13 Syllables

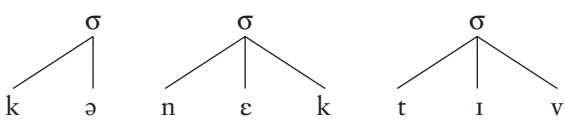
13.1 Syllables in Phonological Theory

Among phonological entities, syllables are unusual in the degree to which they stand out to the native speaker at the conscious level. It is relatively easy for people to count the syllables of a word – much easier than counting the segments. People also find it intuitive to count out syllables and arrange them in time whenever they use them in verse, chant, and song.

Looking within phonology itself, we find that syllables frequently appear in environments of phonological rules, both for deriving allophones and in morphophonemic alternation. Syllables also are the units that bear stress (chapter 14) and serve as the "anchor points" for tones in tonal systems and in intonation (chapter 15). It is hardly surprising that phonologists have often made use of syllables in phonological theory.

13.2 Representation

Various means are used to depict syllables formally. In the International Phonetic Alphabet, syllables are shown by separating them with a boundary symbol, specifically a period; thus, *connective* is represented with its syllabification as [kə.nɛk.tɪv]. Another approach, followed here, eschews boundary symbols and assumes instead that syllables are *phonological constituents*. For representing such constituency, the clearest notation is tree structure. In the representation for *connective* below, the syllable constituents are labeled with /σ/ (Greek sigma, for "syllable"):



A more concise notation uses brackets, annotated with σ: $[_{\sigma}$ kə$]_{\sigma}$ $[_{\sigma}$ nɛk$]_{\sigma}$ $[_{\sigma}$ tɪv$]_{\sigma}$ or, still more concisely, $[$kə$]_{\sigma}[$nɛk$]_{\sigma}[$tɪv$]_{\sigma}$. The full tree notation will be used here for phonological derivations in which segments get added to or removed from syllables, or for cases where brackets must be reserved for morphological or syntactic structure.

In discussing syllables, it is useful to be able to refer to certain substrings of them. The **onset** of a syllable is defined as the consonant or sequence of consonants at the beginning of a syllable. The **coda** is the consonant or sequence of consonants at the end of a syllable. The **nucleus** of a syllable is the vowel or diphthong found at the syllable's core and functioning as its sonority peak (sometimes **peak** is used instead of nucleus). It is obligatory for a syllable to have a nucleus, very common for a syllable to lack a coda, and less common for it to lack an onset.

In some theories, the onset, nucleus, and coda are described as constituents (they are daughters of the syllable node σ, and dominate segments). This book will use "onset," "nucleus," and "coda" merely as useful descriptive terminology. The representations used will be the simple structures shown above in which σ dominates segments directly.

13.3 Syllabification

In principle, syllabification could be part of the phonemic representation of forms. Where this is so, we would be able to detect it in the form of minimal pairs (chapter 2) that differ only in syllabification. Thus, we could imagine a language in which there is a word judged by native speakers to be syllabified $[$at$]_{\sigma}[$ra$]_{\sigma}$, which means (say) 'sheep', and a different word judged to be syllabified $[$a$]_{\sigma}[$tra$]_{\sigma}$, which means 'goat'. This would be a minimal pair for syllabification. Such distinctions have in fact been suggested, but only for a very few languages (see Further reading). In most languages, however, syllabification is predictable: starting out from the string of segments, one can predict the syllabification (or multiple syllabifications, in cases of free variation). Just as a complete phonological description seeks to derive all of the predictable allophones of the language by rule, it should also derive the syllabification.

The basis on which syllabification is derived must be (partly) language-specific: every language has its own principles of syllabification. We can see this by looking at very similar segmental strings that get syllabified differently in different languages. The word for 'four' in Spanish is syllabified $[$kwa$]_{\sigma}[$tɾo$]_{\sigma}$. But in Ilokano, where the same word occurs as a borrowing, it is syllabified $[$kwat$]_{\sigma}[$ɾo$]_{\sigma}$.[1]

[1] The question arises of how we know this. First, native speakers of both languages intuit these syllabifications. Second, the distribution of allophones supports it: for instance, the /t/ of Ilokano $[$kwat$]_{\sigma}[$ɾo$]_{\sigma}$ is the preglottalized [ˀt] allophone that we generally find in syllable-final position, not the plain [t] found syllable-initially. In addition, vowels are typically shorter when they are followed by a consonant in their syllable, and the Ilokano [a] vowel is noticeably shorter than the Spanish.

13.3.1 General principles of syllabification

Such interlinguistic differences, however, are usually modest; it is the cross-linguistic resemblances that are perhaps more striking. It is possible to state a set of "garden-variety" principles of syllabification that give at least an approximation to syllabification in most languages; and this task is addressed in the following sections.

13.3.1.1 Finding the syllable nucleus

The nucleus of the syllable is normally a vowel or diphthong, though in some languages other segments with lower sonority (liquids and nasals) can be syllabic and form syllable nuclei; this is discussed in §4.4.3.

Definitionally (see §4.4.3), there is a one-to-one correspondence between [+syllabic] sounds and syllables; every [+syllabic] sound is the nucleus of its own syllable. However, the questions of what sounds count as [+syllabic] is an analytic one and cannot be determined by merely listening to the data. Cases that often need to be addressed are whether a particular sequence should count as [aa] (two [+syllabic, –long] segments) or [aː] (one [+syllabic, +long] segment, §3.4.1); or whether the [l] of a word-final sequence like [abl] has a [+syllabic] [l̩] or a [–syllabic] [l]; the syllabification will depend on this decision.

13.3.1.2 Syllabic affiliations of consonants

Assuming that the choice of [+syllabic] segments has been correctly made, the main task in syllabification is determining to which syllable the consonants belong.

It is generally true that when a consonant immediately precedes a vowel, it must belong to the same syllable as the vowel. As a consequence, VCV is normally syllabified $[V]_\sigma[CV]_\sigma$, not *$[VC]_\sigma[V]_\sigma$. Moreover, while VCCV is sometimes syllabified as $[VC]_\sigma[CV]_\sigma$ and sometimes as $[V]_\sigma[CCV]_\sigma$, it would be very unlikely for it to be syllabified as *$[VCC]_\sigma[V]_\sigma$.

This leaves two choices ($[V]_\sigma[CCV]_\sigma$ and $[VC]_\sigma[CV]_\sigma$) for biconsonantal clusters and three (($[V]_\sigma[CCCV]_\sigma$, $[VC]_\sigma[CCV]_\sigma$, and $[VCC]_\sigma[CV]_\sigma$) for triconsonantal clusters. To choose among these, we will assume that languages have ordered rules that affiliate consonants either to the following or to the preceding syllable. Such rules can be complex, and we will only give some outline analyses here. Before proceeding, however, it is useful to consider a heuristic principle that guides many analyses.

This heuristic, the **Maximal Onset Principle**, states that we can often predict the syllabification of intervocalic clusters by observing *the set of consonant clusters that may begin a word*: VC_1C_2V will be syllabified $[V]_\sigma[C_1C_2V]_\sigma$ if a word can begin C_1C_2V (and similarly, $VC_1C_2C_3V$ will be syllabified $[V]_\sigma[C_1C_2C_3V]_\sigma$ if a word can begin $C_1C_2C_3V$, and so on).

Here is an example: in English, *approve* is syllabified as [ə]$_{\sigma}$[pɹuv]$_{\sigma}$ because English words can begin with /pɹ/; but *Wheatley* is syllabified [wit]$_{\sigma}$[li]$_{\sigma}$, because no word can begin with /tl/. In Persian, the maximal consonant sequence at the beginning of a word is just one, so a word like /æbɾu/ 'eyebrow' must be syllabified [æb]$_{\sigma}$[ɾu]$_{\sigma}$, not *[æ]$_{\sigma}$[bɾu]$_{\sigma}$.

The Maximal Onset Principle often can predict syllabification in languages, but is not infallible. For example, in Ilokano, *kwatro* is syllabified [kwat]$_{\sigma}$[ɾo]$_{\sigma}$ even though there are words that can begin with /tɾ/, for example *tres* 'three'. The principle also produces incorrect results when applied with certain English onsets. /dw/ is a possible (though rare) onset in English (*dwell*), but *Edwardian* seems to be syllabified [ɛd]$_{\sigma}$['wɑɹ]$_{\sigma}$[di]$_{\sigma}$[ən]$_{\sigma}$, not *[ɛ]$_{\sigma}$['dwɑɹ]$_{\sigma}$[di]$_{\sigma}$[ən]$_{\sigma}$. (We can tell this from allophone evidence: [d] shows up in *Edwardian* with the coda allophone heard in *Ed* [ɛd], not the slightly affricated [d^{ʒ}] onset allophone heard in *dwell*.)

The Maximal Onset Principle, though useful, is only a heuristic; it is not really specific enough to be part of a phonological analysis. The reason is that a full grammar of a language should say what the word-initial onsets are; for example that [bl] is a possible onset of English and that *[bn] is not. *[bnɪk] is an impossible word of English, because it begins with an impossible onset. For a language with a syllable onset inventory as complex as that of English, the establishment of a set of rules that can derive all and only the possible onsets involves fairly extensive analysis, which will not be attempted here. The usefulness of the Maximal Onset Principle is that it predicts, correctly in most cases, that if there is a choice between syllabifying a consonant as an onset or as a coda, it will be syllabified as an onset.

13.3.1.3 An outline scheme for syllabification

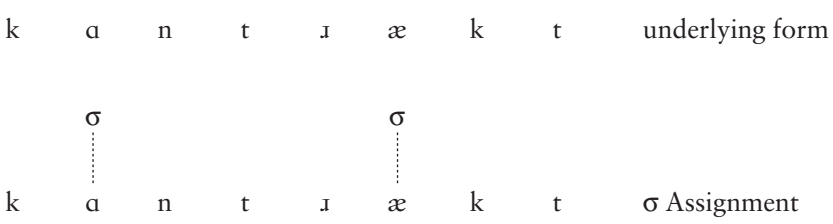
With this background in place, we can set up an outline version of how syllabification works, sufficiently detailed to serve in the discussion that follows. There are three rules, which apply in the order shown.

σ Assignment
Assign syllable nodes (σ) to be in one-to-one correspondence with [+syllabic] sounds.

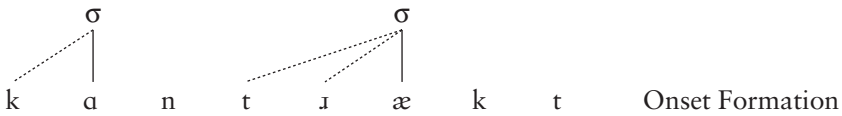
Onset Formation
Join consonants to the following syllable, provided the resulting cluster can occur at the beginning of a word (Maximal Onset Principle).

Coda Formation
Join any consonants not yet syllabified to the preceding syllable.

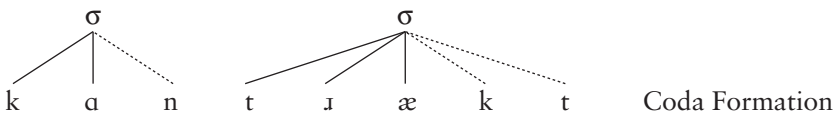
These rules can be illustrated with the English word *contract* (/kɑntɹækt/). First, to enforce the one-to-one correspondence of [+syllabic] sounds and syllables, σ Assignment must affiliate a syllable node with the vowels /ɑ/ and /æ/.



Next, Onset Formation attaches /k/ to the first syllable and /tɹ/ to the second; thus respecting the Maximal Onset Principle (compare *track*, *try*, *tree*, but no words like *[ntɹæk]):



The remaining consonants are syllabified by Coda Formation:



This analysis implements the Maximal Onset Principle through rule ordering: Coda Formation follows Onset Formation and applies only to unsyllabified consonants; hence it syllabifies only the consonants that were not already syllabified by Onset Formation. Where the Maximal Onset Principle does not hold true, as in cases like *Edwardian*, it would be necessary to limit certain cases of Onset Formation to word-initial position.

13.4 Syllables and Phonological Derivations

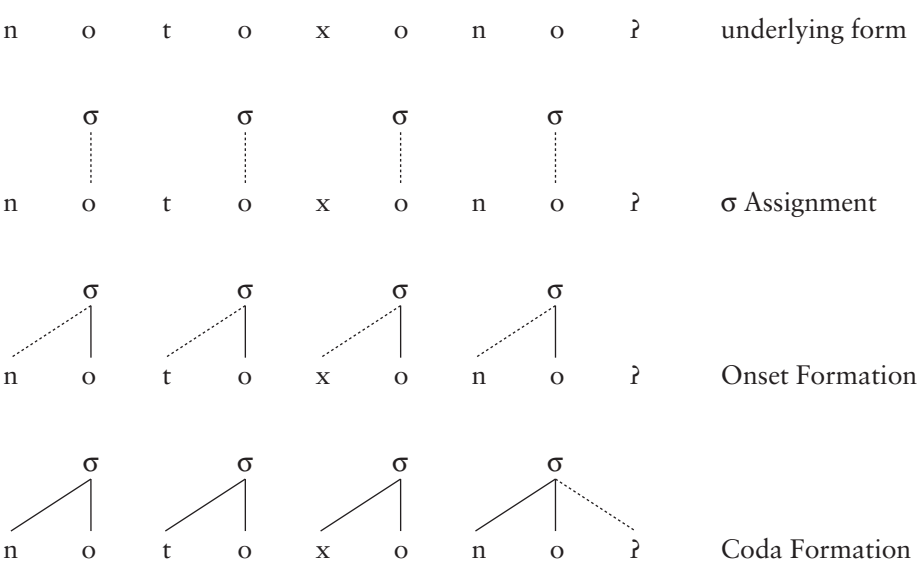
Syllabification is complicated by the fact that the rules of the phonology often rearrange the sequence of consonants and vowels, through deletion, insertion, and other processes. How does syllabification respond to such changes? More generally, what is the place of syllabification in the phonological derivation?

One widely held view, adopted here, is that the rules of syllabification are **persistent**. This means that underlying phonological representations are syllabified by the syllabification rules at the outset of the derivation, and that whenever a phonological rule applies, the syllabification rules reapply if applicable. We will see evidence that bears on this claim later on; for now, I will simply give an example to illustrate the concept of persistence.

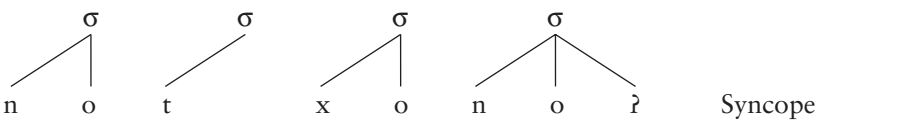
In Tonkawa, an extinct American Indian language once spoken in Texas, there is a Syncope rule that deletes the second vowel of a word when it is not adjacent to a consonant cluster or final consonant:

Tonkawa Syncope
$V \rightarrow \varnothing$ / $[_{word}$ CVC ___ CV

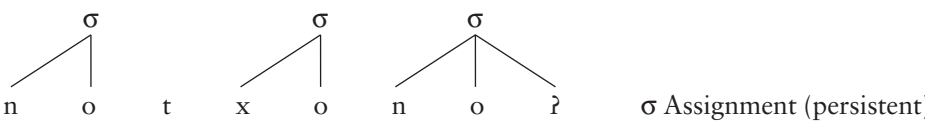
The underlying representation /notoxo-n-o-ʔ/ 'he hoes it' ('hoe-progressive-declarative-3 person present'), would be initially syllabified as shown below:



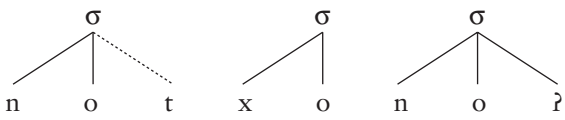
Once the form is syllabified, it is submitted to the phonological rules. Syncope removes the second vowel, creating the following representation:



The syllable nodes are now no longer in one-to-one correspondence with the [+syllabic] segments, [t] being [–syllabic]. Therefore, the persistent rule of σ Assignment is applicable. I assume that what this means is that the σ which is not affiliated with a [+syllabic] sound is removed:



This restores the one-to-one correspondence specified in the rule, but it also "liberates" a [t] which must be syllabified. Onset Formation, in the version appropriate to Tonkawa, is not applicable, as the language tolerates only single consonants at the beginning of a syllable. But Coda Formation is applicable, and it reaffiliates the stranded [t]:



Coda Formation (persistent)

Thus, according to the persistent-syllabification approach, [t] is a syllable-initial segment at the outset of the phonology, but ends up as syllable-final.

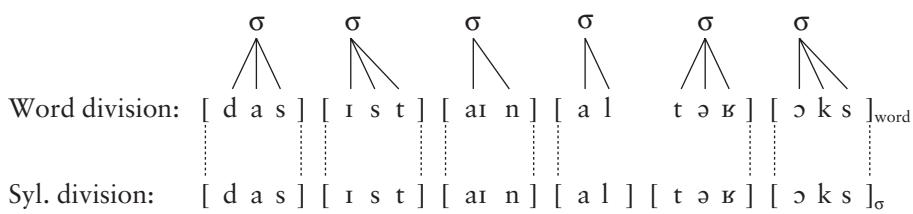
The underlying representation given here can be justified by other forms in the paradigm. For instance, [wentoxonoʔ] 'he hoes them', is derived from underlying /we-notoxo-n-o-ʔ/ 'them-hoe-prog.-declar.-3 pres.' by Syncope, applying to a different vowel of the stem.

13.5 Word Boundaries and Syllables

Just like other phonological rules (chapter 10), syllabification rules often "respect word boundaries"; that is, Onset Formation and Coda Formation are often word-bounded. Consider for instance the following sentence of German:

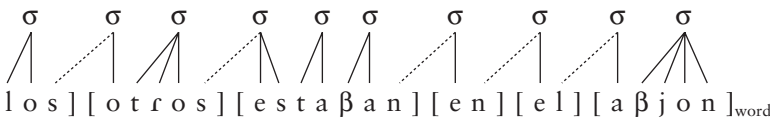
Das ist ein alter Ochs.
[das ɪst aɪn 'altəʁ 'ɔks]
'That is an old ox.'

The final consonants of *das* [s], *ist* [t], *ein* [n], and *alter* [ʁ] all precede vowels, so that, in principle, Onset Formation could affiliate them with the σ nodes attached to these vowels. Under the assumption of a word-bounded Onset Formation rule for German, however, no such affiliation is possible. Instead, these consonants must undergo Coda Formation, and are syllabified within their own word. The resulting alignment of words and syllables is shown below.



Whether Onset Formation is word-bounded or not is evidently language-specific, however. Spanish is an example of a language where Onset Formation applies phrasally: if $Word_1$ ends in a consonant, and $Word_2$ begins in a vowel, then the last consonant of $Word_1$ will be syllabified in the first syllable of $Word_2$:

Los otros estaban en el avion.
[los 'otɾos es'taβan en el a'βjon]
'The others were on the airplane.'



The dotted lines above show the syllable memberships that cross word boundaries.

13.6 The Onset/Coda Distinction and Its Consequences

The remainder of this chapter covers some of the ways in which syllable structure influences segmental phonology. One of these involves an important distinction between onset and coda position: the segments of onsets and the segments of codas show strikingly different phonological behavior. Onsets are often obligatory, articulated more forcefully, and the locus of rich phonemic contrasts. Codas are often optional or even forbidden, they are articulated less forcefully, and they are the locus of phonological neutralization, including deletion. The following survey illustrates these patterns.

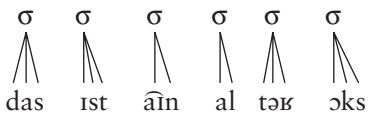
13.6.1 Obligatory onsets, optional codas, forbidden codas

In many languages (e.g. Arabic, Ilokano), every syllable must begin with an onset; that is, no syllable may begin with a vowel. Moreover, onsets are never forbidden; there is no such thing as an onsetless language. For codas, the typology is the opposite. In many languages (e.g. Samoan, Zulu), codas are forbidden. Moreover, there are apparently no languages that require every syllable to have a coda. Thus, the only "universal syllable," present in every language, is CV.

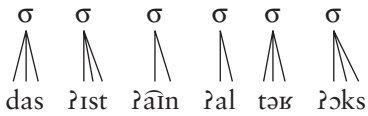
The preference for syllables to have onsets can be seen in German. In the example given earlier, the vowel-initial syllables undergo a rule of Glottal Epenthesis in careful speech, so that they will surface with a /ʔ/ onset.

Glottal Epenthesis
$\varnothing \rightarrow$ ʔ / [$_{\sigma}$ ___ V
Insert a glottal stop at the beginning of a vowel-initial syllable.

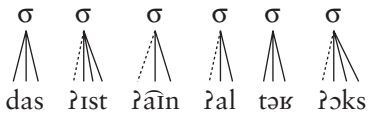
This rule would apply to the example given earlier to derive the following output:



σ Assignment, Onset Formation, Coda Formation



Glottal Epenthesis



Onset Formation (persistent; §13.4)

English has the same rule, mentioned above in §10.4. The English rule probably applies less frequently than its German counterpart and is found more often in clear or emphatic speech. Examples include cases like *three apples* /θɹi æpəlz/ → [θɹi ʔæpəlz], with an epenthetic glottal stop at the beginning of the second word, as well as the case of *Kafkaesque* (/kæfkə-ɛsk/ → [ˌkæfkəˈʔɛsk]) mentioned on p. 209.

There are apparently no epenthesis rules that apply in coda position (such a rule would ensure that every syllable will have a coda).

13.6.2 Neutralization in codas

Coda position is often the location of *neutralization*. There are many examples; we will cover one here from the Cibaeño dialect of Spanish, spoken in the Dominican Republic.

In Cibaeño, as in all Spanish dialects, there is a contrast between the liquids /l/ and /ɾ/. In certain positions, an optional rule of Liquid Gliding applies converting /l/ and /ɾ/ to [j]. /j/ is also a phoneme of this dialect ([rej] 'king'), so this is a triple neutralization. Here are representative data.

Forms with /ɾ/		**Forms with /l/**	
['kaɾta], ['kajta]	'letter'	['alɣo], ['ajɣo]	'something'
['pweɾko], ['pwejko]	'pig'	[almo'aða], [ajmo'aða]	'pillow'
[mu'xeɾ], [mu'xej]	'woman'	[pa'pel], [pa'pej]	'paper'
['paɾke], ['pajke]	'park'	[a'sul], [a'suj]	'blue'
[bol'βeɾ], [boj'βej]	'to return'	[bol'βeɾ], [boj'βej]	'to return'

In all cases in which Liquid Gliding applies, the /l/ or /ɾ/ occurs before a consonant or word finally. When these sounds occur before a vowel, they are unaffected:

[koɾa'son] (only)	'heart'	[ala'meða] (only)	'poplar cove'
['paɾe] (only)	'stop'	['limite] (only)	'limit'[2]

Liquid Gliding creates alternations whenever a vowel-initial suffix is attached to a stem ending in /l/ or /ɾ/, as in the following cases:

[mu'xeɾ], [mu'xej]	'woman'
[mu'xeɾ-es] (only)	'women'
[tɾaβaxa'ðoɾ], [tɾaβaxa'ðoj]	'worker'
[tɾaβaxa'ðoɾ-es] (only)	'workers'

The question at hand is how to formulate a rule that applies both preconsonantally and finally. An analysis occasionally proposed uses so-called **curly brackets**. These are a notational device that denotes the logical notion "or":

Cibaeño Liquid Gliding (with curly brackets)

$$\begin{bmatrix} +\text{sonorant} \\ +\text{consonantal} \\ +\text{continuant} \end{bmatrix} \rightarrow \text{j} \;/\; \_\_\_ \begin{Bmatrix} \text{C} \\ ]_{\text{word}} \end{Bmatrix}$$

Liquids are converted to [j] *if they precede a consonant or are word-final.*

Many linguists have expressed the view that curly brackets offer little or no insight into linguistic phenomena, since they evade the question of what the two listed environments might have in common. For the many cases like Cibaeño Liquid Gliding, a widely adopted alternative solution is to suppose that the environment is *syllable-final*, as follows.

Cibaeño Liquid Gliding (syllable-based version)

$$\begin{bmatrix} +\text{sonorant} \\ +\text{consonantal} \\ +\text{continuant} \end{bmatrix} \rightarrow \text{j} \;/\; \_\_\_ \;]_{\sigma}$$

Liquids are converted to [j] *in syllable-final position.*

In other words, the neutralization of liquids occurs in codas.

[2] No examples of initial [ɾ] are given because this phoneme is excluded from initial position in Spanish; only the trill [r] may occur in this location.

Here are derivations for the relevant forms.

/bolbeɾ/ [bol]$_\sigma$[beɾ]$_\sigma$		/limite/ [li]$_\sigma$[mi]$_\sigma$[te]$_\sigma$	/koɾason/ [ko]$_\sigma$[ɾa]$_\sigma$[son]$_\sigma$	underlying forms syllabification
[boj]$_\sigma$[bej]$_\sigma$	—	—	—	Liquid Gliding (optional)
[boj]$_\sigma$[βej]$_\sigma$	[bol]$_\sigma$[βeɾ]$_\sigma$	—	—	Spirantization (see pp. 33, 42 above)
[boj]$_\sigma$[βej]$_\sigma$	[bol]$_\sigma$[βeɾ]$_\sigma$	[li]$_\sigma$[mi]$_\sigma$[te]$_\sigma$	[ko]$_\sigma$[ɾa]$_\sigma$[son]$_\sigma$	surface forms

The syllabification analysis treats the two cases of gliding in a unified way. In /bolbeɾ/, the first liquid /l/ is made syllable-final because it cannot form an onset with the following syllable (no Spanish syllable begins with [lC]), and of course the utterance final consonant /ɾ/ is necessarily syllable-final as well.

The Cibaeño case is one of many in which a phonemic distinction is "dynamically" neutralized in codas, resulting in alternation. There are also many cases where the restriction is static (for the dynamic/static distinction, see §6.3). In Mandarin Chinese, about 20 distinct consonants are allowed in onsets, but only two or three (/n/, /ŋ/, and in some dialects /ɻ/) are permitted in codas. There are no alternations, because Mandarin underlying forms already conform to these restrictions.

13.6.3 Fortition and lenition

Phonological rules often alter onset consonants so that they have a tighter constriction in the vocal tract. Such changes are often described as **fortition**, literally "becoming stronger." In some cases, fortition is a small effect that produces only subtle allophones. For example, in an English word like *none*, the first (onset) /n/ is given tighter articulatory closure than the second (coda) /n/, but the difference is so small there is no standard way to depict it in IPA transcription. A similar example mentioned above concerns the English phoneme /d/, which has a very slightly affricated allophone [dʒ] before /w/ – but only when it is in onset position: compare *Duane* [dʒweɪn]$_\sigma$ with *Edward* [ɛd]$_\sigma$[wɚd]$_\sigma$.

In other languages, onset fortition can be most noticeable. In the Porteño dialect of Spanish (Buenos Aires), the glide /j/ in onset position is realized as a fricative [ʒ]; that is, it retains the same general place of articulation, but acquires a much tighter closure. In coda, [j] appears.

Porteño Spanish Glide Fortition
j → ʒ / [$_\sigma$ ___ (= syllable-initially)
Realize /j/ *as* [ʒ] *when it is syllable-initial.*

Glide Fortition gives rise to alternations in nominal paradigms. The plural suffix /-es/, attached to the end of a consonant-final noun, causes the noun-final consonant to become an onset, following the rule of Onset Formation. As a result of these syllabifications, Glide Fortition applies in the plural but not the singular, producing alternations like the following.

/lej/ → [lej]	'law'	/lej-es/ → [le**ʒ**es]	'laws'
/komboj/ → [komboj]	'convoy'	/komboj-es/ → [kombo**ʒ**es]	'convoys'
/uɾugwaj/ → [uɾuɣwaj]	'Uruguay'	/uɾugwaj-o/ → [uɾuɣwa**ʒ**o]	'Uruguayan'
/bwej/ → [bwej]	'ox'	/bwej-eɾo/ → [bwe**ʒ**eɾo]	'ox driver'
/rej/ → [rej]	'king'	/rej-eswelo/ → [re**ʒ**eswelo]	'king-diminutive'

The application of Glide Fortition in the paradigm of "law" is shown below.

The crucial aspect of these derivations is that syllabification applies to the output of morphology, just like the rest of phonology does. Thus the /j/ alternates between coda and onset position, and therefore between surface [j] and [ʒ].

Contrariwise, coda consonants often are modified to achieve a looser degree of closure. Thus in English casual speech, coda /l/ can optionally lose its alveolar closure in codas, but not in onsets; e.g. in *tell* or *helping*, but not in *let*. (In IPA this might be transcribed with the symbol [ɣ̟]; hence ['tɛɣ̟], ['hɛɣ̟pɪŋ] vs. ['lɛt].) This process also creates alternations; the /l/ of *tell* can be non-alveolar, but the /l/ of *telling* ['tɛlɪŋ] must have alveolar closure.

Weakening of closure, which is the opposite of fortition, is called **lenition**. It occurs commonly in codas.[3]

13.6.4 Deletion in codas

A natural extension of lenition is deletion, which, as we would by now expect, often targets coda consonants but leaves onset consonants intact. A well-known example is found in the phonology of French, where nasal consonants delete in codas, but not in onsets. This produces nasal ~ zero alternations such as the following.

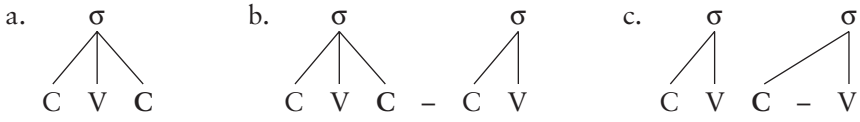
[3] Lenition is also common in intervocalic position. Examples from this book are Maasai Spirantization (p. 42), Spanish Spirantization (p. 42), and English Tapping (p. 143).

‘good-masc.’	‘goodness’	‘good-fem.’	
/bɔn/	/bɔn-te/	/bɔn-ə/	underlying forms
$[bɔn]_σ$	$[bɔn]_σ[te]_σ$	$[bɔ]_σ[nə]_σ$	syllabification
$[bɔ̃n]_σ$	$[bɔ̃n]_σ[te]_σ$	—	**Nasalization:** $V \rightarrow [+nasal] / \_\_\_ \begin{bmatrix} -syllabic \\ +nasal \end{bmatrix}]_σ$
$[bɔ̃]_σ$	$[bɔ̃]_σ[te]_σ$	—	**Nasal Deletion:** $\begin{bmatrix} -syllabic \\ +nasal \end{bmatrix} \rightarrow ∅ / \_\_\_]_σ$
—	—	$[bɔn]_σ$	**Schwa Deletion:** $ə \rightarrow ∅ / \_\_\_]_{word}$
$[bɔ̃]_σ$	$[bɔ̃]_σ[te]_σ$	$[bɔn]_σ$	surface form

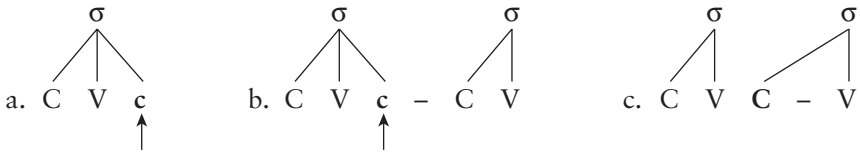
It should be noted that the underlying forms above are rather abstract, and are controversial; see Further reading. However, at the very least the derivation above represents how the alternations originally arose, so the basic point about deletion in codas vs. onsets holds in any event.

13.6.5 A general pattern in syllable-based alternation

The alternations treated in the previous three sections have a similar character. Here is a description of this pattern in general terms. Suppose that a language has stems that end in consonants and suffixes that begin with vowels. In such a situation, a stem-final consonant will have a special status, namely of *alternating in its syllable position*. Where the stem stands alone ((a) below), or followed by a consonant-initial affix ((b)), then Coda Formation will normally place that consonant in coda position. But when the stem precedes a vowel-initial suffix, as in (c), Onset Formation will normally apply. In the diagrams, the crucial stem-final consonant is shown in bold.



If there is a rule of lenition, deletion, or neutralization that applies in codas, it will affect segments marked with an arrow in the diagrams below. The application of any such rule is shown with lower case:



The result will be that the stem alternates, the two allomorphs being [CVc] and [CVC].

An instance of "CV**c**" from the Cibaeño example above would be [mu'xe**j**], "CV**C**" being [muxe**ɾ**(-es)]. Here, "c" stands for the neutralization of distinctions among liquids and [j]. In French, "CV**c**" is /bɔn/ → [bɔ̃], "CV**C**" is [bɔn(ə)], and "c" stands for deletion. The pattern also occurs, in slightly different form, in the Porteño Spanish example of §13.6.2. The Porteño rule is a fortition rule that affects only onsets; but the data pattern that results is the essentially the same.

This pattern is the basis of phonological alternations in a great many languages.

13.7 Syllables and Derivations: Vocalic Epenthesis

Many rules that epenthesize vowels can be analyzed in terms of the syllable structure of the language they occur in. Vocalic epenthesis often makes it possible to syllabify consonants that otherwise could not be syllabified.

Consider the following data from Yawelmani Yokuts, a Penutian language of Northern California. The first row gives four partial verb paradigms, and the second gives the same stems in the form of unaffixed verbal nouns (for morphological conversion processes of this sort, see §5.2).

'Might V'	**'Future II'**	**Nonfuture**	**'Having V'ed'**	**'Future I'**	
[pʰaʔtʰ-al]	[pʰaʔtʰ-ɛn]	[pʰaʔitʰ-hin]	[pʰaʔitʰ-mi]	[pʰaʔitʰ-nitʰ]	'fight'
[ʔilkʰ-al]	[ʔilkʰ-ɛn]	[ʔilikʰ-hin]	[ʔilikʰ-mi]	[ʔilikʰ-nitʰ]	'sing'
[lihm-al]	[lihm-ɛn]	[lihim-hin]	[lihim-mi]	[lihim-nitʰ]	'run'
[ʔajj-al]	[ʔajj-ɛn]	[ʔajij-hin]	[ʔajij-mi]	[ʔajij-nitʰ]	'pole a boat'

Verbal nouns

[pʰaʔitʰ]	'fighting'
[ʔilikʰ]	'singing'
[lihim]	'running'
[ʔajij]	'poling a boat'

These verb stems alternate: an allomorph of the form CVCC occurs before vowel-initial suffixes such as [-al] and [-ɛn], and an allomorph of the form CVCiC occurs before consonant-initial suffixes such as [-hin], [-mi], and [-nitʰ], as well as word-finally as in the verbal nouns. In general, all vowel ~ zero alternations of this type in Yawelmani involve the vowel /i/, which suggests that the alternation is due to epenthesis, not syncope; if it were syncope, we would expect all of the Yawelmani vowels to participate.

Using curly brackets, as in the Cibaeño example above (p. 259), an epenthesis rule can be formulated that derives the correct pattern:

Yawelmani Epenthesis (first version)

$\varnothing \rightarrow$ i / C ___ C$\left\{\begin{matrix} \text{C} \\ ]_{\text{word}} \end{matrix}\right\}$

Insert the vowel [i] *in second position in a triple consonant cluster, or between two word-final consonants.*

This would apply as shown below:

/pʰaʔtʰ+al/	/pʰaʔtʰ+hin/	/pʰaʔtʰ/	underlying forms
—	pʰaʔitʰhin	pʰaʔitʰ	Epenthesis
[pʰaʔtʰal]	[pʰaʔitʰhin]	[pʰaʔitʰ]	surface forms

There are two reasons why rules formulated in this way have struck many phonologists as unsatisfactory. First, as with the Cibaeño Liquid Gliding case, the rule makes no connection between the two cases listed in the curly brackets. Second, the rule does not take account of Yawelmani syllable structure. In fact, all Yawelmani syllables begin with a single consonant, and end with up to one consonant. The underlying representations that undergo Epenthesis are precisely the ones that *could not be syllabified*, under these limitations.

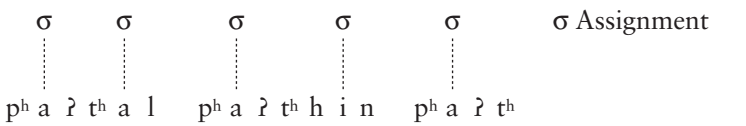
An alternative is to let the principles of syllabification do most of the work for us. The idea is that syllabification incorporates whatever it can, then Epenthesis provides a vowel to permit syllabification of the remainder.

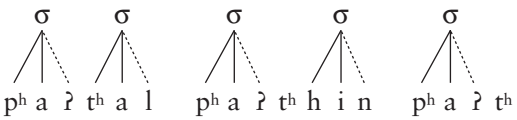
To do this, we must state proper rules of Onset Formation and Coda Formation for Yawelmani, which forms onsets and codas of just one consonant.

Onset Formation (Yawelmani)
Join a single consonant to the following syllable.

Coda Formation (Yawelmani)
Join a single unaffiliated consonant to the preceding syllable.

As before, Onset Formation must precede Coda Formation, forcing the syllabification $[V]_{\sigma}[CV]_{\sigma}$ for /VCV/. Assuming these rules, the forms under examination would be syllabified as follows.





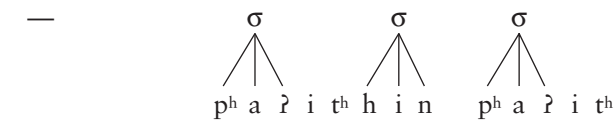
Coda Formation

The result is that there are still consonants (the [tʰ] in the second and third forms), that are as yet unaffiliated with any syllable; such consonants are normally referred to as **stray**.

We now suppose that Epenthesis is formulated to repair any consonants that are left stray following the initial application of syllabification. The rule that is needed can be expressed as follows; the notation C′ indicates an unsyllabified consonant.

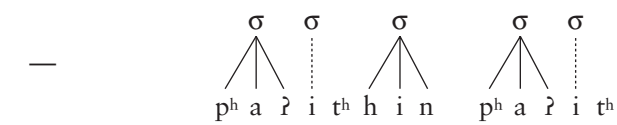
Yawelmani Epenthesis (syllabic version)
∅ → i / ___ C′
Insert [i] *before a stray consonant*.

Since only the last two representations above include unsyllabified consonants, only they trigger Epenthesis:

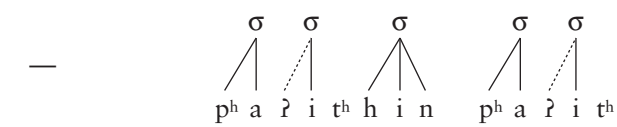


Epenthesis

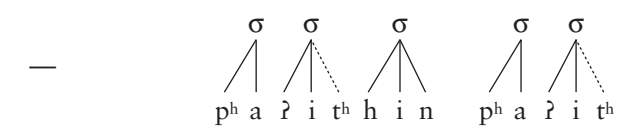
Since syllabification rules are persistent, they will reapply as shown below, establishing the normal syllabification on the surface:



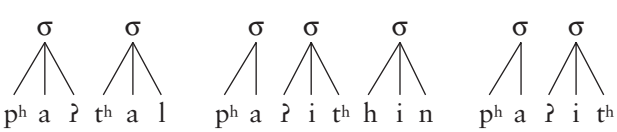
σ Assignment



Onset Formation



Coda Formation



surface forms

It is claimed here that the revised version of Epenthesis is an improvement, for two reasons. First, it unifies the two separate environments of the earlier rule into a single environment. Second, it establishes a connection between the syllabification principles of Yawelmani and the epenthesis pattern – epenthesis renders consonants syllabifiable if they would otherwise not be.

Other epenthesis processes in other languages further support the claimed connection between syllable structure and epenthesis. For instance, both Turkish and Modern Hebrew (chapter 12, Further reading, p. 249) have epenthesis processes that are more complex than that of Yawelmani: they apply only where they produce a well-formed sonority profile, in line with the sonority sequencing restrictions (§4.4.1) observed in these languages.

13.8 Other Remedies for Unsyllabifiable Consonants

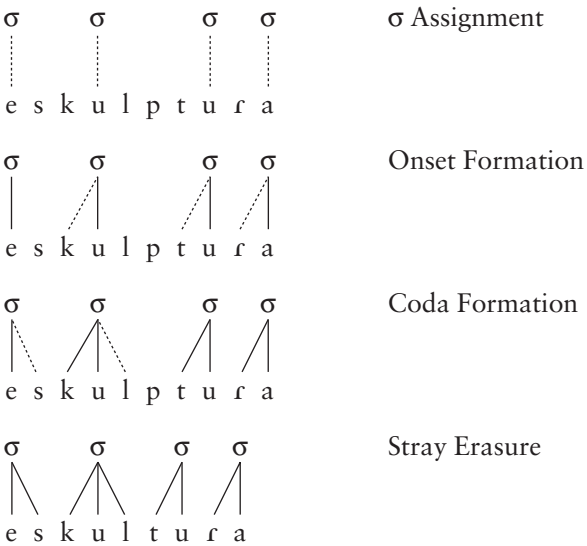
The requirement that every consonant belong to some syllable drives other phonological processes as well.

A close relative of vocalic epenthesis is the family of rules that change [–syllabic] sounds to the corresponding [+syllabic] sounds. Such rules can apply to glides (**glide vocalization**; j → i, w → u), as well as to liquids (l → l̩, r → r̩) and nasals (m → m̩, n → n̩). Thus in English, alternations like *central* ~ *center* ['sɛntɹəl] ~ ['sɛntɻ] plausibly reflect an underlying form /sɛntɹ/, which is retained intact in *central*, where the result can be syllabified ([sɛn]$_\sigma$[tɹəl]$_\sigma$), but replaces the /ɹ/ with its [+syllabic] counterpart [ɻ] (usual IPA transcription: [ɚ]) when the result would not form a legal syllable (*[sɛntɹ]).

In other cases, a language actually sacrifices a consonant where it would not fit into the syllabic pattern. For example, in Spanish the verb *esculpir* [eskul'piɾ] 'to sculpt' consists of the stem /eskulp/ plus the third conjugation infinitive ending /-iɾ/. With the suffix *-tura*, this stem would produce the underlying form /eskulp-tuɾa/, which means 'sculpture'. However, the corresponding surface form is actually [eskultuɾa], with loss of the underlying /p/. This can be understood as the loss of a segment that cannot be incorporated into either neighboring syllable: /lp/ is not a legal coda of Spanish, nor is [pt] a possible onset. The rule that would be needed is something like the following:

Stray Erasure
C′ → ∅
Delete a stray consonant.

Here is a schematic derivation for [eskultuɾa]:



This can only be considered a schematic derivation, since in a full version we would have to provide versions of Onset Formation and Coda Formation that produced all and only the legal onsets and codas of Spanish. The general point at hand is that the loss of /p/ in [eskultuɾa] is related to the general principles of syllable well-formedness in Spanish.

In sum, a frequently followed course in phonological analysis is to set up the syllabification system as an overarching set of well-formedness principles, expressed here through the persistent application of σ Assignment, Onset Formation, and Coda Formation. The segmental rules of the language shoehorn the underlying forms, by means of insertion, vocalization, and deletion, into the legal syllabic forms.

Exercises

1 English /ʌl/ coalescence

In some English dialects the sequence /ʌl/ is optionally realized as syllabic [l̩] in certain environments. Here are relevant data.

dull	['dʌl] or ['dl̩]	*Culver*	['kʌlvɚ] or ['kl̩vɚ]
null	['nʌl] or ['nl̩]	*Mulholland*	[mʌl'hɑlənd] or [ml̩'hɑlənd]
hull	['hʌl] or ['hl̩]	*bulky*	['bʌlki] or ['bl̩ki]
color	['kʌlɚ] only		
Cullen	['kʌlən] only		
Tuller	['tʌlɚ] only		

a. Apply the rules given in the readings to syllabify all the underlying forms above.
b. State a rule for /ʌl/ → [l̩]. To write a rule that is undergone by two segments, merging them into one, use the numerical subscripts shown in fn. 9, p. 101, and let one of the sounds become zero.
c. Give derivations, including the initial syllabification stage, of *dull*, *Culver*, and *color*.

2 *Distribution of English Consonants*

English /w/ may occur in onsets but not codas, as shown by the following examples:

- Onsets: *will* [wɪl], *twin* [twɪn], *away* [ə.weɪ]
- Not codas: no words like *[piw], *['piw.lə][4]

Examine all of the English consonants (see chart on p. 21) and assess each for whether it can occur in onsets, codas, or both. Give examples in the same format as just given. You should be able to find three consonants (including /w/) that are limited to onsets, and one consonant that is limited to codas.

3 *Allophones of German /ʁ/*

In one variety of German, the voiced uvular fricative [ʁ] is in complementary distribution with a voiced uvular approximant, which will be described with the IPA symbol [ʁ̞]. For the features of [ʁ] see p. 96; you may assume that [ʁ̞] differs from [ʁ] in being [–consonantal, +sonorant, +approximant].

a. Produce a phonemic analysis for these two sounds, following the method given in chapters 2 and 3. Your analysis should make use of syllable structure, as discussed in this chapter. Include derivations for the forms ['ʁoːt], [pɑʁɑ'diːs], ['ɪʁ̞], ['fyːʁ̞-t], and ['ɑʁ̞baɪt].

In the data, hyphens are included to help with the meanings; they can be ignored for purposes of syllabification and the allophone environments.

[4] Some textbooks use /w/ as a transcription for the second part of the diphthongs [oʊ] and [aʊ], as in "[ow]" or "[aw]." It is assumed here that this is not a phonologically valid transcription, since if /w/ were generally able to occur in codas we would expect there to be cases like *[iw], *[ew], *[ɛw], etc.

Forms with [ʁ]		*Forms with* [ɐ̯]	
['ʁoːt]	'red'	['ɪɐ̯]	'delusion'
['ɪʁ-ə]	'be mistaken-1 sg. pres.'	['ɪɐ̯-t]	'be mistaken-3 sg. pres.'
['leːʁ-ə]	'empty-fem./plur.'	['leːɐ̯]	'empty'
['bɛsəʁ-ə]	'better-fem./plur.'	['fiːɐ̯]	'four'
['ʁaʊx]	'smoke'	['fyːɐ̯]	'for'
['bɪtəʁ-ə]	'bitter-fem./plur.'	['oːɐ̯]	'ear'
['vandəʁ-ə]	'wander-1 p. sing.'	['fyːɐ̯-t]	'lead-3 sg. pres.'
['ʁuːə]	'rest'	['fyːɐ̯-tə]	'lead-3 sg. past'
['ʁaɪn]	'Rhine'	['vɑɐ̯t-ə]	'wait-1 sg. pres.'
['dʁai]	'three'	['vɛɐ̯k-ə]	'work-plur.'
[pɑʁɑ'diːs]	'paradise'	[pɑɐ̯'taɪ]	'party'
['eːʁɑ]	'era'	['ɑɐ̯baɪt]	'work'
['bʁaɪt]	'broad'	['ɔɐ̯dnʊŋ]	'order'
['fyːʁ-ə]	'lead-1 sg. pres.'		
[leo'noːʁə]	'Leonore'		
[mɑ'ʁiːnə]	'navy'		

b. Add an additional rule to cover these data. The clue is to look for the same stems above as they appear with vowel-initial suffixes.

['bɛsʌ]	'better'
['bɛsʌ-t]	'make better-3 sg. pres.'
['bɪtʌ]	'bitter'
['vandʌ-t]	'wander-3 sg. pres.'

Further reading

The account of syllabification based on ordered rules of consonant adjunction is taken from Daniel Kahn (1976) "Syllable-based generalizations in English phonology," MIT PhD thesis (https://dspace.mit.edu). A set of rules needed to form English onsets can be found in George N. Clements and S. Jay Keyser, *CV Phonology: A Generative Theory of the Syllable* (1983, MIT Press).

The idea that syllabification rules syllabify what they can, letting further rules deal with stray consonants, is from James Harris, *Syllable Structure and Stress in Spanish* (1983, MIT Press). The *escultura* example is taken from this source. The general idea that phonological processes have the goal of making underlying representations conform to general structural principles on the surface (§13.7, §13.8) has been extensively elaborated in Optimality Theory; for readings in this area see p. 68.

Barra Gaelic (phonemic syllable division): George N. Clements, "Syllabification and epenthesis in the Barra dialect of Gaelic," in K. Bogers, H. van der Hulst and M. Mous, eds., *The Phonological Representation of Suprasegmentals* (1986, Foris). Cibaeño Spanish Liquid Gliding: Rafael Nuñez-Cedeño (1997) "Liquid gliding in Spanish and feature geometry theories," *Hispanic Linguistics* 9: 143–64. Efik (phonemic syllable division): William E. Welmers, *African Language Structures* (1973, University of California Press). French nasal vowels: Sanford Schane, *French Phonology and Morphology* (1968, MIT Press); Bernard Tranel *Concreteness in Generative Phonology: Evidence from French* (1981, University of California Press). Ilokano syllabification: Bruce Hayes and May Abad (1989) "Reduplication and syllabification in Ilokano," *Lingua* 77: 331–74. Porteño Spanish fortition: James Harris and Ellen Kaisse (1999) "Palatal vowels, glides and obstruents in Argentinian Spanish," *Phonology* 16: 117–90. Tonkawa syncope: Harry Hoijer "Tonkawa," in Harry Hoijer et al., eds., *Linguistic Structures of Native America* (1946, Viking Fund). Yawelmani epenthesis: Stanley Newman, *Yokuts Language of California* (1944, Viking Fund).