this idea has recently been developed within the framework of dependency grammar, see Anderson and Jones 1974). The difficulty of working with Hjelmslev's definitions is that they are made without regard to the phonetic

substance, and what appears to be basically the same unit in different languages, viz. the syllable, will therefore be given a number of quite different structural interpretations within Hjelmslev's framework (cf. Fischer-Jørgensen: "The most suitable method will probably be to choose the structural unit presenting the closest affinity to the phonetic syllable", but this unit "will hardly be structurally the same in different languages" (1952, p. 16; my italics)). This is in fact to deny the very existence of a universally defined phonological syllable.

But does such a universally defined phonological syllable in fact exist? What I mean by "phonological" in this context is simply that it is more abstract than "phonetic". But it is a consequence of the claims made in section 3.4 above that we should expect a universal definition of the phonological syllable to apply at a level of representation not very distant from the phonetic surface. And the characterization of the phonological syllable to be given in the following sections in fact applies at such a level (see section 4.2 below). However, it should be emphasized that within generative phonology the distinction between phonological (as used here) and phonetic (e.g. syllable) is a matter of degree, not of principle.

It is a common feature of most definitions of the phonological syllable that they only make reference to one aspect of the problem of the syllable, either to its boundaries, or to its peak, or to the fact that it is the bearer of prosodic entities, or to its capability of occurring as an utterance. These definitions all have a certain value within given methodological frameworks, but they are far from giving an adequate picture of the nature of the syllable. A more insightful characterization of the syllable can be given, I think, if we go back to Jespersen's (1897-99) theory of the syllable as a top of sonority. The idea that each syllable consists of exactly one relative sonority maximum (the peak), that the least sonorous segments occur

farthest off the peak, etc., is a way of condensing information concerning several aspects of the nature of the syllable: the syllabic peak is defined by the syllabic sonority structure, the syllable boundaries can be defined as the relative sonority minima in the cases where they are not determined by grammatical boundaries (see section 3.4 above), the voiced part of the syllable (which is also defined by the syllabic structure) is phonetically the bearer of tone, the non-consonantal part of the syllable is "the nucleus", etc. In the following sections we shall try to develop Jespersen's general theory of the syllable within the framework of modern phonological theory, i.e. to make the content of the sonority hierarchy precise, defined with currently used phonological distinctive features. We shall also state some limitations of this general theory (it goes without saying that not every part of Jespersen's syllabic theory can - or ought to - be redefined within a quite different conceptual framework from his of the late nineteenth century).

4.2   The distribution of distinctive features around the syllabic peak

In Basbøll 1973 (p. 106ff) I argued that it is an empirical problem at what level phonotactic restrictions in a given language are best described. I also claimed that the most general distributional statements of Danish vowels and consonants can be given at an intermediate level of the phonological component, defined by the fact that the diphthongization of short vowels plus homosyllabic voiced continuants has been applied, but neither the rule which devoices continuants after aspirates, nor the rule which deletes [ŋ̩] after low back vowels. Furthermore, the variable rule which shortens long vowels before homosyllabic voiced (non-lateral) continuants ought not to be applied.

At this intermediate level the inventory of non-syllabic
segments (i.e. the inventory of segments which can occur out-
side the syllabic peak; ˌ under a vowel symbol indicates that
the vocoid in question does not form the syllabic peak, see
below) is the following:

p t k b d g s f h v ɣ ð m n ŋ l ʁ u̯ n̩ i̯.

Words like skærv, lav (adj.), ud, bor, var, hagl, elv, talg,
plaske, sjæl at this level consist of the following sequences
of segments: [sgæn̩ʔv, læːʔv, uːʔð, boːʔn̩, van̩, hau̯ʔl, ɛlʔv,
talʔɣ, plasgə, sjɛːʔl].

At this level of description I postulate that syllables
containing a full vowel (see section 3.4.1 above) have the
following hierarchical structure (cf. Basbøll 1973, p. 130ff):

```
        ┌──────────────────────────────────┐
        │   ┌──────────────────────────┐   │
        │   │   ┌──────────────────┐   │   │
        │   │   │   ┌──────────┐   │   │   │
        │   │   │   │+syllabic │   │   │   │
        │   │   │   └──────────┘   │   │   │
        │   │   │  -consonantal    │   │   │
        │   │   └──────────────────┘   │   │
        │   │      +sonorant           │   │
        │   └──────────────────────────┘   │
        │          +voiced                 │
        └──────────────────────────────────┘
               THE SYLLABLE
```
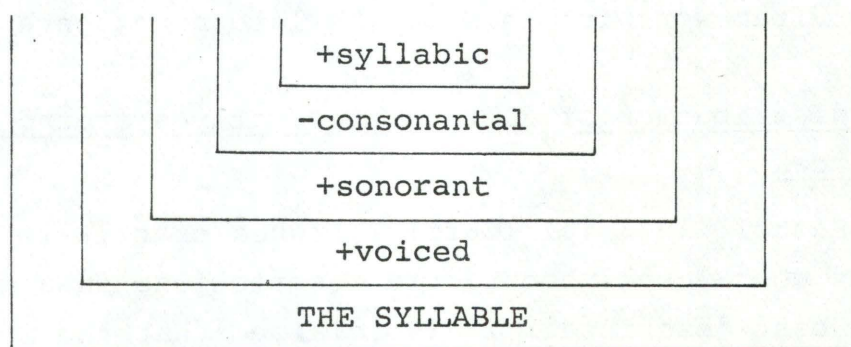
Fig. 1

The distinctive features are used in accordance with the
principles of Ladefoged 1971. I shall briefly comment on each
of the hierarchical features.

syllabic means "constitutes the peak of a syllable".[1]
When a Danish syllable contains several vocoids, it is clear
from an auditory point of view that exactly one of these con-
stitutes the syllabic peak. E.g. the first syllable of ivrig
and juridisk both contain the sequence of segments [iu], but
in the former word [i] constitutes the syllabic peak, whereas
it is [u] in the latter. I follow the traditional transcrip-
tion in writing a [ˎ] under a vowel symbol which does not con-
stitute the syllabic peak: ivrig, juridisk [iu̯ʁi, i̯uʁidisg]
(more examples of this sort are given in section 4.5 below).
However, since the articulatory and acoustic correlates of the
feature [syllabic] are largely unknown, there are evidently
great difficulties in defining it (see Ladefoged 1971, p. 81f).
Nevertheless, I do not think it is logically circular to include
this feature in the syllabic hierarchy, since its placement at
the top of that hierarchy reflects the observation that when the
syllable contains one or more vocoids (i.e. non-consonantal
segments, see below), then its peak falls in a vocoid. But it
is undeniable that the feature [syllabic] has another status in
the syllabic hierarchy than the other features since it is not
defined by any inherent quality of the segment in question
(thus each of the pairs [i] and [i̯], [l̩] and [l], etc., are in
a sense the same segment type), but only in a given context with-
in the syllable. On the special status of this feature within
the present model, see section 4.5 below.

consonantal is, according to Ladefoged, a cover feature
"in that it can be defined only in terms of the intersection of
classes already defined by other features. Thus non-consonantal
sounds are non-lateral and sonorant. They correspond largely to
what Pike (1943) called vocoids, which he defined as central,
resonant orals" (1971, p. 91). I here use [-consonantal] as

1) In Basbøll 1973 I used a terminology which I now think should
   be abandoned: I then used [+syllabic] roughly for what is here
called [-consonantal], and for the syllabic peak I employed the
label vowel (which then, in fact, had to be taken as a distinc-
tive feature).

equivalent to [+sonorant, +continuant, -lateral] (it must be a lapse (which is, however, repeated on p. 108) in Ladefoged's formulation that he does not include "continuant" (in the sense of SPE) or "non-stop" (in his own terminology) in his characterization of non-consonantal sounds). According to this definition, the class of consonants is the union of the class of obstruents (i.e. [-sonorant]), the class of nasals (i.e. [+sonorant, -continuant]), and the class of laterals (i.e. [+lateral]). According to the syllabic hierarchy, all syllabic segments found at the present level are non-consonantal. Of the non-syllabic segments found at this level, only [i̯ u̯ ŋ̍ ð] are non-consonantal.[1]

sonorants have "a comparatively large amount of acoustic energy within a clearly defined formant structure" (Ladefoged 1971, p. 58). It is a consequence of this definition that voiceless sounds are always obstruents. All non-consonantal segments are sonorants. Of the consonantal segments found at the present level, [p t k b d g s f h v ɣ ʁ] are obstruents, [m n ŋ l] sonorants.[2]

---

1) It is a consequence of the definition of [-consonantal] adopted here that [ð] must be classified as a vocoid (in disagreement with Basbøll 1973), since it is (at the level used throughout the present discussion) a sonorant and neither a nasal nor a lateral. This is in accordance with Heger's classification (forthcoming), which is purely phonetically based.

2) It is also a consequence of the definitions that [ʁ] must be classified as an obstruent (and not as a consonantal sonorant as in Basbøll 1973), just like [v] ([ʁ] is neither a vocoid nor a nasal nor a lateral). Also this is in agreement with Heger's phonetic classification (as well as with the phonetic classification of Eli Fischer-Jørgensen, personal communication), and since I have argued elsewhere that the Danish /r/ is an underlying obstruent, the so-called "consonantal r" must be [-sonorant] throughout the derivation.

voiced is used here as a binary feature defined by the
vibration of the vocal cords during the articulation. All
sonorants are voiced. Of the obstruents found at the present
level, [p t k b d g s f h] are voiceless, [v ɣ ʁ] voiced.

Those are the features which define the syllabic hierar-
chy of Danish. There are, of course, other distinctive features
too (see section 4.4 below).

Fig. 1 should be read as follows: the syllabic peak to-
gether with possible adjacent glides (i.e. [-syllabic, -con-
sonantal]) constitute the non-consonantal part of the syllable,
often called the "nucleus". The non-consonantal part together
with possible sonorant consonants constitute the sonorant part
of the syllable. The sonorant part together with possible
adjacent voiced obstruents constitute the voiced part of the
syllable. The voiced part together with possible adjacent
voiceless segments constitute the syllable (or syllabic theme,
in Hjelmslev's terminology).

Thus the following "implication chains" hold true without
exception:

[+syllabic] ⊇ [-consonantal] ⊇ [+sonorant] ⊇ [+voiced]
and: [-voiced] ⊇ [-sonorant] ⊇ [+consonantal] ⊇ [-syllabic].

(The two implication chains are notational variants in a system
where all the features are binary.)

These implication chains predict the systematic non-
occurrence of certain combinations of distinctive features, viz.
[+syllabic, +consonantal], [-consonantal, -sonorant], [+sonorant,
-voiced], [+syllabic, -sonorant], [+syllabic, -voiced], [-con-
sonantal, -voiced]. That only vocoids can be syllabic is a
trivial consequence of the fact that the present model only con-
cerns syllables with a full vowel as peak (in syllables with a
weak syllabic peak, also consonantal sonorants can be syllabic,
at least at the phonetic level, see below). That only consonantal

sounds can be obstruents is a consequence of our _definition_
of [-consonantal] as equivalent to [+sonorant, +continuant,
-lateral]. That only obstruents can be voiceless is an empir-
ical consequence of the definition of [sonorant] (by "empirical
(consequence)" I mean that it does _not_ follow from the _formula-
tion_ of the definition itself). That the last three combina-
tions mentioned are excluded follows from the systematic non-
occurrence of the first three, mentioned in the beginning of
the paragraph.

However, the important point in this connection is not
only to what degree the implication chains are based on observ-
able facts on (Danish) syllable structure (see the following
section), on the nature of the human speech and hearing appara-
tus, or on the formal definition of the distinctive features
used. But it is in itself significant that exactly these
features can be arranged into a syllabic hierarchy. It should
be emphasized that all the features used here are well motivated
in phonological theory, and that their definitions have not
been given with the syllabic hierarchy in mind (as a matter of
fact, such considerations are not included in Ladefoged's treat-
ment of the distinctive features at all). Furthermore, all the
hierarchical features except [syllabic] have well-defined artic-
ulatory and/or acoustic correlates. As mentioned above, the
acoustic and articulatory correlates of the auditive feature
[syllabic] are largely unknown, cf. sections 4.5 and 4.6 below.

One possible interpretation of the model is that the
hierarchical features do not "belong to" one segment at a time,
but that they characterize the "central part" of the syllable
as a whole (where this part has a different extension for dif-
ferent features).

It can be shown that each of the hierarchical features has
its function in the syllabic hierarchy, i.e. the removal of any

of these features will cause a decrease in the explanatory value
of the model (see the following section). But it is clear that
in many concrete cases, the extent of several hierarchical
features will be identical: e.g. in a monosyllable like tak,
the syllabic part, the non-consonantal part, the sonorant part,
and the voiced part of the syllable all equal the vowel a.

The feature hierarchy for syllables with a weak syllabic
peak is a strict subset of the feature hierarchy for syllables
with a full vowel as peak, viz. that given in fig. 2.

$$\boxed{\begin{array}{c} \boxed{\text{+syllabic}} \\ \text{+voiced} \end{array}}$$
THE SYLLABLE
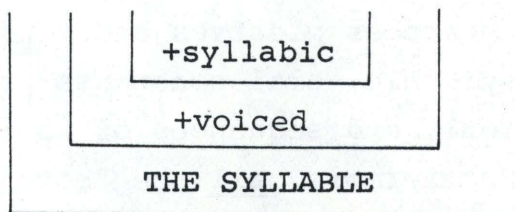
<u>Fig. 2</u>

The "implication chains" which can be read from fig. 2
are the following:

$$[\text{+syllabic}] \supseteq [\text{+voiced}]$$
and $\quad [\text{-voiced}] \supseteq [\text{-syllabic}]$

(i.e., [-voi]-segments are never [+syl]; this has the status of
an empirical finding).

Within this weak syllabic hierarchy there is thus no moti-
vation for a distinction between the non-consonantal and the
sonorant part of the syllable, nor for a distinction between the
sonorant and the voiced part of the syllable (see below).

4.3 Ordering relations in Danish as explained by the proposed feature hierarchy

Fig. 3, which in all relevant respects is a notational variant of fig. 1, expresses the order relations holding between segments within the same syllable more directly (in fig. 3 I only write the features which cannot be deduced from the implication chains).

Fig. 3 correctly predicts the order of any permitted (unordered) set of either initial or final segments, together with the following additional restrictions: In the initial part of the syllable, s precedes plosives and v precedes ʁ; in the final part of the syllable, oral sonorants precede nasals (see the following section), and sequences of non-sibilant obstruents end in a dental. Furthermore, all the "boxes" of fig. 3 can be descriptively motivated as "order classes" (cf. Sigurd 1965, Vestergaard 1968) for the phonotactic description of Danish (see Basbøll 1973). This highly general model of the syllabic hierarchy, defined in terms of phonologically well motivated distinctive features, thus explains a very large part of the phonotactic structure in Danish.

Fig. 4 is the similar "linearization" of fig. 2, i.e. it should predict the combinatory possibilities and order in syllables with a weak syllabic peak. (Included in fig. 4 are only segments which can occur in such weak syllables, cf. Basbøll 1973, p. 134ff. The syllable boundaries are supposed to be in accordance with the principles of section 3.4.1 above. p t k are only found initially in weak syllables in certain pronunciations, cf. section 3.4.1 above.)

Examples showing the structure of weak syllables in this respect are ændre, ellers, himlens [ɛndʁʌ, ɛlʔʌs, hemļns], which are, at the level used througout this discussion, $ɛn$dʁə$, $ɛlʔ$əņs$, hemləns$.

−voi	−son +voi	+cons +son	−syl −cons	+syl	−syl −cons	+cons +son	−son +voi	−voi
sfh ptk bdg	vʁ	l mn	i̯	vowels	u̯i̯ð	l mnŋ	vʁ	sf bdg

Fig. 3

−voi	−syl +voi	+syl	−syl +voi	−voi
bdg (ptk)	lʁn	e	lnŋð	sd

Fig. 4

A reasonable question to ask at this point is the following: Since phonotactics plays a crucial role as evidence for the syllabic hierarchy according to our model, and since the phonotactics of different languages can be highly diverse, can this model in any sense be a candidate for a phonological universal?

First of all, the fact that some of the "boxes" (i.e. of the features in the hierarchy) have no descriptive justification in a given language, does in itself not prove that the model is not universal. As long as a language (with a less rich range of possible consonant combinations than e.g. Danish) does not offer counter-examples to the orderings predicted by the general model, then it is in accordance with the model in the sense that a strict subset of the hierarchical features in the same order will be a relevant model for its syllabic structure (just as the model in fig. 2 is no counter-example of the validity of the model in fig. 1 for Danish).

But cases like initial [ŋk-, mb-] in many African languages and [mgl-, lg-] in Russian are more serious to the hypothesis. However, [ŋk-, mb-] can be considered counter-examples only if [ŋ, m] in these clusters are voiced and the "clusters" in fact function as such, i.e. only if [ŋk-, mb-] do not function as unit phonemes (as "prenasalized stops" or the like). And in the cases where /ŋk-/ etc. are true combinations and thus apparent counter-examples to the hypothesis, it is a question whether the nasal does not constitute a syllabic peak (or a "mora") of its own (as could be shown in a tone language if /ŋkɑ/ may have different tones on /ŋ/ and /ɑ/). In all probability, however, there will turn out to be some real counter-examples to the hierarchy (cf. the description of the Mazateco syllable by Pike and Pike 1947). In that case, the syllabic hierarchy might be considered the maximally "natural" or "unmarked" arrangement of distinctive features in the syllable

(a universal <u>tendency</u>, if you like), but not a universal <u>law</u> without exceptions.

As for the Russian examples, the violation of the model in fig. 1 is clear. But notice that fig. 1 will apply to Russian if the feature [sonorant] is removed from the model. And notice, furthermore, that it is <u>not</u> possible to reverse any of the hierarchical features if the model is still to be consistent with the data. I.e., it is <u>not</u> true in Russian that sonorant consonants cannot be nearer to the syllabic peak than voiced obstruents (e.g. [gl-, br-]). This may lead to the following hypothesis concerning the universality of fig. 1: The hierarchical features are [+syllabic, -consonantal, +sonorant, +voiced]. Each language takes all of these features or any subset of them <u>in the order given</u> to form its syllabic hierarchy. Viewed from this angle the hypothesis predicts that the syllabic hierarchy for a given language will always be a strict (ordered) subset (in the sense in which fig. 2 is a strict subset of fig. 1) of the universal hierarchy. I.e., if a certain universally hierarchical feature plays a role for the syllabic hierarchy of a given language, then its place in that language-specific hierarchy is predictable from the universal hierarchy.

It is clear that the explanatory force of the model for a given language increases when the proportion of mirror-image ordering relations which are accounted for by the model (see the following section) increases. If this proportion is small, then the model is unsuccessful with respect to the language in question. And since a hierarchy must contain at least two units, it will be nonsense to speak about [syllabic] as the <u>only</u> feature involved in the syllabic hierarchy in a given language (phonologically speaking, this would only amount to saying that the syllabic peak occurs within the syllable). In languages with no hierarchical features the predictive value of the model is, of course, <u>nil</u>. And languages which use two or more of the hierarchical

features in their syllabic hierarchy, but in the reverse order
of that predicted here, will be counter-examples to the hypo-
thesis suggested above.

The feature hierarchy proposed here agrees well with the
psycho-linguistic test results reported by Pertz and Bever
(1973). These authors tested a number of the markedness rela-
tions among different consonant clusters postulated, mainly on
the basis of typological evidence, by Greenberg 1965 and Cairns
1969 (of the type 'initial cluster AB is more marked than initial
cluster CD'). A number of monolingual English-speaking persons,
both adolescents and children, were asked which cluster was
likely to be found in the largest number of languages, and their
responses agreed (with one exception, see below) with the postu-
lated markedness relations (so that the less marked cluster was
supposed by the test subjects to occur in more languages). The
exception was that the sequence liquid-nasal seemed to be less
marked than liquid-voiced obstruent, in disagreement with Green-
berg and Cairns (who did, in fact, not distinguish between
voiced and voiceless liquids; this is, of course, an error,
cf. Pertz and Bever 1973, p. 72).

The feature hierarchy proposed here in fact explains all
the test results of Pertz and Bever, in connection with the fol-
lowing two very natural axioms: (i) a cluster which violates
the hierarchy is more marked than one which does not, and
(ii) if two clusters both violate the hierarchy, and if they
both begin with a certain hierarchical feature, then the cluster
which violates the hierarchy "with more steps" is the more marked
one (e.g. liquid-nasal is less marked than liquid-voiced ob-
struent, and nasal-voiced obstruent less marked than nasal-
voiceless obstruent).

Notice that this explanation of their results does not
depend on the universality of the syllabic hierarchy proposed
here: it only presupposes that the syllabic hierarchy is valid

for the language of the test subjects, i.e. English (which it clearly is). As a matter of fact, I am anything but convinced by Pertz and Bever's general line of reasoning that if English-speaking test subjects can react differently to clusters which do not occur in English, and which have the same "Distance from English" in the sense of Greenberg and Jenkins 1964, then they must have internalized a _universal_ hierarchy of clusters. They do not at all consider the possibility that the internalized hierarchy may be relevant only to English and more or less "English-like" languages.

4.4 Hierarchical, semi-hierarchical, and cross-classificatory features

According to the hypothesis sketched here, the following features in the order given constitute the "syllabic hierarchy": [+syllabic, -consonantal, +sonorant, +voiced][1]. Of these features, [syllabic] differs from the others in that its phonetic correlates are undefined. The content of this feature label will be discussed in the following section.

Other distinctive features are _not_ _hierarchical_, but cross-classificatory (cf. the distinction between a hierarchical

---

1) Or [α syllabic, - α consonantal, α sonorant, α voiced] (cf.
    the implication chains of section 4.2 above). The reason why we need to write a coefficient together with the feature dimension is, of course, that [consonantal] always has the opposite coefficient of the other hierarchical features. This is due to the fact that we have chosen (like Ladefoged 1971, p. 108) not to deviate unnecessarily from the usual feature labels. But it would have been more satisfactory to call the feature [vocoid] (in the sense of Pike 1943), not only because it is [+vocoid] (but [-consonantal]) which is _defined_ by a _configuration_ (as opposed to a disjunction) of distinctive features (cf. Ladefoged ibid.), but also because it is [+vocoid] which plays a part in the syllabic hierarchy like the _positive_ values of the other hierarchical features.

(McCawley) and a cross-classificatory (SPE) conception of
grammatical boundaries, discussed in section 3.3 above). This
is true of the feature or features accounting for different
places of articulation (cf. section 3.2 above), the features
accounting for differences of vowel quality, and for further
features characterizing different "articulation modes" of con-
sonants (like the features characterizing sibilance, stridency,
aspiration, etc.; I shall not commit myself as to what the
exact inventory of such features is).

It is an important characteristic of most cross-classi-
ficatory features that they are not involved in ordering rela-
tions, whereas they are sometimes essential for the statement
of other distributional restrictions like "aspirates do not
combine", "labials do not combine". However, some cross-classi-
ficatory features can, in fact, be involved in ordering rela-
tions, but then these ordering relations are not mirror-image-
like. E.g. s and the plosives in Danish are not distinguished
by any hierarchical feature. Nevertheless, the ordering rela-
tion obtains in the initial part of the syllable that s precedes
a plosive, but it is well known that the inverse relation does
not hold in the final part of the syllable (e.g. aks, ask, cf.
Vestergaard 1968, p. 64f). Similarly, it is a general ordering
restriction in the final part of the syllable that sequences of
non-sibilant obstruents end in a dental (Basbøll 1973, p. 127).
But the inverse relation does not hold in the initial part of
the syllable, etc.[1]

---

1) Jørgen Rischel suggests (personal communication) that the
   ordering relations which are here called "mirror-image-like"
should be termed "distance relations" instead, since they refer
to the (relative) distance (of non-syllabic segments) from the
syllabic peak. According to this terminology, cross-classifi-
catory features are not involved in distance relations (whereas
they can be involved in other ordering relations). I entirely
agree with this suggestion.

There is at least one phonological feature in Danish which is neither hierarchical nor cross-classificatory in the above-mentioned sense, viz. [continuant].[1] Within the sonorant part of the syllable this feature seems to be hierarchical (see fig. 5):
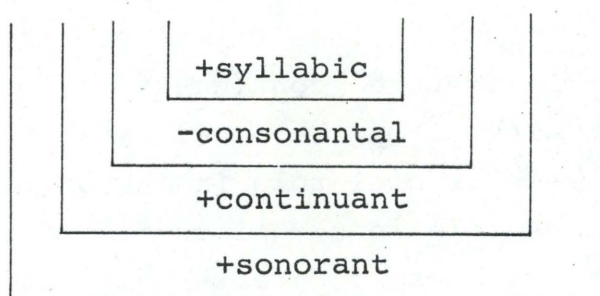
```
┌─────────────────────────────────────────┐
│        ┌──────────────────────┐          │
│        │     +syllabic        │          │
│   ┌────┴──────────────────────┴──────┐   │
│   │        -consonantal              │   │
│ ┌─┴──────────────────────────────────┴─┐ │
│ │           +continuant                │ │
│ │                                      │ │
│ └──────────────────────────────────────┘ │
│              +sonorant                    │
└───────────────────────────────────────────┘
```

Fig. 5

---

1) By different linguists the nasal consonants have been defined either as [+continuant], viz. if the definitions are acoustically/auditorily based (e.g. Jakobson, Fant and Halle 1952), or as [-continuant], viz. if the definitions are articulatorily based (e.g. SPE and Ladefoged 1971, who uses [α stop] as equivalent to [$-\alpha$ continuant] in SPE). I follow the latter definition which seems to me to fit well into the general framework of distinctive features: The nasals in a given language regularly follow the same pattern as the stops (as opposed to the fricatives) with regard to place of articulation. Furthermore, the natural class consisting of vocoids, laterals, and nasals is already defined by the feature [+sonorant] (it is, of course, due to the nature of the human speech apparatus that a sonorant with no passage of air through the mouth must be a nasal). The most important argument for the classification of nasal consonants as [-continuant] within the present framework is, however, the fact that it permits the class of vocoids (i.e. the [-consonantal] segments) to be defined as the segments which are [+sonorant, +continuant, -lateral]. And there seems to be no way of defining this natural class (which includes, of course, the nasalized vocoids) as equivalent to a configuration of already established distinctive features if the nasal consonants are [+continuant], i.e. [-consonantal] will not be a cover feature in the sense of Ladefoged 1971. This seems to me a serious drawback of this alternative definition of [continuant].

The following implication chains hold in Danish syllables with
a full vowel as peak:

$$[+syllabic] \supseteq [-consonantal] \supseteq [+continuant]$$

and: $[-continuant] \supseteq [+consonantal] \supseteq [-syllabic]$. But notice
that it is not true that $[+continuant] \supseteq [+sonorant]$, or
$[-sonorant] \supseteq [-continuant]$, since fricatives are $[+continuant,$
$-sonorant]$. I.e., the feature $[continuant]$ cannot be included
in the syllabic hierarchy. On the other hand, the feature
$[continuant]$ can play a crucial role in mirror-image ordering
relations (or distance relations), since nasals (i.e. $[+sonorant,$
$-continuant]$) generally occur in greater distance from the syl-
labic peak than laterals (which are $[+consonantal, +sonorant,$
$+continuant]$ within the present framework). I therefore use
the label "semi-hierarchical" for a feature like $[continuant]$.

I have not used the feature $[nasal]$ in the discussion
for two reasons. First, this feature is not hierarchical within
the sonorant part of the syllable in languages with a contrast
between oral and nasalized vowels (like French), whereas it
follows from our definitions that $[continuant]$ will always be
"semi-hierarchical" (since $[-consonantal]$ always equals
$[+sonorant, +continuant, -lateral]$, and since the relation be-
tween (sonorant) laterals and (sonorant) nasals seems universally
to be that indicated here, cf. Jespersen 1897-99, p. 523ff).
Second, in languages like Danish which do not have phonologically
relevant nasalized vowels, $[+nasal]$ can, in the phonology, be
used as a cover feature which is always equal to $[+sonorant,$
$-continuant]$. It is thus completely redundant in the phonology
of e.g. Danish (just as $[consonantal]$ is completely redundant
since $[-consonantal]$ always equals $[+sonorant, +continuant,$
$-lateral]$; but it may very well, of course, be economical to
include redundant features in the phonological description).

I have not included the feature [lateral] in the discussion for a similar reason. It follows from our definitions that the class of sonorant laterals (that is, all the laterals which exist in Danish at the level under discussion here, viz. 1) can be <u>defined</u> as [+consonantal, +sonorant, +continuant]. This means that the class of (sonorant) laterals equals the class of consonantal sonorants minus the nasals. I.e., the place of the feature [-lateral] in that part of the syllabic hierarchy which only comprises the continuant sonorants would necessarily be equal to the place of [-consonantal] and thus completely redundant. All this is, of course, a consequence of the fact that we do not recognize the existence of any consonantal sonorants which are not laterals or nasals. (In languages with a contrast between sonorant and obstruent laterals, the feature [lateral] will be cross-classificatory.)

4.5 The feature [syllabic]

In section 4.2 above we said that the feature [syllabic] indicates that the segment in question constitutes the peak of its syllable. It was also emphasized that the articulatory and acoustic correlates of this (auditorily defined) feature are largely unknown.

In this section we shall briefly examine two questions: (i) is the feature [syllabic] <u>redundant</u> at the systematic <u>phonetic</u> level, i.e. can the occurrence of the syllabic peak in a syllable be predicted from the occurrence of other distinctive features in the chain of segments which constitutes the syllable? and (ii) which role does the feature [syllabic] play in a generative phonology of Danish, i.e. must it be specified in the phonological representations in the lexicon, can the coefficients of this feature change in phonological derivations, etc.?

The features involved in the syllabic hierarchy in Danish except [+syllabic], i.e. [-consonantal, +sonorant, +voiced], together with the semi-hierarchical feature [+continuant] define the following syllabic hierarchy of segment types:

> vocoids (i.e. [-consonantal] ≡ [+sonorant, +continuant, -lateral])
>
> laterals (i.e. [+lateral] or [+consonantal, +sonorant, +continuant]
>
> nasals (i.e. [+sonorant, -continuant])
>
> voiced obstruents (i.e. [-sonorant, +voiced]; they are in Danish always [+continuant] too)
>
> unvoiced segments (i.e. [-voiced]).

In the spirit of Jespersen (1897-99, p. 525, also 1926, p. 112)[1], we shall (in fig. 6) give a graphical illustration of the "sonority relations" in a number of segment sequences on the systematic phonetic level:

---

1) I differ from Jespersen in that I do not distinguish between voiceless stops and fricatives (his groups 1a and 1b, 1897-99, p. 523f, and 1926, p. 191), and between sonorant r-sounds (i.e. the "syllable final /r/") and vocoids, nor between vocoids of different height (i.e. his groups 4-8). However, in order not to get a high number of counter-examples to his scheme, viz. all the initial clusters of s plus a stop, Jespersen in the graph considers 1a, 1b as one group. Within his framework, this is nothing but a trick; within our model, however, this is due to the fact that no feature(s) distinguishing between s and the stops can be arranged into the syllabic hierarchy, quite apart from any ordering considerations (e.g. it is the very existence of the class of fricatives that makes it impossible to include [continuant] into the syllabic hierarchy, see the preceding section).
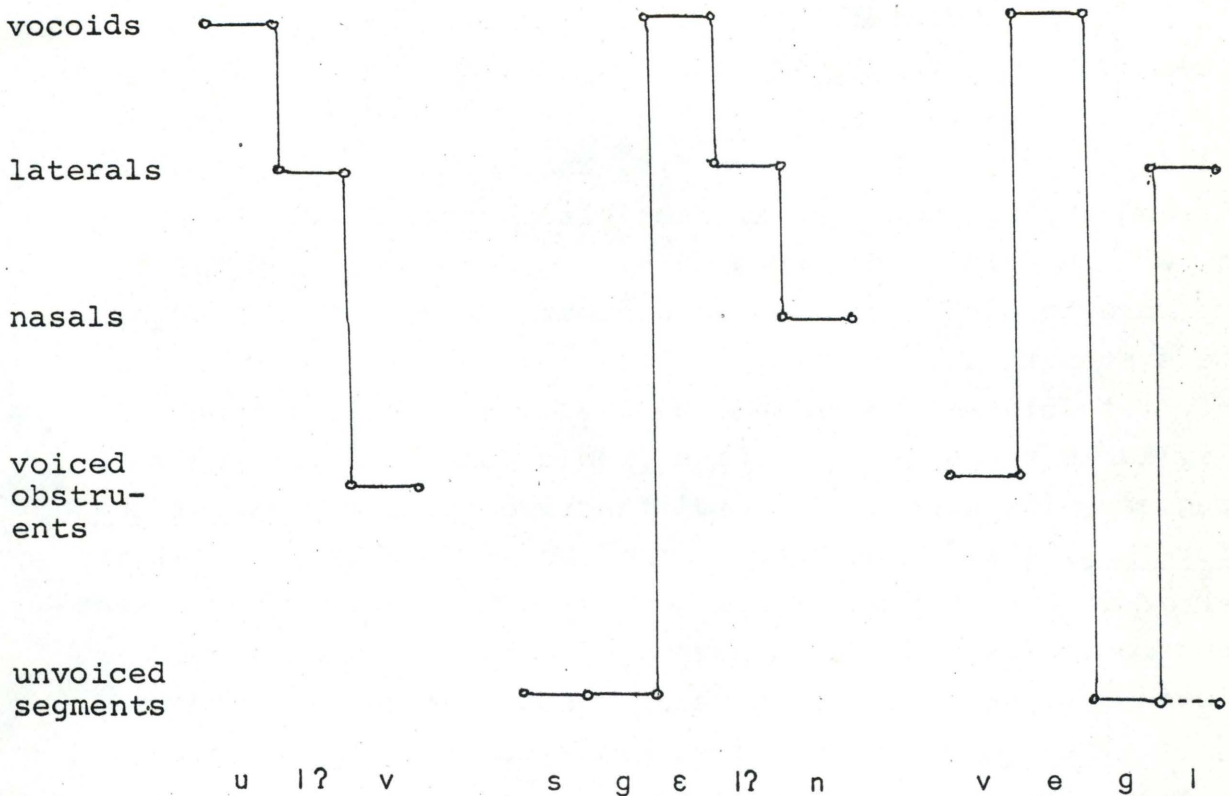
Fig. 6

The relative maximum is the syllabic peak. [ul?v] is a normal monosyllabic word with [u] as its peak (notice that stød is not considered a segment in this connection). The imperatives skeln and vikl both exhibit word-final consonant clusters which do not occur outside imperative forms. However, skeln is always pronounced as a normal monosyllable, and it is clear from the graph that it does not violate any systematic order restriction based upon the syllabic hierarchy (i.e. distance relation-restrictions). vikl, on the other hand, will, according to our model, have two syllabic peaks if it is pronounced with a fully voiced

[l] (and this violates the general principle that imperatives
of verbs whose infinitives end in shwa are shorter by one syl-
lable than the infinitive form); however, if they are pro-
nounced with an unvoiced [l̥] instead (the dotted line in fig. 6),
the number of syllables will be respected according to the
model (cf. Basbøll 1970, p. 21ff). Whether the syllabic peaks
predicted by the model are in fact also heard as syllabic peaks
(e.g. whether vikl pronounced with a voiced [l] is a perfect
rhyme word to Mikkel pronounced without the vocoid [ə]) ought
to be systematically tested.

It should be emphasized, however, that the location of
the syllabic peaks is not always predictable from the sequence
of segments (defined by their distinctive features, except the
feature [syllabic]), neither at the phonetic surface nor at the
level of description which has been used throughout the present
discussion. For example, a narrow unrounded palatal vocoid
followed by a narrow rounded velar vocoid can be realized as
[i̯u] (e.g. in just [i̯usd]) or as [iu̯] (e.g. in ivrig [iu̯ʁi]).
Similarly, there is a possible contrast between [i̯ɒ] or [i̯ʌ]
(e.g. in hjort, j [i̯ɒ:d, i̯ʌð]) and [iʁ] = [iʌ̯] (e.g. in ir [iʁ,
iʌ̯]; the transcriptions with [ɒ̯, ʌ̯] are mere notational variants),
cf. French examples like houille, oui [ui̯, u̯i] (in pays, paye
[pɛi, pɛi̯] there is also a distinction in the number of syl-
lables).[1] Examples with consonants (which differ as to number
of syllables) are skeln, ellen [sgɛlʔn, ɛlʔn̩ = ɛl̩ʔn = ɛlʔl̩n]
and vidn, bidden [við ʔn, biðʔn̩ = bið̩ʔn = biðʔð̩n] (the latter
transcriptions, i.e. [ɛlʔl̩n, biðʔð̩n], are probably the most
phonetically correct ones in such contexts, at least in younger
Danish standards, if one is forced to make a segmental distinction
between the forms, see the following section; it may, however,
be better to say that the sequence of segments are identical in

---

1) Danish examples like naivist vs. nej vist! are also distin-
   guished by their number of syllables (in addition to vowel
quality distinctions): [naivísd, nɑi̯vésd].

the mono- and bisyllabic forms, and that the distinction in
syllabicity is (phonetically) prosodic[1]).

Although the location of the syllabic peaks in the
majority of cases can be predicted from the sequence of seg-
ments (defined by their distinctive features except the feature
[syllabic]) occurring at the phonetic surface or at the level
of description which has been used throughout the present dis-
cussion, this is thus clearly not always feasible. The con-
clusion is, within a generative framework, that the feature
[syllabic] must be present in underlying forms. The coefficient
for this feature is only changed by the rule shwa-assimilation,
to be discussed in the following section, and maybe by some
very late reduction processes. But apart from these exceptions,
the feature [syllabic] is unchanged throughout the derivation:
e.g. when underlying postvocalic voiced obstruents are turned
into vocoids (viz. /ɣ, v, r/ ⟶ [ɨ̯/u̯, u̯, ɹ̯]) those vocoids are
non-syllabic, i.e. glides; and when adjacent vocoids are com-
pletely assimilated (see the following section), e.g. /diːə/ ⟶
[diːi], the number of syllables is generally kept constant.
In other words: the coefficients for the feature [syllabic]
(which is redundant in the phonological representation, i.e.
each underlying segment has its "natural" value for this feature,
see below) are kept constant throughout the phonological rules
(excluding, of course, morphological rules), apart from the rule
of shwa-assimilation; this is true even when segments are changed

---

1) This agrees well with Rischel (1970c) who has found that
    F_o seems to be an important cue for syllabicity in Danish.
This fact may also help   explain why voiceless segments
generally do not qualify as syllabic peaks (see the following
section). Rischel (1964) also gives an interesting account of
syllabicity as a level of culminative contrast below the stress
levels.

in such a way that their coefficient for [syllabic] is no longer the natural one for the derived segment in the context in question. This agrees well with the idea (cf. Rischel 1970c) expressed in the preceding footnote, viz. that the feature [syllabic] is phonetically prosodic.

Hjelmslev (1951) proposed that words like fadder, vammel [faðʔʌ, vɑmʔl̩] should be derived from monosyllables: /fadr, vaml/, thus explaining the obligatory occurrence of stød (the final consonant clusters have stød-basis, since they begin with a voiced consonant). It is uncertain whether such monosyllabic underlying forms for disyllabic phonetic forms should be postulated in a generative phonology of Danish (cf. Basbøll 1972b, p. 13, 23ff). If they are, the syllabic hierarchy predicts that /r, l/ of /fadr, vaml/ will form a syllabic peak, presupposing that the final /r/ has already, at this point of the derivation, been changed to the corresponding (pharyngeal) vocoid. The underlying non-syllabic /r, l/ can thus be rewritten as the corresponding syllabic segments. Another possibility is that a rule which is sensitive to the syllabic hierarchy inserts a shwa to break up the non-permissible final cluster. (Under the presupposition that the final /r/ is a vocoid at that point of the derivation, the syllabic hierarchy explains why final clusters like /lr, ŋr/ mentioned under principle (ii) in section 3.4.1 above are systematically excluded, viz. excluded by virtue of the distance relation-restrictions.) Both possibilities permit the preservation of the redundancy constraint on phonological information in the lexicon that all consonantal segments are non-syllabic and vice versa, which, of course, also applies if fadder, vammel etc. end in /ər, əl/ in their most underlying forms.

As already mentioned, the feature [syllabic] is redundant
in phonological representations since its coefficient is always
the opposite of the coefficient for [consonantal]; i.e., all
segments in the fully specified phonological representations
will be [αsyllabic, - αconsonantal]. (I do not claim that the
feature [syllabic] is redundant in the phonological representa-
tions of all languages, only that it is redundant in Danish.)
An economical way of doing this seems to be the following: All
segments which in the incompletely specified distinctive feature
matrix are [-consonantal] will get the redundant specifications
[+syllabic, +sonorant, +continuant, -lateral] (and probably
others as well, like [-sibilant]); all segments which in the
incompletely specified distinctive feature matrix have at least
one of the following specifications: [-sonorant], [-continuant],
or [+lateral], will get the redundant specifications [-syllabic,
+consonantal] (and probably others as well, like [-round]).

4.6 Shwa-assimilation

It is well known among students of Danish phonetics and
phonology that shwa can be "assimilated" in different ways to
neighbouring sounds.[1] There is no general agreement on how to
transcribe the results of the shwa-assimilation, however, and
this is probably due to the fact that the acoustic and articulatory
correlates of syllabicity in Danish are largely unknown; in fact
only one very preliminary investigation of this subject has
been published, viz. Rischel 1970c. According to Rischel[2],

---

1) E.g. Jespersen 1897-99, p. 463ff, Uldall 1933, p. 3ff, Ander-
   sen 1955 passim, Hansen 1956, p. 40ff, Fischer-Jørgensen
1962 passim.

2) Rischel emphasizes (personal communication) the highly pre-
   liminary nature of his report, particularly concerning the
perceptual aspect. It is also true that the number of persons
investigated is small. The investigations are planned to be
continued.

some speakers of standard Danish have a consistent difference
in quantity and F_o in assimilated words of the type hårde,
hårdere ([hɒ:ɒ, hɒ:ɒɒ] or the like), and a pilot experiment
with a synthetic stimulus suggested that the word types can be
identified correctly when the only difference in the stimuli
is in F_o. All this points towards a prosodic function of syl-
labicity (somewhat resembling that between accent 1 and accent
2 in Swedish and Norwegian, so that Danish $C_oVC_oə$ words corre-
spond to accent 1, and $C_oVC_oəC_oə$ to accent 2). A transcription
indicating the location of the assimilated shwas by a hyphen
seems to be rather satisfactory from this point of view, in
comparison with transcriptions indicating syllabicity as occur-
ring in one segment only: skeln, vidn, ellen, bidden [sgɛl?n,
við?n, ɛl?-n, bið?-n].

Recently Brink and Lund (forthcoming) have given an alter-
native treatment of shwa-assimilation. They suggest roughly
the following: It is an option for the speaker to retain the
shwa or not. If shwa is not retained, it depends on the
sonority of its neighbouring segments whether it is assimilated
or deleted (sonority is understood basically as in Jespersen
1897-99). If the most sonorous neighbouring segment to shwa is
a voiceless obstruent, then shwa drops without leaving any trace
behind (e.g. passe [pasə, pas] where the second pronunciation is
also that of pas [pas]). If the most sonorous neighbouring seg-
ment to shwa is a sonorant, shwa assimilates to that sonorant
(in such a way that shwa either assimilates completely to the
sonorant in question with the reservation that the assimilated
segment is always syllabic, e.g. koen, ballen [kʰo:?on, balḷn],
or in such a way that shwa is elided while making the sonorant
in question syllabic, e.g. gode, pæne, tale [go:ð̩, pʰɛ:n̩, tˢæ:ḷ];
Brink and Lund set up a number of principles which they claim
predict which type of assimilation will be chosen in a certain
context).

If there can really be given substance to the claim that shwa is assimilated to its most sonorous neighbouring segment, then data from the treatment of shwa in different contexts can give independent evidence for the sonority hierarchy, suggesting that sonority may be an independently needed auditory dimension (a multivalued linearly ordered distinctive feature), although it can be defined by distinctive features that are needed in the phonology for independent reasons. And I see no reason, after all, why a prosodic treatment of syllabicity, and a treatment in terms of a sonority hierarchy which has independent motivations, should in principle be incompatible.

References

Andersen, Poul 1955:   "Dansk fonetik", in: Nordisk Lære-
bog for talepædagoger (Copenhagen),
p. 308-354

Anderson, John M. and   "Three theses concerning phono-
Charles Jones 1974:   logical representations", JL 10,
p. 1-26

Austin, John 1971:   Topics in Danish Phonology (un-
published thesis, Cornell Univer-
sity)

Basbøll, Hans 1969:   "The phoneme system of advanced
standard Copenhagen", ARIPUC 3/
1968, p. 33-54

Basbøll, Hans 1970:   "Notes on the phonology of Danish
imperatives with a digression on
vowel quantity", ARIPUC 4/1969,
p. 15-42

Basbøll, Hans 1972a: "Some conditioning phonological
factors for the pronunciation of
short vowels in Danish with special
reference to syllabification",
ARIPUC 6, p. 185-210.

Basbøll, Hans 1972b: "Some remarks concerning the stød
in a generative grammar of Danish",
in: Kiefer, F. (ed.), Derivational
Processes (Stockholm), p. 5-30

Basbøll, Hans 1973:   "Notes on Danish consonant combi-
nations", ARIPUC 7, p. 103-142

Basbøll, Hans   1974:   "Structure consonantique du mot italien", Revue Romane 9, p. 27-40

Basbøll, Hans   forthcoming: "Schwa, jonctures et syllabification dans les représentations phonologiques du français"

Brink, Lars and Jørn Lund forthcoming: Udtaleforskelle i Danmark (Copenhagen)

Cairns, Charles E. 1969:   "Markedness, neutralization, and universal redundancy rules", Lg. 45, p. 863-885

Chafe, Wallace   1970:   Meaning and the structure of language (Chicago)

Chomsky, Noam   1964:   "Current issues in linguistic theory", in: Fodor, J.A. and J.J. Katz (eds.), The structure of language (Englewood Cliffs, New Jersey 1964), p. 50-118

Davidsen-Nielsen, Niels 1974: "Syllabification in English words with medial sp, st, sk", JPh 2, p. 15-45

Davidsen-Nielsen, Niels forthcoming: "A phonological analysis of English sp, st, sk with special reference to speech error evidence", to be published in: Journal of the International Phonetic Association

Dell, François   1973:   Les règles et les sons. Introduction à la phonologie générative (Paris)

Derwing, Bruce 1973:   Transformational grammar as a
                            theory of language acquisition
                            (Cambridge)

Ege, Niels 1965:   "The Danish vowel system", Gengo
                            Kenkyu (Journal of the Linguistic
                            Society of Japan) 47, p. 21-35

Fischer-Jørgensen, Eli 1952: "On the definition of phoneme
                            categories on a distributional
                            basis", AL 7, p. 8-39, reprinted in:
                            Hamp, E., F. Householder and R. Auster-
                            litz (eds.), Readings in Linguistics
                            II (1966), p. 299-321

Fischer-Jørgensen, Eli 1962: Almen fonetik (Copenhagen)

Fischer-Jørgensen, Eli 1973: "Supplementary note to Hans Bas-
                            bøll's commentary on Hjelmslev's
                            analysis of the Danish expression
                            system", ALH 14, p. 143-152

Fudge, Erik 1969:   "Syllables", JL 4, p. 47-68

Grammont, Maurice 1933:   Traité de phonétique (Paris)

Greenberg, Joseph 1965:   "Some generalizations concerning
                            initial and final consonant se-
                            quences", Ling. 18, p. 5-34

Greenberg, J.H. and   "Studies in the psychological cor-
J.J. Jenkins 1964:   relates of the sound system of
                            American English", Word 20, p. 157-
                            177

Hansen, Aage 1956:   Udtalen i moderne dansk (Copenhagen)

Hjelmslev, Louis   1939:   "The syllable as a structural
                               unit", Proc. Phon. 3, p. 266-272,
                               reprinted in: Essais linguistiques
                               II = TCLC 14 (1973), p. 239-245

Hjelmslev, Louis   1951:   "Grundtræk af det danske udtryks-
                               system med særligt henblik på
                               stødet", Selskab for nordisk filo-
                               logi. Årsberetning for 1948-49-50
                               (Copenhagen 1951), p. 12-24,
                               English translation (by F.J. Whit-
                               field) in: Essais linguistiques
                               II = TCLC 14 (1973), p. 247-266

Hoard, James   1971:   "Aspiration, tenseness, and sylla-
                               bication in English", Lg. 47,
                               p. 133-140

Hooper, Joan   1972:   "The syllable in phonological
                               theory", Lg. 48, p. 525-540

Jakobson, Roman   1941:   Kindersprache, Aphasie und all-
                               gemeine Lautgesetze (Uppsala),
                               English translation: Child lan-
                               guage, aphasia and phonological
                               universals (The Hague 1968)

Jakobson, R., G. Fant and   Preliminaries to speech analysis
M. Halle   1952:   (Cambridge, Mass.)

Jespersen, Otto   1897-1899:   Fonetik   (Copenhagen)

Jespersen, Otto   1926:   Lehrbuch der Phonetik (4th ed.)
                               (Leipzig/Berlin)

Kiparsky, Paul 1973: "On phonological representations",
in: O. Fujimura (ed.), Three Di-
mensions of linguistic theory
(Tokyo), p. 1-136

Kloster Jensen, M. 1963: "Die Silbe in der Phonetik und
Phonemik", Phonetica 9, p. 17-38

Ladefoged, Peter 1971: Preliminaries to linguistic phon-
etics (Chicago)

Linell, Per 1974: Problems of psychological reality
in generative phonology = ruul
(Reports from Uppsala University,
Department of Linguistics) 4

Malmberg, Bertil 1965: "Kring stavelseproblemet", Nyare
fonetiska rön (Lund), p. 168-183

McCawley, James D. 1968: The phonological component of a
grammar of Japanese (The Hague)

O'Connor, J.D. and "Vowel, consonant and syllable;
J.L. Trim 1953: a phonological definition", Word
9, p. 103-122

Pertz, Doris and "Sensitivity to phonological uni-
Thomas Bever 1973: versals in children and adolescents",
Working Papers on Language Univer-
sals 13 (Stanford University), p.
69-91

Pike, Kenneth 1943: Phonetics (Ann Arbor)

Pike, Kenneth 1947: Phonemics (Ann Arbor)

Pike, Kenneth and "Immediate constituents of Mazateco
Eunice Pike 1947: syllables", IJAL 13, p. 78-91

Rischel, Jørgen 1964:   "Stress, juncture, and syllabi-
                               fication in phonemic description",
                               Proc. Ling. 9, p. 85-93

Rischel, Jørgen 1969:   "Notes on the Danish vowel pattern",
                               ARIPUC 3/1968, p. 177-205

Rischel, Jørgen 1970a: "Consonant gradation: A problem in
                               Danish phonology and morphology",
                               in: Benediktsson, H. (ed.), The
                               Nordic Languages and Modern Lin-
                               guistics (Reykjavik), p. 460-480

Rischel, Jørgen 1970b: "Morpheme stress in Danish",
                               ARIPUC 4/1969, p. 111-144

Rischel, Jørgen 1970c: "Acoustic features of syllabicity
                               in Danish", Proc. Phon. 6, p. 767-
                               770

Rischel, Jørgen 1972:   "Compound stress in Danish without
                               a cycle", ARIPUC 6, p. 211-230

Rischel, Jørgen 1974:   Topics in West Greenlandic phono-
                               logy (Copenhagen)

Schane, Sanford 1973:   Generative phonology (Englewood
                               Cliffs, New Jersey)

Sigurd, Bengt 1965:   Phonotactic structures in Swedish
                               (Lund)

Spang-Hanssen, Henning 1959:   Probability and structural classi-
                               fication in language description
                               (Copenhagen)

Stanley, Richard 1967:   "Redundancy rules in phonology",
                               Lg. 43, p. 393-436

Uldall, H.J.   1933:   A Danish phonetic reader   (London).

Uldall, H.J.   1936:   "The phonematics of Danish", Proc.
                              Phon. 2, p. 54-57

Vestergaard, Torben 1968:   "Initial and final consonant
                              combinations in Danish mono-
                              syllables", SL 21, p. 37-66