Phonology

We saw in the previous chapter that phonetics is the sub-field of linguistics concerned with the description of speech sounds. The sub-field known as phonology is concerned with how these sounds are systematically organized in a language, how they function in a language, how they are combined to form words, how they are categorized by, and interpreted in, the minds of speakers. Put simply, phonology is the study of the sound patterns of language, how speech sounds are grouped by speakers to effect communication. Yule (2000) claims that phonology is essentially the description of the systems and patterns of speech sound in a language. Then, phonology is concerned with the abstract or mental aspect of the sounds in language rather than with the actual physical articulation of speech sounds. Phonology is about the underlying design, the blueprint of each sound type, which serves as the constant basis of all the variations in different physical articulations of that sound type in different contexts.
Phoneme: The Phonological Unit of Language

Phoneme is the smallest meaning-distinguishing sound unit in the abstract representation of the sounds of a language. Slash marks are conventionally used to indicate a phoneme, /p/, an abstract segment, as opposed to the square brackets, as in [p], used for each phonetic or physically produced segments. An essential property of a phoneme is that it functions contrastively. For example, there are two phonemes /f/ and /v/ in English because they are the only basis of the contrast in meaning between the word *fat* and *vat* or *fine* and *vine*. This contrastive property is the basic operational test for determining the phonemes that exist in a language. If we substitute one sound for another in a word and there is a change of meaning, then the two sounds represent different phonemes.

Consider the following English words:

- *sip*  
  - *chunk*
- *zip*  
  - *junk*

Each word differs from the other words in both form and meaning. The difference between *sip* and *zip* is signaled by the fact that the initial sound of the first word is [s] and initial sound of the second word is [z]. The forms of the two words—that is, their sounds—are identical except for the initial consonants. [s] and [z] can therefore distinguish or contrast words. They are distinctive sounds in English. Such distinctive sounds are called **phonemes**. Phonology tells us that they function as phonemes, acting to contrast words.

Phone and Allophone

The phoneme is the abstract segment or sound type (‘in the mind’). There are many different versions of that sound type regularly produced in actual speech (‘in the mouth’). We can describe those different versions as **phones**. Phones are phonetic units and appear in square brackets. When we have a group of several phones, all of which are versions of one phoneme, we add the prefix ‘allo-‘ (=one of closely related set) and refer to them as **allophones** of that phoneme.
For example, the sounds we have indicated as [p] really comes in different varieties in English. One of these types, indicated by [pʰ], occurs in words such as *pill* and *peace*. This p-sound is produced with an accompanying puff of air called *aspiration*. In pronouncing another major p-sound, indicated by [pʹ], there is little or no aspiration; this sound occurs in a word like *spill*. A third major p-sound, indicated by [pˉ], is unreleased p which may occur at the end of a word like *stop*. To deal with these p-sounds, the linguists suggested the existence of an abstract p, which they termed the *phoneme* /p/. (In referring to phonemes, slashes are used). A *phoneme* was defined as an abstract phonological unit that represents class of real sounds, termed the *allophones* of a phoneme. The /p/ in English, then, is represented by the allophones [pʰ], [pʹ], and [pˉ] representing the p-sounds in *pill*, *spill*, and *stop*.

Let’s look at another example. The [t] sound in the word *tar* is normally pronounced with a stronger puff of air than is present in the word *star*. If you put the back of your hand in front of your mouth as you say *tar* and *star*, you should be able to feel some physical evidence of *aspiration* (the puff of air) accompanying the [t] sound at the beginning of *tar*, (but not in *star*). This aspirated version is represented more precisely as [tʰ]. That is one phone. In the pronunciation of a word like *eight* [eİt], the influence of final dental
The [T] sound causes a dental articulation of the [t] sound. This can be represented more precisely as [t5]. That’s yet another phone. Because these variations are all part of one set of phones, they are typically referred to as allophones of the phonemes /t/, as shown in the following diagram:

<table>
<thead>
<tr>
<th>Phoneme</th>
<th>allophones</th>
</tr>
</thead>
<tbody>
<tr>
<td>/t/</td>
<td>[t], [t5], phone</td>
</tr>
</tbody>
</table>

The crucial distinction between phoneme and allophones is that substituting one phoneme for another will result in a word with different meaning (as well as different pronunciation), but substituting allophones only results in a different (or perhaps unusual) pronunciation of the same word.

**Phonemic and Phonetic Transcriptions**

Phonemic transcription (also called broad transcription) only shows functional differences, i.e. differences between sounds which are used to distinguish word meaning. It only uses enough symbols to represent each phoneme of the language. Phonetic transcription (also called narrow transcription), on the other hand, is much more detailed and attempts to provide a more faithful representation of speech. It normally represents the allophones of a phoneme that occur in various contexts but can be made to show even finer detail, if necessary.

<table>
<thead>
<tr>
<th>Words</th>
<th>Broad Transcription</th>
<th>Narrow Transcription</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>attend</td>
<td>/ənənd/</td>
<td>[ənəζend]</td>
<td>The raised ⟨ζ⟩ shows ASPIRATION, i.e. there is a slightly delay between the release of the stop [t] and the onset of voicing in the vowel [e]. An aspirated stop is released with greater force than an unaspirated one</td>
</tr>
<tr>
<td>two</td>
<td>/tw/</td>
<td>[tw]</td>
<td>The raised ⟨η⟩ shows lip-</td>
</tr>
</tbody>
</table>

[Image 161x129 to 451x134]
rounding (the speaker starts rounding the lips before the production of [t] is completed in anticipation of the vowel [u] which is made with rounded lips.

| eight  | /eitT/  | [eit5T] | The subscript (5) marks dental sounds; here, in anticipation of the dental fricative [T], the tongue make contact with the upper front teeth rather than the alveolar ridge.
| seat   | /si:t/  | [si/t] | The symbol [/] marks pre-glottalization. There is glottal reinforcement—with a glottal stop coinciding with or slightly anticipating the allophone of /t/ that occurs in word final position. The airstream is simultaneously obstructed at two points like a river dammed at two points. In some accents the word ends in an glottal stop, with no [t] element at all.

The various [t] sounds are in complementary distribution, each one has got its special contexts in which it occurs. They are allophones of the phoneme /t/.

In order to describe the allophones of a phoneme or to make a narrow phonetic transcription you will need to know various DIACRITICS devised by phoneticians for this purpose. An annotated list of common diacritics is provided in the table below:

|     | VOICELESS | This indicates that a segment type that is normally fully voiced is fully or partially devoiced (in English, word final voiced stop like /g/ are realized as [ŋ] as in bug /bŋg/).
| ☞   | ASPIRATED | For example, [pɛs tɛs kɛs]. This indicates that a segment is aspirated (e.g. voiceless stops in English are aspirated when they occur at the beginning of a stressed syllable in words like [kɛsθend], [pɛset] and [kɛθt].

# Table of Common Diacritics

| 8   | VOICELESS | This indicates that a segment type that is normally fully voiced is fully or partially devoiced (in English, word final voiced stop like /g/ are realized as [ŋ] as in bug /bŋg/).
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Ω LABIALISED For example, [pΩ tΩ kΩ]. It indicates labialization (lip rounding), e.g. non-labial consonants followed by round vowels are labialized in English words like [tΩu:] two and [kΩu:l] cool.

¬ SYLLABIC Example (syllabic) [l] and [n]. It indicates that a consonant functions as syllable nucleus (e.g. in English the nasals and [l] are syllabic when they occur at the end of a word if they are preceded by another consonant as in [ketl] kettle and [kZtn] cotton.

+ FRONTED Velar is made with the blade of the tongue moved forward close to the hard palate when it is followed by a front vowel as in [k+i:] key.

~ NASALIZED It indicates that air escapes through the nose as in [pΘn] pan.

: LONG It shows that a segment is long (e.g. the vowel in the word see [si:]).

Minimal Pairs and Complementary Distribution

How do we know what these abstract units of sound called phonemes are? In order to find the phonemes of language, the linguists, especially structuralists, developed the concept of minimal pairs. A first rule of thumb to determine the phonemes of any language is to see whether substituting one sound for another results in different word. If it does, the two sounds represent different phonemes. Any two words are called as minimal pairs when they:

(i) have the same number of segments
(ii) differ in meaning
(iii) exhibit only one phonetic difference that occurs in the same place in the string

In such cases, this one phonetic difference indicates that two separate phonemes are involved. Thus, in practical term, phonemes distinguish meanings; and phoneme can also be defined as the smallest meaning distinguishing unit of sound. For instance, the word pin and bin mean different things, and only difference in these words occurs in the initial sounds. Thus, minimal pairs demonstrate the existence of the phonemes /p/ and /b/. The pair of words pin and ban, on the other hand, differs in more than one sound, and, therefore, does not represent a minimal pairs.
By using the concept of a minimal pair, we can determine that the three \( p \)-sounds do not represent three phonemes. Certainly, it is possible to pronounce the word *cap* with either an aspirated or unreleased \( p \), \([p^h]\) or \([p^-]\); however, the two forms \([\text{kæp}^h]\) and \([\text{kæp}^-]\) are not minimal pair, eventhough they involve different sounds, because they are identical in meaning. These two \( p \)-sounds are therefore said to exhibit **free variation**; that is, the pronunciation may vary without signifying a change in meaning. One concludes that the unreleased \( p \) and the aspirated \( p \) are not representations of different phonemes in English but are, in fact, allophones of one phoneme, /\( p /\).

Every phoneme has at least one allophone; some have more. In English, /\( f /\) and /\( s /\) are examples of phonemes having only one allophones. When phonemes have more than one allophone in a language, that allophone are said to be in complementary distribution. **Complementary distribution** means that the allophones of a particular phoneme occur in different phonetic environment (that is, with different sounds surrounding them). In other words, the phonetic environment determines which of the allophones of /\( p /\)–\([p^h]\), \([p^-]\), and \([p^-]\)–are in **complementary distribution**. The \([p^h]\) occurs before stressed vowels, as in *pat*, or *pot*; a \([p^-]\) occurs in all environments, and a \([p^-]\) may occur at the end of the word, as in *hip*. The fact of their complementary distribution means that these allophones do not occur in minimal pairs in English.

**Phonemic Analysis**

1. **Allophonic Rules**

   In earlier discussion of phonemes and allophones, we claimed that allophones are predictable realizations of phonemes, and as such their occurrences can be expressed formally by rule. These rules that link an abstract phoneme to its allophonic realizations are called **allophonic rules**.
The form of allophonic rules may be best illustrated by an example:

(Context)

\[ /t/ \rightarrow [t'] \quad / \quad / \quad _3 \]

(input) (output) (Conditioning factor)

This rule tells us that the phoneme /t/ is realized by its palatalized allophone when it occurs before palatal approximant. Like all allophonic rules, this rule may be divided into two halves, which are separated from each other by a slash—/. We shall refer to the first half, on the left side of the slash, as the process side. On the process side of the rule we find the input segment to the rule and its input—in this case [t] and [t']. The part of the rule to the right of the slash specifies the context in which the rule operates and gives the conditioning factor. In this example the allophone occurs before a palatal approximant which is the conditioning factor.

The process side of any allophonic rule is basically:

\[ /X/ \rightarrow [Y]/ \]

that is, phoneme X is realized as allophone Y.

The context of the rule may be quite complex, and there are three basic possibilities.

a. the conditioning factor may occur to the right of the input phoneme:
This possibility is illustrated by palatalization of /t/ discussed above.

b. the conditioning factor may precede the input:

As an example, consider the realization of /t/ in *bathtap*. In this sequence /t/ may be dentalised under the influence of the preceding dental. We can capture this in the following rule:

/t/ \rightarrow [t5]/T___

c. the input phoneme occurs between two conditioning factors

In some varieties of English /t/ and /d/ are realized between vowels as an alveolar tap—[ ]. If we take /s/ as input, then the rule for this process would be:

/t/ \rightarrow [ ]/ V___ V (where V = any vowel)

In each of the example above, the process applies in a single context. If a process applies in two (or more) contexts do we write two rules or can we still write a single rule?

Consider dentalised and unreleased allophones of /t/. /t/ is dentalised when is followed by a dental fricative, for example *eighth* [e0t5t]. However /t/ is also dentalised if it is word-final and the next word begins with a dental fricative, for example in *not think* [nZt5t0Nk]. Dentalization occurs both within a word and over word boundaries. This gives us two rules:

/t/ \rightarrow [t5]/ ____ T
/t/ \rightarrow [t5]/ ____ #T

(# = word boundary)
In both of these rules the process is the same: only the context is different. We can collapse these two rules into one by isolating the common material—in this case the process and part of the environment, and then by placing the non-overlapping part of the contents inside curved brackets or parentheses:

/t/ \rightarrow [t\varsigma] / ___ (#)T

The material inside the brackets is optional. It may or may not be present. The rule states that /t/ is realised by its dentalised allophone when it is followed by a voiceless dental fricative, and when it is followed by word boundary and a voiceless dental fricative.

2. Allophonic Processes

In the following, we will consider various sorts of allophonic processes. They are aspiration, assimilation, elision, insertion (epenthesis) and fusion.

a. Aspiration

In English, one allophone of the voiceless stop is aspirated. Although the environment in which aspirated stops occur is more complex than that of [t\varsigma], it is possible to write a rule which predicts where these allophones will occur. Concentrating on the voiceless alveolar stop /t/, consider the following words:

The /t/ in ten [t\varsigma en] is aspirated, whereas in stem [stem] it is not. You can test this for yourselves. Put your hand close to your mouth and utter both words. You should feel a small puff of air on your hand when you release the /t/ in ten but not in stem. Based on these two words, it would appear that for /t/ to be aspirated it must appear in initial position in a word. We might posit as our rule that /t/ is realized as [t\varsigma] if it occurs in initial position in a word. Formally, this would be stated as:

/t/ \rightarrow [t\varsigma] / # ___

However, now consider attack. This contains [t\varsigma] but not in initial position. This violates our initial hypotheses. How might we rescue our hypotheses? We could simply add the new
environment to our rule. However, that would suggest that aspiration of initial and non-initial stops is unrelated. It is unlikely that the same process would be triggered by two unrelated environments. Any solution should attempt to capture what ever is common to both the non-word initial aspirated stop the word-initial ones. What do the stops in *ten* and *attack* share? It could be the case that */t/* is aspirated only when followed by a front vowel. If we divide the word *attack* into syllables, we would find that it contains two syllables, with the dividing line falling between the initial vowel and the first consonant. Now, although */tɕ/* *attack* does not occur word-initially, it does occur syllable-initially. Given that *ten* is a single or monosyllabic word, we can now see that syllable-initial position is the common factor, and revise our initial rule. A voiceless stop is aspirated if it occurs in syllable-initial position. Formally this gives:

\[
/*t/ \rightarrow */tɕ/ \quad (\_\_\_\_\_\_\_\text{indicates a syllable boundary})
\]

Finally, consider *tautology*. This word contains two occurrences of */t/* in initial position—in the first and second syllable. In this case, stress is given to */t/* in the second syllable. We can now conclude that a voiceless stop aspirated when it occurs in the final position of a stressed syllable. Formally, this is stated as:

\[
/*t/ \rightarrow */tɕ/ \quad \_\_\_\_\_\text{V} + \text{stress}
\]

b. Assimilation
Assimilation is the modification of a sound in order to make it more similar to some other sound in its neighborhood. The advantage of having assimilation is that it results in smoother, more effortless, more economical transitions from one sound to another. In short, it facilitates the task of speaking.

The process of assimilation is directionality. We can say whether a sound becomes more like either the sound that precedes it or the sound that follows it. If a sound becomes more like the sound that precedes it, the process is called progressive assimilation; if, on the other hand, a sound is modified so that it becomes more like the sound that follows it, the process is called regressive assimilation.
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Consider the words *happen* and *input*. If pronounced and transcribed, we would probably get:

<table>
<thead>
<tr>
<th>Carefully pronunciation</th>
<th>casual speech</th>
</tr>
</thead>
<tbody>
<tr>
<td>happen [hΘp↔n]</td>
<td>[hΘp↔m]</td>
</tr>
<tr>
<td>input [oŋpYt]</td>
<td>[ompYt]</td>
</tr>
</tbody>
</table>

In both examples, the alveolar nasal, /n/, becomes more like the bilabial stop, /p/, by becoming a bilabial nasal, [m]. Furthermore, in both examples the bilabial stop triggers the assimilation, and the alveolar nasal is the segment which changes. All assimilation processes involve at least one segment which is changed and one which is the source of the change. We shall refer to the segment which is changed as the TARGET, and the segment which influence the target as the SOURCE.

Although all assimilation processes involve a source and a target, what may vary is the position of the source in relation to the target. Where the source comes before the target the direction of the influence is from left to right, or forward through the word, (→). This is called PROGRESSIVE ASSIMILATION because the influence progresses forwards through the word. This direction of assimilation is also referred to as ‘perseverative assimilation’—it preserves some aspect of a segment, beyond the segment from which it originates. The first example, *happen*, is an example of progressive assimilation, which may be expressed by the following rule:

\[
/n/ \rightarrow [m]/p^{(source)} \quad (target)
\]

\[
/n/ \text{ is realized as } [m] \text{ when it is preceded by } /p/
\]

The second example, *input*, is an example of regressive assimilation. REGRESSIVE ASSIMILATION is where the source comes after or to the right of the target, and the direction of influence is from right to left, or backwards through the word, (←). This type of assimilation may also be called ‘anticipatory assimilation’ because a segment is altered in a way which anticipates a phonetic property of a segment which
comes later in the word. The rule for this regressive assimilation is:

\[ /n/ \rightarrow [m] / \_ \text{(target)} \_ / \text{p (source)} \]

\[ /n/ \text{ is released as [m] when it is followed by /p/}. \]

There are some types of assimilation processes:

1) **Palatalization**
   - There are two conditions when palatalization happens:
     - When a velar consonant is followed by a front vowel, there occurs some slight anticipatory fronting of the part of the tongue that makes contact with the roof of the mouth. This fronting is indicated by a subscript (,) under the consonant. The effect of the fronting is that the velar consonant is made partly in the palatal region. This process is called PALATALIZATION.
     - For example:
       
       \[
       \text{key } [k+i:] \rightarrow [k:A:k+i:]
       \text{car } [k:A:] \rightarrow [k:A:k+i:]
       \text{keep } [k+i:p] \text{ calm } [k:A:lm] \rightarrow [k+i:pkA:lm]
       \text{give } [\gamma+\omega\nu] \text{ guns } [\gamma \text{ nz}] \rightarrow [\gamma+\omega\nu\gamma \text{ nz}]
       \]
     - These examples tell us that velar consonants [k] and [\gamma] often have slightly palatalized allophones which occur before front vowels because the tongue is raised toward the hard palate in the production of front vowels and speakers anticipate that gesture and start making it before they have completed the articulation of [k] and [\gamma].
     - When alveolar consonant is at the end of a word and followed by another word which begins with an alveo-palatal consonant as in the following examples:
       
       \[
       \text{his shoes } [\h\nuz \Sigma uz] \rightarrow [\h\nuZ \Sigma uz]
       \text{nice shirt } [\nu\alpha\omega \Sigma \in t] \rightarrow [\nu\alpha\omega\Sigma \Sigma \in t]
       \]

2) **Labialization**
   - Labialization refers to the position of the lips during the articulation of a sound. During the articulation of back
rounded vowels, the lips are, of course, rounded. This lip rounding, represented by diacritic (Ω), may spread to adjacent consonants. This gives:

- pool  \[pΩzυ:\]  
- two  \[tΩzυ:\]  
- shoe  \[ΣΩυ:\]

In each case shown the word above is said with some degree of secondary lip rounding. Anticipating the net segment, which is a rounded vowel, the speaker starts rounding the lips before the articulation of the consonant is completed. This assimilation process is called LABIALIZATION or ROUNDING.

3) **Voice assimilation**

This type of assimilation involves phonation, or voice. In assimilations of voice, a sound becomes more like its neighbors by agreeing in voice. Voice assimilation happens in two conditions: plural noun suffix-s and the third singular person present tense suffix-s.

- Consider the regular plural ending in English. It is written as –s, but it may, in fact, be pronounced as [-s] as in *pets* [pets]; or as [-z] as in *bells* [belz] or even as [-əz] as in *roses* [rχζωζ]. The choice is not random. The principle that determines the shape of the suffix is VOICE ASSIMILATION; this suffix must always agree in voicing with the preceding sound.

- This VOICE ASSIMILATION is also applicable to the third singular person present tense suffix-s. It is written as –s, but in the realization, it can be pronounced [s] as in *talks* [tAːks]; [z] as in *needs* [niːdz] and [-əz] as in *teaches* [tiːz].

4) **Place of articulation assimilation**

This type of assimilation refers to the place of articulation of nasal which is predictable from the place of articulation of the consonant that comes after it. In other words, the nasal is called HOMORGANIC with consonant that goes after it i.e. the nasal shares the place of articulation of the following consonants. Hence, the use of the label
HOMORGANIC NASAL ASSIMILATION to refers to this assimilation process. For example:

/in-/ + appropriate ➔ [inχproprọet]
in-/ + plausible ➔ [ωmplọYsọbγl]
in-/ + gratitude ➔ [ωNγretọzYd]

Homorganic nasal assimilation is not an automatic and obligatory rule of English phonology. It applies selectively to certain forms and is not triggered by phonological information alone. The homorganic nasal assimilation rule normally applies to in- but not to un-, except in casual speech where, for example, unkempt and unpleasant may be pronounced [ N kempt] and [ mplezχnt] respectively.

It is interesting that across word boundaries, in fast speech, consonants (especially alveolar ones), can be optionally homorganic with the following consonant, for examples:

bad man [bΘd mΘn] ➔ [bΘh mΘn]
ten men [ten men] ➔ [tem* men]
what car [wZt kΨ] ➔ [wZk* kΨ:]
top ten [tZp ten] ➔ [tZt* ten]

5) Manner of articulation assimilation
This type of assimilation happens when prefix negative in- is attached to words initially with liquid, /l/ or /r/. The nasal of the negative prefix assimilates the manner of articulation features of the liquid so that /n/ becomes [l] before /l/-commencing roots or [r] before /r/-commencing roots. For example:

/in-/ + legal ➔ illegal
/in-/ + licit ➔ illicit
/in-/ + regular ➔ irregular
/in-/ + rational ➔ irrational

However, this alternation is not purely phonetically conditioned since [n] can be followed by [l] or [r] in words such as unloved or unreasonable.
6) Nasalization

Nasalization is a process whereby an oral segment acquires nasality from a neighboring segment. In order to produce a nasal segment, it is necessary to lower the velum (soft palate) and allow air escape through the nose (the lower the soft palate is, the higher will the degree of nasalization be). In English, the velum is usually lowered for only the three nasal stops—[m, n, N]. Nasalization occurs when the velum is lowered during the production of a segment which is not normally nasal. The most common occurrence of nasalization in English is regressive nasalization of vowels in vowel-nasal sequences. For example:

\[
\text{congress} \ [k\zeta V\varsigma \text{res}] \rightarrow [k\zeta Z\varsigma \text{res}]
\]

\[
\text{pan} \ [p\odot Vn] \rightarrow [p\odot \Theta n]
\]

In this example, the nasal is the source and the vowel is the target. The property of nasalization is transferred from the source leftwards to the target giving regressive nasalization. This may be represented by the following rule, where V represents any vowel, N any nasal, with the diacritic (:) to indicate nasalization:

\[
V \rightarrow V\gamma/ \ldots N
\]

c. Fusion

Fusion is a type of assimilation where two segments assimilate to each other. The outcome of this assimilation is a third distinct segment which combines properties of the two assimilating segments. For example,

\[
\text{caught you} \ [k\varsigma :t \varphi u:] \rightarrow [k\zeta :\leftrightarrow]
\]

\[
\text{would you} \ [wYd \varphi u:] \rightarrow [wY\leftrightarrow\leftrightarrow]
\]

In both examples the alveolar stop and following palatal approximants, /\varphi/, fuse to give the voiceless and voiced post-alveolar affricates [±] and [→]. The voice, place, and manner of articulation of the two input segments are combined to form a third segment. The voiced quality of the fused segment is decided by the voice quality of the first consonant. The place of articulation is mid-way between alveolar and palatal, and the
manner of articulation of both the input segments is reflected in the fused segment, which is both a stop and continuant.

d. Elision
Elision is the deletion of a segment normally present in the stream of speech. The most frequently elided consonants in English are /t/ and /d/. For example:

- West Cliff /west klif/ [wesklif]
- Thousand points /ΤΨΥζ↔ν p ω nts/ [ΤΨΥζ↔ν p ω nts]

The elision of a segment may allow an assimilation to occur. For example:

- hand bag /hΘnd bΘγ/ → [hΘnbΘγ] → [hΘmbΘγ]

As well as consonants, vowels may also be elided. This is most obvious in the various contractions found in English, for example, I am → I’m; she is → She’s; do not → don’t. Vowel elision also occurs in other words, for example, bottle /bΖl/ → [bΖl], police /pΖli:s/ → [pli:s] and geography /→i:Ζγθfio] → [→Ζγθfio].

e. Insertion (epenthesis)
It is also possible for segments not normally present in careful speech styles to be inserted. The term for such insertions is epenthesis. Both consonant and vowel epenthesis occur in English. In some dialects of English schwa [↔] is inserted between two consonants. For example:

- film /fωlm/ → [fωlm]
- athlete /ΘΤι:t/ → [ΘΤι:t]
- girl /γorl/ → [γorl]

Distinctive Features
In our discussion of phonology we have established two different but related units—phonemes and allophones. Although both units may described in articulatory terms, for example the phoneme /t/ may be defined by three-term label (stop, alveolar and voiceless), many phonologists have considered phonemes to be indivisible. They were the smallest unit with which many phonologists worked. However,
other phonologists proposed that the phonemes were very simply cover symbols, and could be composed into smaller units, which they called **distinctive features**. For these phonologists the fundamental or primitive unit of phonology was no longer the phoneme but the distinctive features. They did not adopt this position without sound arguments.

**Sets of Distinctive Features in English**
Distinctive features may be divided into various groups. There are those features which allow us to identify the major classes of sounds—vowel and consonants—and to distinguish between the sonorant and obstruent consonants. There are also features which define place of articulation, manner of articulation, and voicing. Features are often thought of as being binary. In the description of any segment the property associated with each feature will be either present or absent. If it is present this will be signaled by a plus (+) and a minus (-) will signal absence.

1. **Major Class features**
   The major class features define the major classes of sounds that are relevant in phonological analysis. The major classes include **CONSONANTALS-NONCONSONANTALS, SYLLABIC-NONSYLLABIC, SONORANTS-NONSONORANTS (OBSTRUENTS).**
   a. **CONSONANTALS-NONCONSONANTALS** [\(\forall \text{ cons}\)]
      Consonantal sounds are produced with a drastic stricture along the centre-line of the vocal tract. It means that one of the active articulators (the lower lip or tongue) obstructs the flow of air at some points in the vocal tract. Nonconsonantal sounds are made without such obstruction. In other words, to produce nonconsonantal sounds we involve a free flow of air through the oral cavity.
      - [+cons] : stop, affricate, fricative, nasals and liquids
      - [-cons] : vowels and glides
   b. **SONORANTS-NONSONORANTS (OBSTRUENTS)** [\(\forall \text{ son}\)]
      Sonorant sounds are produced with a vocal cavity disposition which makes spontaneous voicing easy; while nonsonorant (obstruent) sounds have a vocal cavity disposition which inhibit spontaneous voicing or involve a radical obstruction of the air flow.
      - [+son] : vowels, nasals, and liquids
- [- son]: stops, affricate and fricative

c. SYLLABICS-NONSYLLABICS ($\forall$ syll)
   Syllabic sounds are sounds which function as syllable nuclei; nonsyllabic sounds occur at syllable margin
   - [+syll]: vowels and consonants (liquid [l] in bottle and candle and nasals [m] in bottom and [n] as in botton)
   - [-syll]: all other sounds

The three features are distributed over the classes identified above as follows:

<table>
<thead>
<tr>
<th>Obstruents</th>
<th>Nasals</th>
<th>Liquids</th>
<th>Glides</th>
<th>Vowels</th>
</tr>
</thead>
<tbody>
<tr>
<td>[+cons]</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>[+son]</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>[+syll]</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>

There two points to note about this table. First, the glides [φ, ω] are [-cons], [+son] and [-syll]. Glides were phonetically like vowels, but still classified as consonants. Like vowels, the glides are [-con], that is, they are produced with a free flow of air through oral cavity. However, like consonants (unlike vowels) the glides are [-syll], that is they cannot function as nucleus of a syllable. Secondly, these three features are not sufficient to uniquely identify the above five classes. Nasals and liquids have identical features specifications. Clearly, we require an additional feature to allow us to distinguish between the two classes.

2. Tongue body features
   These features relates to the position of the tongue in the oral cavity in relation to neutral position. The position of the tongue is neutral when we stop articulating and allow our articulators to return to their rest position, our vocal cords will remain open, our velum will be lowered, and our mouth will most likely close. However, our tongue does not simply lie on the floor of the mouth. In its rest position, it remains partially raised. The rest position for the tongue is close to that of final vowel in the word sofa [s :f-]. This position is taken as the rest or neutral position for the tongue. These features include HIGH-NONHIGH, LOW-NONLOW and BACK-NONBACK sounds.
a. HIGH-NONHIGH $[\forall \text{high}]$
   High sounds are produced with the tongue raised from neutral position; while non-high sounds are made without such raising of the body of the tongue.
   - $[+\text{high}]$: palatal, velar, glides $[\text{w, } \varphi]$ and high vowels $[\text{i, } \text{u}]$
   - $[-\text{high}]$: labials, dentals and non-high vowels

b. LOW-NONLOW $[\forall \text{low}]$
   Low sounds are those produced with the tongue lowered from the rest or neutral position; while non-low sounds are produced without depressing the level of the tongue in this manner.
   - $[+\text{low}]$: low vowels
   - $[-\text{low}]$: all other sounds

c. BACK-NONBACK $[\forall \text{back}]$
   Back sounds are those produced with the body of the tongue retracted from the neutral position; while non-back sounds are those produced with the body of the tongue either in neutral position or pushed forward.
   - $[+\text{back}]$: back vowels and velars
   - $[-\text{back}]$: labials, dentals, palatals and glottal

The features high and low define three classes: $[+\text{high}, -\text{low}]$, $[-\text{high}, -\text{low}]$, and $[\text{high}, +\text{low}]$. Since $[+\text{high}]$ implies $[-\text{low}]$, and $[+\text{low}]$ implies $[-\text{high}]$, the first and the third of our classes can be referred to as $[+\text{high}]$ and $[+\text{low}]$ respectively. While segments can be $[-\text{low}, -\text{high}]$, that is mid, no segment can be $[+\text{high}, +\text{low}]$. This would imply a segment in which the tongue is both simultaneously raised and lowered from the rest position. This is impossible.

The three features are distributed over the classes identified above for vowels as follows:

<table>
<thead>
<tr>
<th>front</th>
<th>central</th>
<th>back</th>
<th>high</th>
<th>mid</th>
<th>low</th>
</tr>
</thead>
<tbody>
<tr>
<td>$[\text{i}]$</td>
<td>$[\rightarrow]$</td>
<td>$[\text{Y}]$</td>
<td>$[\text{I}]$</td>
<td>$[\ ]$</td>
<td>$[\emptyset]$</td>
</tr>
<tr>
<td>$[+\text{high}]$</td>
<td>$+$</td>
<td>$-$</td>
<td>$+$</td>
<td>$+$</td>
<td>$-$</td>
</tr>
<tr>
<td>$[+\text{low}]$</td>
<td>$-$</td>
<td>$-$</td>
<td>$-$</td>
<td>$-$</td>
<td>$-$</td>
</tr>
<tr>
<td>$[+\text{back}]$</td>
<td>$-$</td>
<td>$-$</td>
<td>$+$</td>
<td>$-$</td>
<td>$+$</td>
</tr>
</tbody>
</table>
The three features are distributed over the classes identified above for consonants as follows:

<table>
<thead>
<tr>
<th></th>
<th>Labials</th>
<th>Dentals</th>
<th>Alveolars</th>
<th>Post-alveolar</th>
<th>Palatals</th>
<th>Velars</th>
</tr>
</thead>
<tbody>
<tr>
<td>[+high]</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>[+low]</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>[+back]</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>

The above feature matrices fail to distinguish between some segments. The labial, dental and alveolar have identical descriptions. It is obvious that further features are required to allow us to distinguish between these classes.

3. Cavity features
These features refer to place of articulation (the features of consonants). They specify where in the vocal tract modifications of the stream take place in the production of particular sounds. These features include CORONAL-NONCORONAL sounds and ANTERIOR- NONANTERIOR sounds.

a. CORONAL-NONCORONAL [\^cor]
Coronal sounds are articulated with the blade of the tongue raised from the neutral position toward the front teeth, the alveolar ridge or hard palate; noncoronal sounds are made when the blade of the tongue remains in the neutral position.
- [+cor]: dentals, alveolars, post-alveolar, and palatals
- [-cor]: all other consonants (labial, velar)

b. ANTERIOR- NONANTERIOR [\^ant]
In the production of anterior sounds, the main obstruction of the airstream is at a point no farther back in the mouth than the alveolar ridge (or in front of the post-alveolar region); for non-anterior sounds, the main obstruction is at a place farther back than the alveolar ridge (or at the back of post-alveolar region).
- [+ant]: labials, dentals, alveolars and post-alveolars
- [-ant]: all other consonants (palatals and velar)

The features are distributed over the classes identified above as follows:
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### 4. Manner features

These characterize the way in which the airstream is obstructed in the production of a consonant. These features include CONTINUANTS-NONCONTINUANTS and DELAYED RELEASED-NONDELAYED RELEASE.

#### a. CONTINUANTS-NONCONTINUANTS [∀cont]

Continuants are produced by impeding, but not completely blocking, the flow of air through the glottis, or pharynx or through the centre of the oral track; non-continuants are made by completely blocking the flow of air through the centre of the vocal tract.

- [+cont]: fricative, liquids, glides and vowels
- [-cont]: affricate, nasals and oral stops

#### b. DELAYED RELEASED-NONDELAYED RELEASE [∀ del rel]

This feature is only applicable to sounds produced in the mouth cavity and distinguishes stops from affricates. In stops, the closure is released abruptly while in affricates it is released gradually.

- [+del rel]: affricates
- [-del rel]: all other sounds

---

<table>
<thead>
<tr>
<th></th>
<th>Labials</th>
<th>Dentals</th>
<th>Alveolars</th>
<th>Post-alveolar</th>
<th>Palatals</th>
<th>Velars</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[p]</td>
<td>[T]</td>
<td>[t]</td>
<td>[ɛ]</td>
<td>[f]</td>
<td>[k]</td>
</tr>
<tr>
<td>[+cor]</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>[+ant]</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

If we add these new features to the matrix introduced above, we get

<table>
<thead>
<tr>
<th></th>
<th>Labials</th>
<th>Dentals</th>
<th>Alveolars</th>
<th>Post-alveolar</th>
<th>Palatals</th>
<th>Velars</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[p]</td>
<td>[T]</td>
<td>[t]</td>
<td>[ɛ]</td>
<td>[f]</td>
<td>[k]</td>
</tr>
<tr>
<td>[+high]</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>[+low]</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>[+back]</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>[+cor]</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>[+ant]</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
5. **Source features**

These features refer to the acoustic output of a segment. As with the manner features two are required for English. These features include **VOICE-VOICELESS** and **STRIDENTS-NONSTRIDENTS**.

a. **VOICE-VOICELESS (\texttt{\forall \text{voi}})**

Voiced sounds are produced with the vocal cords vibrating at regular intervals; voiceless sounds are produced without such periodic vibration.

- [+]voi: all voiced segments
- [-voi]: all voiceless segments

b. **STRIDENTS-NONSTRIDENTS (\texttt{\forall \text{strid}})**

This feature is an acoustic feature. Stridents sounds are characterized by high-frequency noise such as you hear when compressed air escapes from a puncture. Contrast [s] and [T] in English. [s] is [+]strid, while [T] is [-strid].

- [+]strid: labiodentals, alveolar, palato-alveolar fricatives and affricates
- [-strid]: all other segments

\[
\begin{array}{cccccccccc}
\text{syll} & \pi & b & t & d & k & g & l & \text{cons} & \text{sons} \\
\text{high} & + & + & + & + & + & + & + & + & + \\
\text{low} & - & - & - & - & - & - & - & - & - \\
\text{back} & - & - & - & + & + & + & + & + & + \\
\text{cor} & - & + & + & - & - & + & + & + & + \\
\text{ant} & + & + & + & + & + & + & - & - & - \\
\text{cont} & - & - & - & - & - & + & + & + & + \\
\text{del} & - & - & - & - & - & - & - & - & - \\
\text{strid} & - & - & - & - & - & + & + & + & + \\
\text{voi} & + & + & + & + & + & + & + & + & + \\
\text{h} & + & \rightarrow & l & r & \text{q} & \text{w} & m & n & \text{N} \\
\text{cons} & + & + & + & + & - & + & + & + & + \\
\text{sons} & - & - & + & + & + & + & + & + & + \\
\text{high} & - & + & + & - & - & + & + & + & + \\
\text{low} & - & - & - & - & - & - & - & - & - \\
\text{back} & - & - & - & - & - & - & - & - & - \\
\text{cor} & + & + & + & + & + & + & + & + & + \\
\text{ant} & - & - & + & + & + & + & + & + & + \\
\end{array}
\]
Phonotactics

Phonotactics of a language are a list of restrictions on the distribution of segments, possible combinations of segments into clusters, and admissible syllable types. By knowing the possible consonant clusters in English, we can recognize which combination of segments are possible in English, and which combination do not occur, that is we know the phonotactics of English.

Phonotactics refers to the possible combinations of a language. It is simplest to start by looking at what can occur in initial position—in other words, what can occur at the beginning of the first word when we begin to speak after a pause. We find that the word can begin with a vowel, or with one, two or three consonants. No word begins with more than three consonants. In the same way, we can look at how a word ends when it is the last word spoken before a pause; it can end with a vowel, or with one, two, three, or (in a small number of cases) four consonants. No word ends with more than four consonants.

1. The consonant clusters in initial position

The maximum cluster of consonants (C) in initial position in English is three, and they must be followed by a vowel (V), thus: CCCV. If there are three consonants, however, the first must be /s/, the second must come from the set /p, t, k/, and the third must come from the set /l, r, w, j/. In short, the possible combination of English consonants is:

- $s + p + l/r/j$ as in splash, sprain, spurious
- $s + t + r/j$ as in strain, stew
- $s + k + l/r/w/j$ as in screech, sclerosis, squander

If there are only two consonants in the cluster, the first must come from the set /p, t, k, b, γ, f, v, T, s, Σ, h/ in the following patterns:

- $p + l/r/j$ as in play, pray, pure
- $t + r/j/w$ as in tray, tune, twin
- $k + l/r/w/j$ as in climb, crab, cure, queen
b + l/r/j as in blue, bruise, beauty
- g + l/r/w/j as in glow, grow, argue Gwen
- f + l/r/j as in fly, fry, fury
- v + j as in view
- T + t/j/w as in through, thews, thwart
- s + l/j/w/p/t/k/m/n as in slow, suit, sweet, spoil, steal, sky, smother, snow
- Σ + r as in shred
- h + j as in huge

2. The consonant clusters in final position

English permits up to four consonants in word final position, so we have CCCVCCCC as a possible English word. Such words are uncommon but ‘strength’ illustrate the pattern. The following types of clusters can be established, starting with VCC:

- p + t/T/s as in swept, depth, caps
- t + T/s as in eighth, puts
- k + t/s as in packed, box
- b + d/z as in rubbed, nibs [nɒbz]
- g + d/z as in sagged, rugs
- ± + t as in itched [ɔ±t]
- m + p/d/f/T/z as in limp, drummed, nymph, warmth, rims
- n + t/d/z/s as in mint, lined, lunch, hinge, mince, tenth, buns
- N + k/d/z/T as in mink, longed, bangs, leght
- l + p/l/k/b/d/z as in help, guilt, bulk, bulb, build, filch, bulge, helm, sullen, elf, shelf, health, else, heels, Welsh
- f + t/T/s as in left, fifth, oafs
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- **v + d/z** as in loved, gives
- **T + t/s** as in earthed, hearths
- **Δ + d/z** as in bathed, oath
- **s + p/t/k** as in wasp, waste, risk
- **z + d** as in seized
- **Σ + t** as in wished
- **∞ + d** as in roughed [rY∞d]

The VCCC pattern is quite frequent in English although it is not found as widely in the language as the VCC pattern. It is not necessary to go into the same detail for VCCC as for VCC but it can be claimed that the following list comprehends all forty-nine possibilities:

- **pts** as in scripts [skrøpts]
- **pst** as in lapsed [løps]
- **pTs** as in depths [dEpTs]
- **tTs** as in blitzed [bløtst]
- **dst** as in midst [mødst]
- **kts** as in facts [føkts]
- **kst** as in next [nøkst]
- **ksT** as in sixth [søksT]
- **mpt** as in bumped [b mpt]
- **mps** as in limps [lømmps]
- **mfs** as in nymphs [nømfs]
- **ntT** as in thousandth [TaYs↔ntT]

- **nts** as in pints [patønts]
- **ndz** as in finds [faøndz]
- **n±t** as in lunched [l n±t]
- **n→d** as in lunged [l n→d]
- **nTs** as in tenth [tEnTs]
- **nst** as in minced [mønßt]
- **nzd** as in cleansed [kIEnzd]
- **Nst** as in amongst [↔m N st]
- **Nkt** as in linked [løNkt]
- **NkT** as in length [lENkT]
- **Nks** as in thanks [ΤΘNks]
- **lpt** as in helped [hElpt]
The VCCCCC pattern, where four consonants occur at the end of a word or syllable is rare in English and is only found when the inflectional endings /s/ and /t/ are added to a VCCC form as in ‘thousandths’ [θaʊɔnθs], ‘exempts’ [iɡˈɛmptɪz], or ‘glimpsed’ [ɡλɪmpst].

The English Syllables

Sounds are organized into syllables using strictly limited vowel and consonant combination that differ from language to language. Syllables, in turn, are organized into words. Each word consists of one or more syllables, and each syllable consists of one or more sounds.

Syllable is generally an easy notion for native speakers of a language to understand, although technical definitions are not straightforward.
The table below gives some English words with one, two, three and four syllables. In general, a syllable is a phonological unit consisting of one or more sounds. Each syllable has a nucleus, which is usually a vowel (but it can be certain syllabic consonants such as [l], [m] and [n]). Syllables are usually smaller than a word and bigger than a single sound, but some single sound [χ] is a syllable and a word (as in a book).

<table>
<thead>
<tr>
<th>One Syllable</th>
<th>Two Syllables</th>
<th>Three Syllables</th>
<th>Four Syllables</th>
</tr>
</thead>
<tbody>
<tr>
<td>ton /tɒn/</td>
<td>even /i-χn/</td>
<td>loveliest /l v-li-χst/</td>
<td>anybody /e-ni-bΩn-di/</td>
</tr>
<tr>
<td>spin /spɔn/</td>
<td>although /l- do/</td>
<td>anyone /e-ni-wχn/</td>
<td>respectively /ri-sprk-tχv-li/</td>
</tr>
<tr>
<td>through /θru:/</td>
<td>consists /kχn-sists/</td>
<td>syllable /siol-χ-bχ/</td>
<td>definition /def-χ-ni- Σχn/</td>
</tr>
<tr>
<td>sail /sɛl/</td>
<td>writer /ræl-tχ/</td>
<td>computer /kχn-pϕu-tχ/</td>
<td>algebraic /æl- →χ-bre-χk/</td>
</tr>
</tbody>
</table>

The kinds of sounds that can make up a syllable differ from language to language and are strictly limited within each language. If you examine the four words of the following phrase, you will notice that English syllable allow several patterns of consonants and vowels. (We use the abbreviation C for consonant and V for vowel; as in the transcription above, we have separated the words into syllables with dashes _.)

in a pre-vi-ous chap-ter /ɒn χ pri-vʊ-ʃəz əʊp-tχr/ VC V CCV-CV-VC CVC-CVC

From this example, we see that English allows the following syllable types; VC, V, CCV, CV, and CVC. Other syllables structures can be seen in words like past (CVCC), square (CCCVC), churned (CVCCC), squirts (CCCVCCC): and there are still other possible syllable structure in English. The rule that describes possible syllable structures in a language is called phonotactic constraints.
Syllable Boundaries and Consonant Cluster

Technically, the basic elements of the syllable are the onset (one or more consonants) and rhyme. The rhyme (sometimes written as ‘rime’) consist of vowel, which is treated as the nucleus, plus any following consonant(s), described as the coda. The diagram of syllable structure as follows:

![Syllable Structure Diagram]

Both the onset and the coda can consist of more than one consonant, also known as consonant cluster. The combination /st/ is a consonant cluster (CC) used as onset in the word stop, and as coda in the word post. There are many CC onset combinations permitted in English phonotactics, as in black, bread, trick, twin, flat, and throw.

English can actually have larger onset clusters, as in the word stress and splat consisting of three initial consonants (CCC). The phonotactics of this larger onset consonant cluster is not too difficult to describe. The first consonant must always be /s/, followed by one of the voiceless stop (/p/, /t/, /k/) and then one of the liquids or glides (/l/, /r/, /w/), for example splash, spring, strong, scream and square.

The Structure of English Syllable

Let us now look in more detail at syllable onsets. If the first syllable of the word in question begins with a vowel (any vowel may occur, though /Y/ is rare) we say that this initial syllable has a zero onset. If
the syllable begins with one consonant, that initial consonant may be any consonant phoneme except /N/; /loʊ/ is rare. We now look at syllable beginning with two consonants. When we have two or more consonants together, as mentioned above, we call them a **consonant cluster**.

Initial two-consonant clusters are of two sorts in English. One sort is composed of /s/ followed by one of a small set of consonants; examples of such clusters are found in words such as ‘sting’ [stʌŋ], ‘sway’ [sweʊ], ‘smoke’ [smoʊk]. The /s/ in these clusters is called the **pre-initial** consonant and the other consonant (t, w, m in the above examples) is the **initial** consonant. These clusters are shown in the following table:

<table>
<thead>
<tr>
<th>pre-initial</th>
<th>initial</th>
</tr>
</thead>
<tbody>
<tr>
<td>p</td>
<td>t</td>
</tr>
<tr>
<td>spin</td>
<td>stik</td>
</tr>
<tr>
<td>smel</td>
<td>sm</td>
</tr>
</tbody>
</table>

*Note:* two consonant clusters of s plus l, w, j are also possible (e.g. stəp, swəʊN, sju:) and even perhaps sr in ‘syringe’ [sərɪn] for some speakers.

The other sort begins with one of a set of about fifteen consonants, followed by one of the set l, r, w, j as in, for example, ‘play’ [pleʊ],
‘try’ [traʊ], ‘quick’ [kwɒk], ‘few’ [fjuː]. We call the first consonant of these clusters the **initial consonant** and the second the **post-initial**.

When we look at three-consonants clusters, we can recognize a clear relationship between them and the two sorts of two consonants cluster described above; examples of three-consonant initials clusters are: *split* [split], *stream* [striːm], *square* [skweɪr]. The *s* is the pre-initial consonant, the *p*, *t*, and *k* that follow *s* in the three examples words are the initial consonants and the *l*, *r* and *w* are post-initial. In fact, the number of possible initial three-consonant clusters is quite small and they can be set out in full

<table>
<thead>
<tr>
<th>Post-initial</th>
<th>l</th>
<th>r</th>
<th>w</th>
<th>ɸ</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>s- plus initial</strong></td>
<td>p</td>
<td>splay</td>
<td>spray</td>
<td>-</td>
</tr>
<tr>
<td>t</td>
<td>-</td>
<td>string</td>
<td>-</td>
<td>stew</td>
</tr>
<tr>
<td>d</td>
<td>sclerosis</td>
<td>screen</td>
<td>squeak</td>
<td>skewer</td>
</tr>
</tbody>
</table>

We know have a similar task to do in studying final consonant clusters. Here we find the possibility of up to four consonants at the end of a word. If there is no final consonant we say that there is a **zero coda**. When there is one consonant only, this is called the **final** consonant. Any consonant may be a final consonant except *h*, *r*, *w*, ɸ. There are two sorts of two-consonant final cluster, one being a final consonant preceded by a **pre-final** consonant and the other a final consonants form a small set: *m*, *n*, *N*, *l*, *s*. We can see these in *bump* [b mp], *bent* [bent], *bank* [bθŋk], *belt* [belt], *ask* [ɑsk]. The post-final consonants also form a small set: *s*, *z*, *t*, *T*; example words are: *bets* [bɛts], *beds* [bedz], *backed* [bθkt], *bagged* [bθgd], *eighth* [eθt]. These post-final consonants can often be identified as separate morphemes (although not always, e.g. *axe* [æks] is a single morpheme and its final *s* has no separate meaning). A point of pronunciation can be pointed out here: the release of the first plosive of a plosive-plus-plosive cluster such as the *g* (of *gd*) in [bθgd] or the *k* (of *kt*) in [bθkt] is usually without plosion and is therefore practically inaudible.

There are two types of final three-consonant cluster; the first is pre-final plus final plus post-final, as set out in the following table:
Chapter 6: English Phonology: The Sound System of Language

<table>
<thead>
<tr>
<th></th>
<th>Pre-final</th>
<th>Final</th>
<th>Post-final 1</th>
<th>Post-final 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>helped</td>
<td>he</td>
<td>l</td>
<td>p</td>
<td>t</td>
</tr>
<tr>
<td>banks</td>
<td>bØ</td>
<td>N</td>
<td>k</td>
<td>s</td>
</tr>
<tr>
<td>bonds</td>
<td>bZ</td>
<td>n</td>
<td>d</td>
<td>z</td>
</tr>
<tr>
<td>twelfth</td>
<td>twe</td>
<td>l</td>
<td>f</td>
<td>T</td>
</tr>
</tbody>
</table>

The second type shows that more than one post-final consonant can occur in a final cluster: final plus post-final 1 plus post final 2. Post-final 2 is again one of s, z, t, d, t.

<table>
<thead>
<tr>
<th></th>
<th>Pre-final</th>
<th>Final</th>
<th>Post-final 1</th>
<th>Post-final 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>fifths</td>
<td>fω</td>
<td>-</td>
<td>f</td>
<td>T</td>
</tr>
<tr>
<td>next</td>
<td>ne</td>
<td>-</td>
<td>k</td>
<td>s</td>
</tr>
<tr>
<td>lapsed</td>
<td>lØ</td>
<td>-</td>
<td>p</td>
<td>s</td>
</tr>
</tbody>
</table>

Most four-consonant clusters can be analyzed as consisting of a final consonant preceded by a pre-final and followed by post-final 1 and post-final 2, as shown below:

<table>
<thead>
<tr>
<th></th>
<th>Pre-final</th>
<th>Final</th>
<th>Post-final 1</th>
<th>Post-final 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>twelfths</td>
<td>twe</td>
<td>l</td>
<td>f</td>
<td>T</td>
</tr>
<tr>
<td>prompts</td>
<td>prZ</td>
<td>m</td>
<td>p</td>
<td>t</td>
</tr>
</tbody>
</table>

A small number of cases seem to require different analysis, as consisting of a final consonant with no pre-final but three post-finals:

<table>
<thead>
<tr>
<th></th>
<th>Pre-final</th>
<th>Final</th>
<th>Post-final 1</th>
<th>Post-final 2</th>
<th>Post-final 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>sixths</td>
<td>sω</td>
<td>-</td>
<td>k</td>
<td>s</td>
<td>T</td>
</tr>
<tr>
<td>texts</td>
<td>te</td>
<td>-</td>
<td>k</td>
<td>s</td>
<td>t</td>
</tr>
</tbody>
</table>

To sum up, we may describe the English syllable as having the following maximum phonological structure:

<table>
<thead>
<tr>
<th></th>
<th>Pre-initial</th>
<th>Initial</th>
<th>Post-initial</th>
<th>VOWEL</th>
<th>Pre-final</th>
<th>final</th>
<th>Post-final 1</th>
<th>Post-final 2</th>
<th>Post-final 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ONSET</td>
<td>PEAK</td>
<td>CODA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>