Phonetics & Phonology

Phonology
- Syllables -

(Hall, Kapitel 8; Ladefoged, Chapter 10)

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Basics

it is quite hard to define what a syllable actually is

roughly:

a syllable is a sequence of sounds that can be articulated in one go in fluent speech

a syllable is the basic rhythmic unit of a language

luckily, our intuitions about syllable boundaries are very good

also children are capable of identifying syllables through clapping, singing

the syllable is a domain for phonological processes and phonotactic well-formedness requirements
it is characteristic for a syllable to have a opening and closing phase:
In the IPA, syllable boundaries are marked by a dot:

\[\text{[fal.ten]}\]

the onset/coda correspond to an increase/decrease of sonority

therefore **syllable peaks** are usually formed by the most sonorant segments (i.e. vowels, sometimes sonorant consonants) in a language

the **phonotactics** of a language describe the permissible sequences of segments in the onset and coda of the syllable in a language
for an example for a phonological process that operates on the syllable domain, consider **final devoicing** in German again

<table>
<thead>
<tr>
<th>Word</th>
<th>Syllable boundary</th>
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<th>Syllable boundary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lob</td>
<td>[loːp]</td>
<td>lob+e</td>
<td>[loːbə]</td>
</tr>
<tr>
<td>Rad</td>
<td>[ræːt]</td>
<td>Rad+es</td>
<td>[raːdəs]</td>
</tr>
<tr>
<td>Tag</td>
<td>[taːk]</td>
<td>Tag+e</td>
<td>[taːɡə]</td>
</tr>
<tr>
<td>Nerv</td>
<td>[nɛrf]</td>
<td>nerv+ös</td>
<td>[nɛrvʊs]</td>
</tr>
<tr>
<td>streb+sam</td>
<td>[streːpzaːm]</td>
<td>streb+e</td>
<td>[streːbə]</td>
</tr>
<tr>
<td>Bünd+nis</td>
<td>[bʏntnɪs]</td>
<td>Bund+es</td>
<td>[bʊndəs]</td>
</tr>
<tr>
<td>bieg+sam</td>
<td>[biːkzaːm]</td>
<td>bieg+en</td>
<td>[biːɡən]</td>
</tr>
<tr>
<td>les+bar</td>
<td>[leːsbaːɾ]</td>
<td>les+en</td>
<td>[leːzən]</td>
</tr>
</tbody>
</table>
The Syllable as Domain

observation (ignoring syllables):
obstruents become voiceless (1) word-finally or (2) at a morpheme boundary with a following consonant

\[
[-\text{son}] \rightarrow [-\text{voice}] / \_ \left\{ \begin{array}{c}
\# \\
+ [+\text{cons}] \\
\end{array} \right\}
\]

the rule can be simplified if we take syllable boundaries into account:

obstruents become voiceless at the final boundary of a syllable

\[
[-\text{son}] \rightarrow [-\text{voice}] / \_ \sigma
\]

alternative way to indicate syllable boundaries:  \( \sigma \) [ resp. ] \( \sigma \)

\[
[-\text{son}] \rightarrow [-\text{voice}] / \_ \sigma
\]
This simple rule does its job

\[
/\text{taːg/} \quad /\text{biːg. zam/} \quad /\text{biː. ɡən/} \quad \text{UR}
\]
\[
\downarrow \quad \downarrow \quad \text{---} \quad \text{final devoicing}
\]
\[
[\text{taːk}] \quad [\text{biːk. zam}] \quad [\text{biː. ɡən}] \quad \text{SF}
\]

The word form *biegen* illustrates that morpheme boundaries and syllable boundaries do not always coincide.

\[
\sigma \quad \sigma
\]
\[
\underline{\text{b iː g ə n}}
\]
\[
\underline{\text{M M}}
\]
Phonotactics

phonotactics means the description of well-formedness conditions for syllables

for instance, no German word starts with the sequence of segments [lt], but there are words that end in this sequence, e.g. kalt

such regularities actually hold for syllables and not only words

stated more precisely, the sequence [lt] is not permitted in the onset but it is allowed in the coda

with these conditions in place it is clear that the following is no valid syllabification of falten:

*[fa.ltən]
Phonotactics

universals

different languages allow for a different number of segments in the onset and the coda

in some languages a *cluster* of four or more consonants is allowed in the onset, e.g. Polish [vzdwus] („along“)

in some other languages only one consonant is allowed, e.g. Hawaiian [a.lo.ha] („love“)

the following is a universal concerning onsets:

- $\sigma [CV$ syllables occur in all languages
- some languages allow for empty onsets
- if a language has $\sigma [C^nV$ syllables, it also has $\sigma [C^{n-1}V$ syllables (n>1)
similar restrictions occur w.r.t. the coda

for instance, in German up to five consonants are allowed in the coda, e.g. in *Herbsts* [hɛrpɛsts]

in other languages, the coda must be empty, e.g. in Hawaiian and the Samoan language, e.g. [wa.hi.ne] („woman“).

a universal concerning the coda is the following:

- if a language has $VC^n$ syllables, it also has $VC^{n-1}$ syllables

syllables with empty coda are called **open**, those with at least one segment in the coda are called **closed**
Phonotactics

universals

vowels are the typical syllable peak; in every language vowels occur as syllable peaks

if necessary, the peak of a syllable can be explicitly marked by the diacritic of the IPA

some languages also allow for sonorants at the syllable peak, e.g. German:

lesen [leː.zən] haben [haː.bən]
Wandel [van.dɛ̃] Haken [haː.kɛ̃]

a few languages allow obstruents as syllable peaks, e.g. Imdlawn Tashlhiyt Berber (spoken in Morocco):

[tf.tkt] „you sprained sth.“ [tr.kəʃ] „she hid“
in German one observes the following **phonotactic restrictions**: 

- the onset is empty or contains up to three consonants
  - if the onset is empty, the vowel at the syllable peak is unstressed; otherwise the onset must contain the glottal stop [ʔ]:
    - *nahe* [ˈnaː.ə] *etwaig* [ˈʔeːt.vɑː.iç]
    - *Chaos* [ˈkaː.ɔs] *chaotisch* [kaːˈʔoː.tɪʃ]

in some cases, this prevents the pronunciation of two adjacent vowels, i.e. a **hiatus**

all consonants can occur as the sole onset in a syllable, but [s] and [ŋ] do not occur word-initially:

- *reiß*en [raɪ.ʃən] *#s*
- *lange* [laːŋə] *#ŋ*
of German

in bipartite onsets (i.e. those with two consonants), some sequences are found while others do not occur:

the sequence obstruent + sonorant occurs frequently, e.g.

\[ \sigma [tR] \quad \sigma [pR] \quad \sigma [kn] \quad \sigma [k] \quad \sigma [f] \]

a sequence sonorant + obstruent does not occur at all, e.g.

\[ \ast \sigma [nk] \quad \ast \sigma [lf] \quad \ast \sigma [Rp] \quad \ast \sigma [mt] \]

there are only a limited number of onsets with three consonants:

\[ \sigma [SpR] \quad \sigma [Sp] \quad \sigma [StR] \quad \sigma [skR] \quad \sigma [sk] \]
Phonotactics

of German

as one-element codas all consonants occur except voiceless obstruents and [h].

voiceless obstruents do not occur because of final devoicing, [h] needs to be ruled out explicitly: *h]₀

for bipartite codas, one observes the opposite behavior from onsets: the sequence sonorant + obstruent occurs frequently, e.g.

\[
\begin{align*}
\text{Rt]}_0 & \quad \text{Rf]}_0 & \quad \text{mt]}_0 & \quad \text{lk]}_0 & \quad \text{ns]}_0
\end{align*}
\]

a sequence obstruent + sonorant does not occur, e.g.

\[
\begin{align*}
*\text{tR]}_0 & \quad *\text{pR]}_0 & \quad *\text{kn]}_0 & \quad *\text{kl]}_0 & \quad *\text{fl]}_0
\end{align*}
\]
Phonotactics

sonority sequencing principle

these observations illustrate that German follows (more or less) the important universal **sonority sequencing principle (SSP):**

\[
\text{in each syllable, sonority increases up to the peak and then decreases}
\]

sonority of segments can be determined along the **sonority hierarchy** which looks as follows:

\begin{center}
\begin{tabular}{cccc}
plosives & fricatives & nasale & liquide \\
vowels & & & \\
\end{tabular}
\end{center}
Phonotactics

sonority sequencing principle

examples which adhere to the SSP:

etwa\textit{ig}

\[ [\text{I c}] \]

fro\textit{h}

\[ [\text{f R O:}] \]

\textit{blank}

\[ [\text{b l a n k}] \]
Phonotactics

sonority sequencing principle

the SSP explains the observed phontactic restrictions for the German onset and coda:

in the onset sonority must increase, hence a sequence of sonorant + obstruent is excluded

in the coda sonority must decrease, hence a sequence of obstruent + sonorant is excluded

still there are many exceptions to the SSP that need to be described explicitly, e.g.

* o [tl] * o [ZR] although the SSP is adhered to

o [ʃt] o [sk] although (it seems that) the SSP is violated
Syllable Structure

to describe phonological process concerning syllable structure, it is
important to describe syllable structure precisely

therefore the syllable is analysed as having (sub-syllabic) constituents

to describe the internal structure of the syllable, one uses
autosegmental representations, i.e. several tiers that are
connected by association lines

\[
\begin{array}{c}
\sigma \\
\downarrow \\
\text{blank}
\end{array} \quad \begin{array}{c}
\sigma \\
\downarrow \\
\text{fallen}
\end{array} \quad \begin{array}{c}
\sigma \\
\downarrow \\
\text{ten}
\end{array}
\]

\[\text{syllable tier} \quad \text{association lines} \quad \text{segmental tier}\]
the syllable itself is made up of two constituents: **onset** and **rhyme**

the rhyme has two further constituents **nucleus** (another word for „peak“) and **coda**
we saw already that it made sense to talk about onset and coda, since phontactic restrictions were about them

another restriction in German: in the onset sequences of homorganic obstruent + sonorant are prohibited

\[ * _\sigma [pm] \quad * _\sigma [fm] \quad * _\sigma [tn] \quad * _\sigma [dl] \quad * _\sigma [k\bar{\imath}] \]

one could write that as the following autosegmental restriction:

\[ * \text{onset} \]

\[ -\text{son} \quad \alpha\text{place} \quad +\text{cons} \quad +\text{son} \quad \alpha\text{place} \]
Syllable Structure

onset, nucleus and coda

autosegmental representations of syllable structure make the feature $[\pm\text{syllabic}]$ redundant: one can define that all and only the elements below the nucleus node are $[+\text{syllabic}]$, all others are $[-\text{syllabic}]$

using autosegmental representations, it is clear how to derive the form $[\text{le:z} \mathring{n}]$ of lesen from underlying $/\text{le:z} \mathring{n}/$ by schwa-elision
Syllable Structure

onset, nucleus and coda

yet another refinement of final devoicing which shows the importance of the coda:

\[
\begin{align*}
\text{Jagd} & \quad [\text{jajkt}] & \text{Obst} & \quad [\text{opst}] \\
\text{Magd} & \quad [\text{makt}] & \text{Abt} & \quad [\text{apt}] \\
\text{hebt} & \quad [\text{hept}] & \text{sagt} & \quad [\text{saakt}]
\end{align*}
\]

observation:
not only a syllable-final obstruent is devoiced, but all obstruents in the coda

one could have a rule as follows:

\[
\begin{align*}
\text{coda} & \\
\text{[-son]} & \rightarrow \text{[-voice]} / \_
\end{align*}
\]
Syllable Structure

rhyme

so far so good, but why do we need another constituent „rhyme“ comprising nucleus and coda?

because the constituent *rhyme* plays an important role in rhymes

in rhymes, the *rhyme* of the final syllables (or the *rhyme* of the preceding syllable plus final syllable, z.B. *schweifen* - *ergreifen*) coincide; the onset and preceding syllables may vary:

*Wenn dein Fahrrad vorne quakt,…*

... *hast du's auf 'nem Frosch geparkt.*
Syllabification

maximum onset principle

**syllabification** means the division of a sequence of segments into syllables

two important factors for syllabification are the **phonotactic restrictions** (and the **SSP**)

but they alone do not suffice to uniquely syllabify a word such as *falten*; it could syllabified as [fal.tən] or [falt.ən] (according to the phonotactic restrictions in German/the SSP)

the principle that is important here is the **maximum onset principle**: form the largest possible onset without violating phonotactic restrictions
Syllabification

maximum onset principle

eexample: syllabification of *fal*ten

1.) associate a nucleus with each [-cons] segment

2.) associate as many as possible consonants to the left with the onset (without violating phonotactic restrictions)

3.) associate the remaining consonants with the coda

1.) N

2.) O N O N

    f a l t e n

    f a l t e n
Syllabification

maximum onset principle

2.) not possible:

* O N O N

f a l t e n

3.) O N C O N C

f a l t e n

* \( \sigma \) [It because of the SSP

association of the nucleus and coda with the rhyme and the onset and the rhyme with the syllable node yields the final representation:
Quantity

syllable weight

the rhyme determines the **weight of a syllable**

in Latin, a **heavy syllable** consists of a consonant in the onset and a long vowel, a diphthong, or a vowel followed by a consonant:

```
CV:  C\_\_V  CVC
```

a **light syllable** consists of a consonant in the onset and a short vowel: CV

a rule for determining word stress in Latin:

> *in a(n at least) trisyllabic word the penultimate syllable is stressed if it is heavy, otherwise the antepenultimate syllable*

this predicts the following stress pattern (stress marked by `^`):

```
['do.mi.nus] „master“  [i.ni.'mi:.kus] „enemy“
[mi.no.'tau.rus] (name)  [mo.'les.tus] „annoying“
```
the distinction between heavy and light syllables can be read off the rhyme structure, if one adds another **timing tier** (where long vowels are represented by means of two timing units)

now it is more obvious: in heavy syllables the rhyme includes a branch

general observation for many languages: stressed syllables are heavy
Quantity

the additional **timing tier** is sometimes also called the **skeleton**

these tier provides time units, called **timing slots**

with this additional tier we can represent length as follows:

```
  X  |  X  X  |  X  X  |  X  |  X  X  
  a  |  a:\  |  a  u  |  t  |  t:  
```

short vowel    long vowel    diphthong   (short) consonant  long consonant
Quantity

length (also w.r.t. consonants) is a distinctive feature in some languages, e.g. in Finnish:

muta („mud“)  
\[/m\text{ u t a/}\]

mutta („but“)  
\[/m\text{ u t a/}\]

muuta („different“)  
\[/m\text{ u t a/}\]

muutta („change“)  
\[/m\text{ u t a/}\]

long consonants can be analysed as sequence of two segments and are then called **geminates**
Quantity

compensatory lengthening

the autosegmental representations using a timing tier allow for a straightforward explanation of the so-called **compensatory lengthening**.

compensatory lengthening is the lengthening of a vowel upon the loss of a adjacent consonant

the historical change from Indo-European to Latin provides examples:

<table>
<thead>
<tr>
<th>Indo-European</th>
<th>Latin</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>[nisdos]</td>
<td>[niːdus]</td>
<td>„nest“</td>
</tr>
<tr>
<td>[kasnos]</td>
<td>[kaːnus]</td>
<td>„grey“</td>
</tr>
<tr>
<td>[sluːbrikos]</td>
<td>[luːbrikus]</td>
<td>„slippery“</td>
</tr>
<tr>
<td>[snurus]</td>
<td>[nurus]</td>
<td>„daughter-in-law“</td>
</tr>
</tbody>
</table>
Quantity

compensatory lengthening

the following happens:
before anterior consonants (e.g. [d n l]) the segment [s] is elided. At the same time, a preceding short vowel becomes long.

the following elision targeting [s] works on the segmental tier

\[ [s] \rightarrow \emptyset / \_ [+ant, +cons] \]

all that is needed in addition is the following autosegmental association rule that re-associates a floating timing slot with a preceding vowel in the rhyme:
Quantity

compensatory lengthening

these rules allow for the following derivations:

units that cannot be associated are deleted (Stray Erasure).
Exercise

(1) Show the syllable structures for each of the following words. Furthermore, use the skeleton tier to indicate the quantity aspects:
   (a) [fiːl]               (b) [hɪm.ˈlɪʃ]             (c) [ʔalt]
   (d) [fɾoː]               (e) [ʔo.ko.noː.ˈmɪʃ]     (f) [ɡə.ˈfaː.ɲ]

(2) Show an detailed derivation of the syllabification of the following German words (cf. the slides „Syllabification“):
   (a) [neːbliç]           (b) [hɪmlɪʃ]              (c) [ʃtrʊkˈtʊʁ]

(3) Which of the following (made up) syllables violate the SSP? Explain!
   (a) [tvuʃʃ]           (b) [ɪrmp]               (c) [zdaç]
   (d) [ʃuːlps]           (e) [bvmrɛ]              (f) [muːrʃ]
Additional Material
Quantity

affricates

affricates such as $[\text{pf ts tj d₃}]$ can be analysed as sequence of two segments that are associated with one timing slot/one position in the skeletal tier:

$$[	ext{pflu:k}]$$

$Pflug$

$$[	ext{tσvirm}]$$

$Zwirn$
Quantity

affricates

this analysis makes perfect sense since affricates show these two aspects: sometimes they behave like a sequence of two segments, but w.r.t. phonotactics they behave like a single segment

bi-segmental arguments:
1.) to the right they behave like fricatives, but
2.) to the left they behave like plosives

1.) in 3rd pers. singl present active: allomorph [ət] after coronal plosives, allomorph [t] after coronal fricatives and affricates

(a)  
\[ba[\text{d}ə\text{t}]\]  
\[rei[\text{t}ə\text{t}]\]  
(b)  
\[rei[\text{s}t]\]  
\[wə[\text{t}]\]  
(c)  
\[schwi[\text{t}_s\text{t}]\]  
\[ma[\text{t}_s\text{t}]\]

to the right, \([\text{t} \text{s} \text{t}]\) behave as the fricatives \([s \text{ f}]\)
Quantity

affricates

2.) before a word-final [f] a [n] can occur, before word-final [p] only [m] may occur:

(a) fünf
    Hanf
    Senf

(b) *fünp
    *Hanp
    *Senp

(c) Lump
    Pomp
    Pump

the affricate [pf] behaves as the plosive in this respect and allows only for preceding [m]:

Kampf    Sumpf    Pimpf

to the left, [pf] behaves as the plosive [p]
Quantity

affricates

but for phonotactic reasons, it makes sense to regard affricates as single segments

tripartite onsets with an initial plosive are not allowed in German:

\[ *_{o}[psR] \quad *_{o}[tfr] \quad *_{o}[ksl] \]

affricates are an exception:

\[ Pflug \quad _{o}[pfl] \quad Pfründe \quad _{o}[pfR] \quad zwei, Zwirn \quad _{o}[tsv] \]

here, the affricates do not behave as a sequence of two separate segments

it is still debated what the best analysis of affricates is
Quantity

extrasyllabic and ambisyllabic

if affricates are analysed as above (two segments associated with one position in the skeleton) one can simplify phonotactic restrictions for German by allowing for maximally bipartite onsets

still a problem:
what about exceptions like \( \sigma [ftR] \) or \( \sigma [skl] \), which are tripartite and violate the SSP?

proposal:
alalyse consonants as **extrasyllabic** (i.e. as „not really belonging to the syllable“)
Quantity

extrasyllabic and ambisyllabic

example: *Strumpfs*

both segments [ʃ] and [s] are regarded as extrasyllabic

with this analysis the syllable adheres to the SSP

in German only voiceless coronal obstruents occur extrasyllabic
Quantity

extrasyllabicity and amabisyllabicity

sometimes intuitions are not quite clear about syllabification

examples:  
ger. *Mutter, Wasser, Backe*  
engl. *happy, penny*

according to the rules for syllabification (in particular the maximum onset principle) *Mutter* should be syllabified as follows:

```
     σ  σ
    /   \\
   /     \\
  /       \\
 /         \\
/           \\nO   N   O   N
|   |   |   |   |
X   X   X   X   X
|   |   |   |   |
/   /   /   /   /
\   \   \   \   \nm   u   t   e
```

*Mutter*
Quantity

extrasyllabiciry and ambisyllabiciry

But: the first syllable is stressed although it is light

if one follows the general observation that only stressed syllables must be heavy, the following syllabification must be assumed:

\[
\begin{array}{l}
\sigma \\
R \\
O \\
x \\
m
\end{array}
\quad
\begin{array}{l}
\sigma \\
R \\
N \\
x \\
\varepsilon
\end{array}
\]

Mutter
one solution to unify these two incompatible views is to assume that the segment \([t]\) is **ambisyllabic**

an ambisyllabic segment simultaneously belongs to two syllables

```
\[
\begin{array}{c}
\sigma \\
R \\
O \quad N \quad C \\
X \quad X \quad X \\
m \quad u \quad t \quad e \\
\end{array}
\]
```

*Mutter*

with this analysis: 1.) the maximal onset principle is fulfilled
2.) the stressed syllable is heavy (the rhyme branches)
so far a syllable was structured into constituents; these were associated with the skeleton

an alternative approach is to ignore constituents but make the skeleton positions more meaningful

instead of the simple X timing slots, one subdivides those into C slots (non-syllabic) and V slots (syllabic):
The CV model

by making use of the extrasyllabic analysis in certain cases, it is possible to use a **template** describing the general format of a syllable in German: CCVCC (bipartite onset, nucleus, coda)

extrasyllabic segments lie outside the template; in German only coronal voiceless obstruents occur as those

but now long vowels and diphthongs must be analysed as a VC sequence:
The CV model

diphthongs can be analysed as consisting of a syllabic and a non-syllabic segment (cf. the alternative notations with a glide):

- **rising** diphthongs (first segment non-syllabic)
  - French *oie* („goose“) → [ua]  [وها]  [wa]
  - *Ei, Mais* → [ai]  [ai]  [aj]
  - *Maus, Cowboy* → [au]  [او]  [aw]

- **falling** diphthongs (second segment non-syllabic)

the diacritic indicates non-syllabicity