1. INTRODUCTION

Before the appearance of the non-linear phonology\(^1\), generative phonological theories were primarily based upon the notion that phonological representation is the linear strings of segments that do not have internal hierarchical structures except those provided by syntactic surface structures.

As is clearly shown in the SPE, the notion “syllable” can not have any place in the framework of the generative phonology.

This, by no means, suggest that the notion “syllable” is newly introduced in the phonology. Many phonologists and phoneticians entertained “syllable” in there researches of pronunciation variations in languages. Perhaps the first and the most popular(though not persistently accepted) definition was Stetson’s (1928).

His motor theory of syllable tells us that syllables correlate with the burst of chest pulse

\(^1\) This includes the autosegmental theory initiated by gold Smith (1975) and Metrical phonology advocated by Liberman (1975, 1977) that recognize that there is internal hierarchical structure in the phonological representation without the help of syntactically assigned structure.
activities. This means that the speaker is emitting one syllable at a time, as independent muscular gestures.

This may be true of French, one of the syllable-timed languages. In English, however, each initial burst of the chest pulse is correlated with a stressed syllable (Lass (1984: 248-249)), and the intervals between the stressed syllables are approximately equal. In other words, we can say that English is a stress-timed language. Therefore, Stetson’s motor theory is not entertainable in English phonology.

In order to circumvent the demerits of the motor theory, phonologists tried to formulate abstract theories of syllable in the underlying representation. The typical of this may be Einar Haugen (1956: 216). He proposed “that the syllable be defined as the smallest unit of recurrent phonemic sequence”, and showed that sequential constraints of a number of languages could be generalized, if this approach was accepted.

However, this is never an easy task. These phonemic (phonological) syllables are doomed to be different from the phonetically realized syllables. Let’s take just one example from the Spanish language. Many phonologists suggested that syllable initial /sp, st, sk/ be postulated in the underlying representation, though they never appear at the phonetic level. The tactic is to put those clusters word-initially in the lexical representation and set up an e-epenthesis rule that may separate /s/ and /p, t, or k/ into different syllables.

The word, *spanish*, is not pronounceable to Spanish speaking people. There is a Surface Phonetic Constraints that prevent the word-initial /sC/ (where C represent any stop voiceless sound) cluster. The (1a) may be pronounced somewhat like (1b) by native Spanish speaking people:

1. a. I speak Spanish
   b. I espeak Espanish.

The difficulty of postulating initial /sC/ cluster underlyingly and transforming them to belong to two different syllables may contribute to the difficulty in formalizing syllable theory.

---

2) It is generally accepted in the phonological studies that there are two different types of interval theory. As illustrated below, each language has its own isochronism. The power burst generally coincide with syllables in French bu in English with stressed syllables:

<table>
<thead>
<tr>
<th>English: John bought two new books yesterday</th>
</tr>
</thead>
<tbody>
<tr>
<td>John bought two new books yesterday</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>French: Jean a vu deux livres hier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jean a vu deux livres hier</td>
</tr>
</tbody>
</table>
One further remark should be made in connection with the sonority hierarchy. Jespersen (1932), Pike (1947), Jones (1957) and many other writers tried to define syllable in terms of relative prominence or carrying power of the string of segments. Jones (1957: 55) says that the prominence peak is syllabic and "the word or phrases is said to contain as many syllables as there are peaks of prominence." This may prove valuable to count the number of syllables, but the theory can not provide adequate solution to syllable demarcation. Jones's (1957: 55-6) own remark reflects the problem:

(2) In theory, a syllable consists of a sequence of sounds containing one peak of prominence. In practice, it is often impossible to define the limit of a syllable because there is no means of fixing any exact points of minimum prominence.... In many cases the bottoms of the 'thoughts' must be considered as flat, that is to say, there is no one point which can be regarded as the point of syllable division.

However, there are lots of evidences that disregarding the syllable is a serious deformity of the generative phonology. This situation is, in some sense, predicated in the SPE (380):

(3) ... knowledge of lexical structure goes beyond familiarity with a list of lexical items. For example, speakers can distinguish in various ways among items that are not in their lexicon. Certain "nonsense" forms are so close to English that they might be taken by the speaker to be accidental gaps in his knowledge of the language: e.g., brillig, karulize, thode. Other forms, such as gnip, rtut, or psik, will almost certainly be ruled out as "not English". To account for these and other facts, we must assume that there is more structure to the internalized lexicon than merely the list of known items.

This may mean the incorporation of Morpheme Structure Condition proposed by Stanley (1967) and Surface Phonetic Constraints by Shibatani (1973). But any reader can easily see that there is too much redundancy in taking the two theories together.

Constraints that hold only at the morpho-phonemic level should be stated as MSC's (Morpheme Structure Conditions), and all the constraints that hold at the phonetic level should be stipulated as SPC's (Surface Phonetic Constraints). But "SPC's which are also true at the morpho-phonemic level are marked M/SPC's, indicating that the constraints are also applicable at that level (Shibatani, 1973: 90).

Another example of the inadequacy of linear systems of generative phonology comes from the need to recognize a distinction between "weak" and "strong" clusters in the Stress Assignment Rule of SPE. Without the internal structure of a syllable, it is totally ad hoc, and arbitrary to distinguish strong clusters and weak clusters. This problem was noted in
Actually the situation is more complex. We recall that we were forced to include
the "weak cluster" option not only in the Main Stress Rule and Tensing Rules,
but also in the Auxilliary Reduction Rule…. As noted, this repetition indicates
that we have failed to capture important properties of strong and weak clusters
and thus points to a defect in our theory that merits further attention.

Though syllable was disregarded in SPE, the departure point of generative phonology,
recent studies in the generative framework have given the syllable and ever greater role to
play. Especially in English, there are a lot of evidences that the syllable is a linguistically
significant unit which must have its place in the theory of phonology. First of all, the well
defined theory of syllable can obviate the unnecessary complication of phonotactic
constraints. Secondly, by encorporating syllable in the rule description, the rules may obtain
high degree of naturalness and the domain of the rule application can be simplified.
Moreover, the theory of syllable can provide the adequate definition of the strong and weak
clusters.

In this paper, the majority of the existing theories of syllable are reviewed and reanalyzed.
The aim is to establish a theory of syllable and syllable demarcation so as to generalize and
simplify the framework of the generative phonology.

Chapter 2 approximates the internal structure of syllable and defends the notion of
hierarchical structure. In chapter3, various constraints are dealt with to formulate a syllable
well-formedness condition. Chapter 4 and 5 covers the problems of syllable demarcation.
Different writers proposed different approaches to the theory of syllables that includes the
levels of syllabification and the theoretical status of internal structure of syllable and the
relationship of syllable boundary with other types of syntactic boundary such as word
boundary.

2. SYLLABLE STRUCTURE

The most popular approach in dealing with the multisyllable word is to begin with the
monosyllable word and its structure so as to apply the same principle to multisyllable words.
This attempt was made in Trinka(1966: 64-112). He classified the 14 different types of
monosyllable as in (5).3.


These classified items reveal a couple of easily noticeable generalizations of syllable. First, a syllable must have at least a vowel. Second, one or more consonants may attached either before or after the vowel but it is optional. What is interesting is that this generalization is also true of many other languages. Thereby we can formulate the following structure of a syllable:

(6) syllable = (prevowel consonants +) vowel (+ postvowel consonants)

Another interesting observation is made by Kuryłowicz (1949). He sees the similarity between the sentence structure and the syllable structure:

(7) a. syllable: (consonants) + (vowel + consonants)
   b. sentence: (subject) + (verb + complement)

This view on the sentence structure correctly says that the verb is more closely related to the complement than to the subject. The question is whether the same analogy is true in case of syllable structure or not.

Before answering the question, we have to deal with the appropriateness of dividing the syllable into three subparts, the prevowel consonant clusters (onset), the vowel (peak), and the post vowel consonants clusters (coda). The appropriateness is well illustrated by Pike (1967: 386-7):

(8) The possibility of substitution of one phoneme for another in a particular slot in the margin (onset or coda), for example, is likely to be more dependent upon the particular phonemes manifesting other slots in that margin than it is by the particular phonemes manifesting the nucleus of such syllables. I.e., if a formula CCV is manifested by /s/ in the first consonant slot, and the nucleus slot is filled

3) We can easily see that the plural form of (5g) texts/tekste/ and the third person singular of (5k) prompts/prompts/has 4 consonant clusters after the vowel. But it must be noted that it does not invalidate Trinka's observation here for reasons given in 3.13.
by the phoneme /a/, the list of phonemes which fill the second consonant slot are more likely to be controlled by the presence of the /s/ than they are by the presence of the /a/-e.g., they may be limited to voiceless consonants after the voiceless /s/, etc. Such considerations indicate that a closer relationship exists between the two consonants than exists between either consonant and the vowel.

To extend this observation further, we can make the claim that co-occurrence restrictions between peak and coda are much more likely to exist than are restrictions between either peak or coda and the onset. Indeed, as will be clearly manifested in 2.2, there are no phonotactic restrictions at all for English which involve onset and peak.

With this information, we can say that peak and coda may be combined to gether to form a branch (rime) and the onset and the rime comprises a syllable. This may be illustrated in IC analysis as shown in (9):

(9) SYLLABLE
    └───┘
     |    |
O N S E T  R I M E
     |    |
P E A K  C O D A

Here, we use the terms, onset, rime, peak, and coda, as if they were the constituents. The question that must be given at this point is whether the nodes of the structure should be labelled or the nodes just indicate that they may branch. The answer is that they are categories of a syllable just as NP, VP and PP are categories on the syntactic level. The reason is twofold: first of all, as discussed in Chapter I, the division of strong and weak clusters is crucial in SPE stress assignment rules. The term strong and weak denotes what kind of consonants follow the vowel. The onset part should be separable from the rime in order to make proper definition of strong and weak clusters. Secondly, to provide adequate explanation to vowel harmony and meter assignment, reference to rime structure is imperative. Indeed, McCarthy (1979: 455) tried various structures of syllable and came to the conclusion that peak and coda should form a constituent. For example, compare (10a) and (10b):

(10) a. \( \sigma = \text{Syllable} \)
    ┌─┐
    │ │
onset  rime
    │ │
  f  l  peak  coda
    │ │
  a  w  n  s

---

In (10b) the strength hierarchy, which is assigned to these constituents according to Liberman and Prince (1977: 259), McCarthy (1979: 454) and Kiparsky (1979: 432) is thus peak, onset, and coda. The striking similarity between (10a) and (10b) clearly shows that the grouping of peak and coda into rime is fully legitimate and it achieves the linguistically significant generalization. Kaye and Lowenstamm (1981: 110) share the same opinion:

(11) Phonological processes sensitive to syllable structure are sensitive to the structure of the rime e.g., branching or not. We know of no syllable structure sensitive phonological process that is sensitive to the structure of the onset.

These and many other examples that will be discussed in this paper supports that syllable is not a mere string of segments and that it has the well-formed internal structure with its own categories.

3. CONSTRAINTS ON SYLLABLE

The basic structure of a syllable is introduced in Chapter two, through IC(immediate constituency) analysis. But it is clear from the beginning that an unrestricted binary branching theory provides a much greater number of possible structures than are actually employed in natural languages. So we are in need of certain forms of constraints that will implement the theory, and further, any such constraints must be stipulated in the theory.

To begin with, it may be helpful to differentiate two types of constraint: structural and collocational. The structural constraints of syllable refer to the limitation on the shape of syllable structure that may occur in a given language along with the principle of what phonological classes may occupy a given position within a syllable. Thus a language like Japanese does not allow onset and coda branching: there may be CV or VC type but no CCV or CVCC.
These structural constraints are to be distinguished from the collocational constraints. The collocational constraints limit the types of segment sequences that can be co-locate within onset, peak, or coda. For example, English syllable allows the combination of \([-\text{sonorant}] [+\text{sonorant}]\) cluster in onset. Thereby, blow, fry, and glad may be possible English syllable but such words as lbow, rfy and lgad \([+\text{sonorant}] [-\text{sonorant}]\) cluster) do not seem to exist in English. These and many other marginal constraints should be dealt with within the domain of the collocational constraints.

3.1 Structural Constraints

Kaye and Lowenstamm (1981: 118) assume that a theory of syllable minimally includes as a part of Universal grammar:

(12) Universal Syllable Template (UST)

\[
\sigma \\
\text{[+sonorant]} \quad \text{[-vocalic]} \\
\text{[-sonorant]} \quad \text{[-vocalic]}
\]

There are two principles at work in interpreting the above UST. First, the onset, peak, and coda optionally dominate phonological materials. Secondly, the UST expansion must comply to the feature percolation condition (FPC) proposed by Vergnaud (1979):

(13) FPC: If a node in a tree is labelled with a particular feature or feature complex, then all segments dominated by the node in question must possess the feature or features.

This can be easily verified by the fact that, in (10a), /i/ and /i/ in onset share the feature \([-\text{vocalic}], /a/ and /w/ \text{ in peak are both } [+\text{sonorant}, -\text{consonantal}], and coda elements, / n/, /s/ are \([-\text{vocalic}].\)

5) The worst case of this may be a syllable without peak or even without any segment. But the worst cases can be ruled out as impossible English syllable by postulating a surface structure filter:

\[
\begin{array}{c}
\ast \\
\sigma \\
x \\
\rho \\
y
\end{array}
\]

(A syllable without peak element is not acceptable)

This may be a better approach than saying that peak element is obligatory; because it explains the obligatory nature of syllabic consonant which may not be thought as \([+\text{syllabic}]\) in the underlying representation.
(14), however, though it is permissible English syllable, is blocked by the UST, because the /m/in peak does not have \((-\text{consonantal})\) feature. Therefore, the UST should be revised as in (15):

(15) UST-Revised

\[
\begin{array}{c}
s \\
| \quad h \\
| \quad m \\
| \quad p \\
\end{array}
\]

3.11 Onset expansion

Now, we are going to expand the UST for better explanation of English syllable, starting from onset. If there is only one segment in onset, it can be any segment except /l/ or /k/.

But if there are two, the second should be /l, r, m, w, y/ as shown in (16a, b, c). The only exception is (16d):

(16) a. fly glad fry pray
b. smash snow sneer smart
c. twin pure tune cute
d. spate stake skill

Putting (16d) aside, we can generalize that if there are two segment in onset, they should be \((-\text{sonorant}, +\text{consonantal})\) \((+\text{sonorant})\). This generalization makes the expansion (17) possible:

(17) Expanded onset

\[
\begin{array}{c}
s \\
| \quad h \\
| \quad m \\
| \quad p \\
\end{array}
\]

Now, in connection with (16d), remark should be made on the deviated forms of /sp, st, sk, (and sf)/. These clusters (let’s call them /sC/ clusters) do not correspond to (17) and UST in general in a couple of respects. Above all, note that syllable /sC/ clusters violate the sonority hierarchy (cf. Kiparsky (1979: 432)). Further, the /sC/ clusters show different distributional properties from other clusters: notably these can occur syllable-initially as well as syllable-
final clusters in a language are generally the mirror image of syllable initial clusters (e.g., /pr-/ vs. /-rp/, or /kl-/ vs. /-lk/ (Ewen 1982: 46)). Moreover, what is interesting is that, in English, if there is three consonant cluster in onset, the first two should be /sp, st, or sk/. These facts have led some phonologist to analyze /sC/ cluster as a single phonological unit.

Ewen (1982: 49) cites the same problems in Norweigian, German and concludes that "there is then a great deal of evidence to support the view that the elements of /sC/ clusters are, at least, more intimately linked than those of normal consonant clusters..."

With these informations, we can postulate the following auxilliary template, which is a sort of special form of expansion of the first (+consonantal, -sonorant) segment of onset cluster:

(18) Auxiliary template 1 (AT 1) \[
\begin{array}{c}
+ \text{consonantal} \\
- \text{sonorant}
\end{array}
\]

\[
\begin{array}{c}
\text{sp, st, sk, or sf} \\
\text{coronal}
\end{array}
\]

(17) and (18) can explain a lot of characteristics of English syllable: i.e., that there can not be 4 consonants in the syllable initial, that if three consonant cluster, then the first is /s/ and the second is voiceless and so on...

As is seen here, the majority of Stanley's MSC can be restated in the syllable template and add some degree of explanatory adequacy of the English syllable structure.

3.12 Peak expansion

Phonetically we can find a simple vowel (pat, kick, text...), or diphthongs, /ay, aw, oy/, (kite, cow, toy...). Some might content to say that the off-glides /y, w/ of the diphthongized tense vowels in English (boat, boot, make...) comes after a vowel.

In this connection, Kaye & Lowenstamm (1981: 107) say that even the long vowel should be understood to be functionally identical structure to VG or VC:

(19) In our theory these have exactly the same status as rimes whose second member is non-syllabic.

These observations lead us to postulate peak expansion as show in (20):

(20) Expanded peak \\
\[
\begin{array}{c}
+ \text{sonorant} \\
\end{array}
\]

\[
\begin{array}{c}
\text{[+ syllabic]} \\
\text{[+ sonorant]}
\end{array}
\]

18
Note (20) accidentally allows not only vowel and glides but also the (+sonorant, +consonantal) segments (/r/, /l/) to come into peak. This is a very insightful suggestion that can be defended in connection with the coda structure.

3.13 Coda expansion

As for coda, it may be convenient to make a list of possible and impossible clusters and reanalyze them:

(21) a. φ : aye, rye, boy saw
    b. -C : cat dog rim fell
    c. -CC : (i) axe hand pulse rift
       (ii) ask wasp risk
       (iii) lurk lump milk chirp
       (iv) *rifk *rapf *putk (*asf)9
       (v) *paink *fiemp /fiymp/
    d. -CCC : (i) next first text sixth glimpse
       (ii) *nexp *glimp

As noted in Trinka (cf. Chapter 2), no more than 3 consonants may cluster in coda except when the fourth is grammatical ending such as -s (plural), or -t, -d (past tense).

When there is just one consonant, it may be any consonant except /h/, which show very limited distribution, for example it also cannot stand between two vowels except when the second has stress. (cf. fn. 10).

In case of the two consonant cluster, (21c i & iv) reveals a very interesting fact about English syllable. It is observed by Seikirk (1982: 349):

(22) The second consonant of the coda must be a (+coronal) obstruent.7

This is a very important constraint that must be described in the theory of syllable structure.8

6) The /sf/ cluster is only rarely found in foreign words. It is a highly marked cluster in English. But I know of no other means to treat /sf/ cluster in English.

7) See also Clement and Keyser (1983: 33) and Fujimura and Lovins (1977: 408-9).

8) There are very few counterexamples. The exception may be found in such words as being or oink where the /g/ of being is thought to be the combination of /ng/. Both /n/ preceded by /g/ or /k/ respectively is pushed to the first position of coda, since the peak can only contain two segments, and the second position is already filled by the glides. But taking into consideration their primarily onomatopoeic nature, these rare exceptions can be handled separately from phonological framework. It should also be noted that these deviated form never occur in multisyllable words.
(21c, ii) is the apparent exception to (22), where the second consonant is not coronal. This, however, does not invalidate the generalization. A closer observation will reveal that all the words in (21c, ii) has only /s/ as the first member of coda cluster. This exactly is predicted by our AT 1 (see (18)). This tells us that /k/ or /p/ after /s/ is not the second member but the auxiliary template segment of the first consonant.

Now, look at the words in (21c, iii), where the second element is not coronal and the first element is not /s/. Still those words are fully legitimate as far as English syllable structure goes. Here, the readers must recall that we have expanded peak template in such a way as to accept (+sonorant) as a subpart of peak structure. To put it in another way, the sonorant consonants are not the first members of coda clusters but the second element of peak, thus making the noncoronal obstruents the first elements of coda. This also correctly predicts that the vowels in (21c, iii) should be short.

If they are replaced by long vowels or diphthongs, the resulting syllables are proved to be unacceptable in English (*bawrk, *moylk, *laymp...).

The unacceptability of (21c, v) is now self-evident. Since the second positions of the peak are already occupied by glides, the sonorant consonants must find their places in coda, thereby pushing noncoronal obstruents to the second position, which violate the structure constraint (22).

These are sufficient for making coda expansion:

(23) Coda expansion

\[
-\text{vocalic} \quad -\text{sonorant} +\text{coronal} \quad +\text{consonantal} \quad +\text{consonantal}
\]

It is not an accident that the second and the third consonants in (21d, i) are all coronal. The acceptability of (21d, i) and the unacceptability of (21d, ii) can be explained by postulating another auxiliary template:

(24) Auxiliary Template II (AT 2)

\[
+\text{consonantal} \quad -\text{sonorant} +\text{coronal} \quad s \quad t \quad \text{or} \quad \theta
\]
Now, we have expanded (English) syllable template and two auxiliary templates as in (25):

(25) a. Expanded (English) Syllable template (EST)

\[
\begin{array}{c}
\sigma \\
\left[ -\text{vocalic} \right] \\
\left[ +\text{consonantal} \right] \\
\quad \quad \quad \quad \quad \left[ -\text{sonorant} \right] \\
\quad \quad \quad \quad \quad \left[ +\text{sonorant} \right] \\
\left[ +\text{syllabic} \right] \\
\quad \quad \quad \quad \quad \left[ +\text{sonorant} \right] \\
\quad \quad \quad \quad \quad \left[ +\text{consonantal} \right] \\
\left[ +\text{consonantal} \right] \\
\quad \quad \quad \quad \left[ -\text{sonorant} \right] \\
\left[ +\text{coronal} \right]
\end{array}
\]

b. Auxiliary Template I (AT 1)

\[
\begin{array}{c}
\left[ \text{consonantal} \right] \\
s \\
p, t, k, (or f)
\end{array}
\]

c. Auxiliary Template II (AT 2)

\[
\begin{array}{c}
\left[ -\text{sonorant} \right] \\
\left[ +\text{coronal} \right] \\
s \\
t \text{or } \theta
\end{array}
\]

One final remark should be made on the inflectional ending. As noted in Chapter 2, the maximum four consonants may cluster in coda as in texts /teksts/, which our present structure seems to fail to accept.

First of all, we must note that the suffixes are attached to words, and not to syllables. Therefore the legitimate domain of processing the annexation of suffixes is morphological level. So the proper treatment should be to postulate Chomsky-adjunction of grammatical suffixes to words as shown in (26):

(26)

\[
\begin{array}{c}
\omega (\rightarrow \text{word}) \\
\left[ \omega \right] \\
\left[ \text{Affix} \right]
\end{array}
\]
We must note that this movement process is not blocked by our present AT 2, because all the extrasyllabic grammatical suffixes (plural endigs -s or -z and past tense endings -t or -d) are (+consonantal, -sonorant, +coronal).

3.2 Collocational constraint

So far, our theory of syllable structure can explain the possible English structures. But it should be admitted that the EST and AT are too generous: it is not sufficient enough to rule out all the impossible combinations in English syllables.

The best way to deal with the overly permissive nature of structural constraints is to postulate certain device that can filter out the impossible syllable combinations that the EST and AT allow. Thereby, in this chapter, an attempt will be made to find out some deep structure filters (DSF’s) for the sake of systematized explanation.

3.2.1 DSF in coda

To begin with, take a look at (27):

(27)

\[
\begin{array}{c}
\ast \sigma \\
\ast \sigma \\
\end{array}
\]

Note that the syllable (27) does not violate any of the structural constraints. But it does not seem to be possible in English, unless the final coronal sound, /t/, is understood as an inflectional ending.

(28) a. (ted(st)) (lap(st))
   b. * (te(sp)t) *(ri(sk)t)

Further data in (28) shows that AT should be appended immediately before the syllable boundary. In other words, no segment can intervene between AT and syllable boundary. This may be systematically explained by making the following embedded AT filter:

(29) Embedded AT Filter

\[(\ast (AT)x)_{\sigma} \]

(where x is non null consonant and contains no syllable boundary.)

Further observation will reveal another generalization about English syllable:
(30) a. *ripd *pikze *ribt *pigs/pigs/
b. rent pump ink

The examples in (30a) show combinations of [(+ voiced) (-voiced), or (-voiced) (+ voiced)], all of which are unacceptable. This reveals the general tendency in English that the two consonants in the syllable final should match in voicelessness. And the well-formedness of (30b) further elaborates that the two final consonants must share the same voicelessness quality, only if the first is obstruent. This can be captured in the DSF (31):

(31) \[ \text{\text{sonorant}} \quad \text{voiced} \quad \text{voiced} \quad \text{voiced} \]

Miscellaneously, we can find that /d, g, v, ð, s, z, c, and j/ can not be followed by another consonant in coda. To exclude them from the well-formed syllable set, the following DSF's may be necessary:

(32) a. *[-coronal +voiced] C [a voic e d] C
   (\(d, g, v/\) can not be the first member of coda cluster.)

b. *[-continuant -strident] C [a strident] C
   (\(ð, ð/\) should not be followed by another consonant in coda)

c. *[-sonorant -anterior -coronal] C [a sonorant] C
   (\(s, z, c, j/\) are excluded as the first member of coda cluster.)

3.22 DSF in onset

Now, we will go deeper and try to find out some filters at work in constructing possible syllables in English.

(10) r l w y m n
    p + + - (+) - -
    b + + - (+) - -

9) /sf/ and /sh/ clusters show complementary distribution. /sh/ never comes in onset, while /sf/ never appear in coda. The AT 1 should be rearranged accordingly. But since /sh/ complies to AT 2, the right solution may be to eliminate the parenthesis part of AT 1(18) and make exceptional provision to accept /sf/ only in onset. (see fn. 6)
The first observation may be the consonants that do not occur as the first member or an onset cluster. They are /z, c, j, h/10. (/h/ may be followed by /y/. This will be explained immediately.) Of course, there may be other consonants, such as /l, r, w, y, m, n/, that can not be the leading elements of onset cluster. The latter group, however, by virtue of their not being (-sonorant), can’t occupy the first place of onset cluster, since it is systematically excluded by our EST and AT’s.

But the problem rises in case of /m/, /n/, or /h/. Though they can not make consonant clusters in onset, there are such words as music, newt, and hue. This is also true in the case of other consonants including stops and fricatives as in pure, few, dew and so on. Notice here that the vowel after /y/ is almost always /uw/. There may be some exceptions in words of foreign origin such as fjord, and Tokyo.

One of the explanation of the discrepancy of nasal cluster and the limited distribution of /y/ is to eliminate all /y/ in the underlying representation of English syllable.

Following Levin (1981) and Clements Keyser (1983), instead of putting /yu/ in the underlying representation, we will postulate /i/ in the deep structure. Then the y-insertion rule will insert /y/ before /i/, and then the /i/ will be transformed into /u/, which will be lengthened by virtue of its being tense vowel. This approach automatically explains the (+) of onset /Cy/ clusters.

Secondly, notice the non-existence of onset cluster with /θ, z, zh/ as the first member. This group, unlike /h, ð, j/, may be shown in some words of foreign origin as in zuei. Considering

---

10) To explain this, Clements and Keyser (1983 : 50) suggest that /c/ and /j/ be the combined forms of /t+s/ and /d+z/ respectively, this may be one of the solution but it will further complicate the AT, since the present AT’s do not allow stop+fricative sequence in onset.

In the similar way, /h/ may be classified as voiceless glide (Ladefoged, 1975 : 55-6). I think the best way is to ascribe the distributional limit to the segmental characteristics of those sounds.
the common features they share, [-sonorant, +continuant, +voiced], we may introduce the following DSF:

$$\begin{array}{|c|}
\hline
& \text{(-sonorant)} & \text{(+continuant)} & \text{(+voiced)} \\
\hline
\sigma & \text{C} \\
\hline
\end{array}$$

Further observation of the absence of /bw, pw, fw/ and /dl, tl, θ l/ motivates the filters as in (35):

$$\begin{array}{|c|}
\hline
a. & \text{([-labial]) (+labial)} \\
b. & \text{([-coronal]) (+coronal)} \\
\hline
\end{array}$$

Informally we can interpret the filter (35) as saying that no two consonants of the same place of articulation, except /s/, can form an onset consonant cluster.

Here, the exception /s/ should be properly treated. As shown in AT 1 and AT 2, /s/ can be the first member of the consonant cluster. Still, we are in need of some device that says that only /s/ can form a cluster with nasal sounds, as in smash, or snow. Clements & Keyser (1983: 45, figure 19b), postulated Possible Syllable Structure Condition (PSSC) to accomodate /sN/ cluster in the onset. But we've already postulated the structural constraint (EST & AT), which accomodates the rest of PSSC's proposed by them.

Therefore, tentatively, we will introduce another ad hoc filter to rule out the possibility of the combination of segments other than /s/ and nasal consonants as in (36):

$$\begin{array}{|c|}
\hline
\sigma & \text{([-sN])} \\
\hline
\end{array}$$

(where [-s] means any segment other than /s/)

Now, let's take a look at /sr/ cluster. Neither the structural constraints nor the collocational restrictions so far sift out the /sr/ onset cluster. But it is never realized phonetically. On the phonetic level, only /sr/ appears. What is suggestible here is not to postulate another filter but to allow /sr/ initial clusters in the lexical representation and later by alveolar retraction rule transform it to /sr/.

By and large, the majority of alveolar sounds are retracted before /y/ or /r/ as shown is (37):

$$\begin{array}{|c|}
\hline
\text{a. train: } & /\text{creyn}/ \\
\text{b. lieu: } & /\text{λuw}/ \\
\hline
\end{array}$$

— 25 —
c. news: /njuːz/
d. mansion: /mænˈʃən/

Thus the problem of over permissiveness of the constraints can be treated properly.11

Just one more remark on the three consonant cluster.

(38) a. acceptable: splay spray stray scream sclera
    b. unacceptable: *spway *stnay *stlay *sknash

Perhaps the easiest way to give systematic explanation of (38) may be to assume the three consonant cluster, C\textsubscript{x}C\textsubscript{y}C\textsubscript{z} to be the combination of C\textsubscript{x}C\textsubscript{y} and C\textsubscript{y}C\textsubscript{z}. Therefore we can say that, for example, /spl/ is made of the overlapping well-formed syllable initial sequences /sp/ and /pl/. All sequences of three consonants that can not be so divided are excluded in English. Accordingly, /snr/ is not a possible three member cluster, since /nr/ (C\textsubscript{x}C\textsubscript{y}) is not a possible two member cluster.

Then the diviance of (38b) can be easily understood: words, in (38b) are not acceptable, because the combination C\textsubscript{y}C\textsubscript{z} is filtered out. This necessitates the filter (39):

(39) j(C\textsubscript{x}C\textsubscript{y}C\textsubscript{z})

(where C\textsubscript{x}C\textsubscript{y} or C\textsubscript{y}C\textsubscript{z} violates constraints.)

3.2.3 DSF in rime

It is well-recognized that there are two different types of diphthongs in English as in (40):

(40) a. diagonal diphthong
    i) ay: pine find
    ii) aw: mount sound
    iii) ay: point boy

b. rising diphthong
    i) iy: field scene
    ii) ey: paint rain
    iii) uw: woe wound
    iv) ow: boat low

11 Surface structure filter may be introduced to prevent /sr/ cluster form appearing in the phonetic representation:
   • \textsubscript{sr}
Agreeing with Chomsky & Halle (1968), Kaye & Lowenstamm (1981), Ewen (1982), Noske (1983) and many other writers, we will assume that the diphthongs of (40b) are not present underlyingly. The phonetic diphthongs of (40b) are the result of the application of tense vowel lengthening rule. Surely, some of diagonal diphthongs are produced by the vowel lengthening rule. But still they are indispensable elements in the deep structure.

Then only /ay, aw, oy/ are the legitimate diphthongs in the underlying representation. Note that the first segments all share the feature [-high, +low, +back.] The rest of other possible combinations can be successfully ruled out by (41) filters:

\[
\begin{align*}
\text{(41)} \quad & \text{excluded} \\
\text{a.} & \star \ V \consonant \ [-\text{low}] \quad \text{iw, ew, oy, uy} \\
\text{b.} & \star \ V \consonant \ [-\text{back}] \quad \text{ew, øy, øw} \\
\text{c.} & \star \ [+\text{round}] \quad \text{ow, ow}
\end{align*}
\]

3.24 Overview

In this chapter, an attempt is made to formulate the deep structure filters as a device to counteract the unacceptable syllables that the structural constraints may allow. It must be admitted that, while it is certainly reasonable to postulate the structural constraints, all the filters introduced in this chapter are \textit{ad hoc} in nature. They just describe the English non-syllabic phoneme sequences. It is left open to further simplify the filter system and to accommodate so far unexplained phenomena. There are minor deviations in English. For example, especially in monosyllable, the lax vowel such as /i, ë, u/ are not normally followed by /rc/ coda clusters, and coda combination /ic/ rarely allows back vowels before it (cf. Fujimura & Lovins, 1977: 408).

But since these are just peripheral phenomena and no simple explanation can cover the whole variety of exceptions, it is suggestible, in line with Chomsky (1980: 2), that minor deviations or unexplained phenomena be pushed aside for later incorporation into a better defined theory of English syllable structure.

One more remark is in order about the different nature of structural constraints and DS filters. The onset clusters like /zb, bd, dv, bz/ are not allowed by EST and AT, while /ky, vl, tl, zw.../ are allowed by EST and AT but blocked by DSF. The former group of clusters may not be pronounceable by general English speakers. Thus the imaginary initial cluster
of /nkr/ as in Nkrumah may be pronounced as Nekrumah by the majority of monolingual English speakers.

But, for the clusters of the latter group, those which violate the DS filters, the state of affairs is not the same. Those clusters are not only easily pronounceable by untrained monolingual English speakers, but also are frequently met in words of foreign origin such as Kyoto, Vladimir, Tlingit, or zweiback.

The interaction of structural constraints and collocational restrictions, therefore, not only produces fully acceptable and fully deviant clusters but also make out semi-acceptable (allowed by EST with AT, but blocked by DSF's) clusters.

4. SYLLABLE DEMARCATION

Up to now, the observation of the English syllables is primarily focused upon the monosyllable words. In this chapter, the observation will be extended onto multisyllable words, where the problem immediately rises in connection with delimiting syllable boundary.

Different theories of syllable boundaries bring forth two different points of controversy: i.e., what level syllable boundaries are to be delimited and what criteria are to be used to determine syllable boundaries.

4.1 Level of syllabification

There are largely two different theories about the level of syllabic demarcation exemplified by Noske (1982) and Clements and Keyser (1983) respectively.

Noske (266) says that “rules which insert, delete, or change the position of vowels in a string must precede rules of syllable structure assignment and therefore must precede all rules which crucially refer to syllable structure.” What is meant is that the syllable must be demarcated at the later stage of rule application. Noske(274) summarized his point as in (42):

(42) a. Syllabification does not take place at the underlying level, but at a later stage, after the application of the truncation rule:
   b. once the initial syllabification has taken place, (re-) syllabification takes place persistently.

In Hoard (1971: 136), the syllabification takes place after stress assignment and even after...
the major phonological rules have already applied.

This is against our intuitive knowledge of syllable in general. Logically syllable is the sequence of segments and word is the sequence of syllables. Therefore, when word is introduced, its structure or word boundary should be present. This leads to the conclusion that syllable as subpart of word must exist at the level of lexical representation. Otherwise, any unutterable sequence of segments should be permitted in the underlying representation and perhaps uncountable number of rules are necessary to define correct sequence.

Worse still, in case of English, is Hoard's claim (1971: 136). It is widely accepted that suprasegmental properties such as stress, meter, and foot presuppose syllabification (even in SPE, the need is felt to further elaborate the concept of strong and weak cluster for stress assignment) His theory shows the circularity: stress assignment must refer to syllable, but syllabification should refer to assigned stress. Hooper (1972: 533) also finds out the demerits by saying that "it does not seem to be widely applicable to languages of the world, nor particularly advantageous within the present framework".

Then the next option is to say that the syllabification is done in the underlying representation. Clements & Keyser (1983: 27) take this approach:

(43) It is our view that words are fully syllabified at the level of lexical representation. That is, syllable trees are not built up in the course of phonological derivations but are already present, fully formed, in the lexical representation that constitute the input to the phonological component.

This approach breaks the circularity in Hoard's explanation and further, as noted by Hooper (1972: 534), it makes it possible to achieve simplification in phonological component. This approach is taken for granted in this paper (Chapter 2 and 3) by assuming that structural constraints work as a well-formedness condition. Kaye & Lowenstamm (1981: 13-4) confirm this view by examining Odawa syncope rule and claim that there exists the condition (44):

(44) All syllable constraints are defined at the level of lexical representation.

Thus, any string of segments excluded by EST and AT can not be present in the underlying representation. In other words, all the sequences of segments should be nondistinct from EST and AT. This means that the syllable tree branching must match the branching of templates and that the distinctive feature matrices of its segments must correspond to their counterparts of the templates.
Note that the above discussion does not mean that all the syllables must be demarcated only in the underlying representation and no place else. Resyllabification is necessary. This does not represent the weakness of the approach. Even those writers who claim that syllabification must be done at a later stage of phonological derivation are forced to introduce resyllabification (cf. (42b)).

4.2 Syllabification

First of all, it must be recognized from the beginning that syllables are subcomponents of words, and therefore all the syllabification must be done within the domain of word boundary. The two segments that belong to two different words cannot be in the same syllable.

Hoard (1971: 137) formalized the rule (45) to accommodate the above observation:

\[(45) \#^n \rightarrow [ \cdot ] \]

(Where \( n \geq 1 \) (and [ \cdot ] represent syllable boundary))

Accordingly the /sk/ in sky is in the same syllable but the same sequence in kiss Kate can not be included in the same syllable.

Now let's turn to word-internal syllable demarcation. We all know astray has two syllables. Then where is the division line between the first and the second syllable? This is never an easy question to answer. EST, AT and DSF allow the following three well-formed syllable structures:

\[(46) \]

4.21 Onset maximalization principle

The syllabification proposed by Kahn (1976) and Selkirk (1982) among others contains the
following three stages:

(47) a. Identify [+syllabic] and associate one [+syllabic] to one syllable
    b. Put maximal onset cluster before [+syllabic]
    c. Put maximal coda cluster after [+syllabic]

Here, onset maximalization principle (OMP) is at work in (47b). According to (47), only (46a) is correct because the second syllable has maximal onset cluster, /str/, which is nondistinct from the templates.

OMP, however, is not a panacea. Neither can it be a universal principle, nor can it explain all the syllabification in English.

Kahn (1976: 564), noting that *after* and *aster* are pronounced similarly but are syllabified differently, was forced to postulate his Rule IV to remedy the weakness of OMP.

(48) a. (a) (ster)
    b. (af) (ter)

His Rule IV links /f/ to the second syllable to make it ambisyllabic, while his Rule III associate /s/ to the first syllable. The result is (49)

(49) a. (7 (7
    b. (7 (7

Because of the Rule IV’s *ad hoc* nature, from the beginning, there rises the problem of setting two different kinds of onset cluster regulation: one for Rule II, and another for IV.

Kahn, himself, points out the problems in Rule IV:

---

12) For example, in Polish words like stacja (station) or wyspa(island) are syllabified stac $ja$ and wys $pa$. This may be an evidence against the universality of OMP.

13) (The dotted lines represent ambisyllabification.) Kahn does not elaborate the internal structure of a syllable. His main concern is the boundary. This is in line with many earlier writers on syllable, as is exemplified by Basb (1981: 257): “By ‘syllabification’, I understand the division of a phonological string (consisting of phonological segments and grammatical boundaries) into consecutive syllables, and it therefore concerns the border between contagious syllables, not their internal structure in terms of peak, nucleus, margin and the like…”
As it stands, Rule IV appears to be too general. Words like Medford, Bodkin seem to maintain the interconsonantal juncture. Assigned by Rule II, in spite of the fact that they meet the structural description of Rule IV. Now if IV applied to these words, it would give rise to syllable-initial (df) and (dk). Although these are, in fact, clusters which are prohibited in the complete statement of Rule IIa (OMP). Rule IV can not in general be conditioned by the constraints of IIa, since IV must produce, for example, initial (ft) in after. (1976: 565)

Obviously, OMP is the most promising analytical strategy so far. The point is how to eliminate the potential demerits it has.

4.22 Markedness convention

In this and the following section, we will try to elaborate the possibility of implementing OMP by adopting markedness convention, proposed by Kaye & Lowenstamm (1981). Let's first begin with the problem of syllabification of CVCV sequence.

There may be two options here: i.e., (CVC)$S$(V) or (CV)$S$(CV). OMP predicts that the latter syllabification is preferable. Surely CV type syllable is more prevalent than CVC or V in our language. Hyman (1976: 161) says that CV is the only universal and natural type of syllable in human language:

(51) This (CV) is the only syllable type which is found in all languages; in addition, it is the first which is learned in child language acquisition, even in languages having other syllable types. Other syllable types are more or less marked or unnatural.

A CVC syllable is somewhat unnatural, though it is frequently attested in languages. On the other hand, a VCC syllable is considerably less natural and is found in a relatively few languages.

Truly, if a language has CVC syllable type, it also has CV or V type. In other words, the CVC implies the existence of CV and V. This can be formalized by introducing the concept of markedness (cf. Trubetzkoy (1939), SPE, among others).

Kaye and Lowenstamm (1981: 108) observes that if a language has CVC, it also have CV and V as well as CCV but not CCVC or VC. They further investigate the syllable markedness and made the following formula:

— 32 —
(52) a. Syllable Markedness

<table>
<thead>
<tr>
<th>Onset</th>
<th>Rime</th>
<th>Markedness</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>V</td>
<td>0</td>
</tr>
<tr>
<td>ø</td>
<td>ø</td>
<td>1</td>
</tr>
<tr>
<td>CC</td>
<td>VC</td>
<td>2</td>
</tr>
<tr>
<td>CCC</td>
<td>VCC</td>
<td>3</td>
</tr>
<tr>
<td>C₁,...,Cₙ</td>
<td>VC₁,...,Cₙ₋₁</td>
<td>n</td>
</tr>
</tbody>
</table>

b. \( m(S) = m(O) + m(R) \)

(52b) is to compute syllable markedness index (SMI). So, for example, if a language has SMI of 2, it may have (53a) but not (53b), since syllables in (53b) has SMI bigger than 2:

(53) Syllable Onset + Rime = SMI

<table>
<thead>
<tr>
<th>Syllable</th>
<th>Onset</th>
<th>Rime</th>
<th>SMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. CV</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>V</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>CCV</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>CVC</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>b. VC</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>CVCC</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CCVC</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

The generalization is that, if a language has a syllable with SMI(n), it also has syllables with SMI(n-1), SMI(n-2),..., SMI(n-n). To put it in a different way; SMI(n) universally implies the SMI(n-m) where m is not bigger than n.

4.23 Rightward and Leftward strategy

Kaye and Lowenstamm (1981) claim that all the syllabification rule must refer to the syllable markedness index and say that there are two different strategies in this respect: rightward and leftward.

(54) Rightward strategy (RWS)

Scanning a word from left to right, make the first syllable as unmarked as possible. If a resulting syllable on the right conforms to the formal and substantive constraints of the language (EST, AT and DSF), then there is a syllable boundary at that point. If the resulting right syllable violates a constraints, move syllable boundary over one segment to the right and try again. Repeat until the resulting right syllable is licit. After the first syllable boundary has been found, repeat the process for each successive syllable until
the end of the string is reached (119).

The RWS has the effect of minimizing the SMI of rime at the expense of increasing the markedness of the onset. There is not much difference between RWS and OMP, since OMP also tries to minimize the coda cluster by putting every possible combination in onset.

But contrary to the claim about the universality of OMP, Kaye and Lowenstamm (1981: 121) further introduce leftward strategy (LWS), which is thought to be the mirror image of RWS. They claim that some languages like English or French adopts RWS, while other languages like Polish (see fn. 12) employ LWS. In either case, the syllabification must refer to syllable markedness index.

Both OMP and RWS correctly predict that (46a) is the only viable and legitimate syllabification, but their explanations differ: OMP says that (46a) is correct because the second syllable onset has maximal number of segments. From the viewpoint of RWS, however, (46a) is correct because the first (leftmost) syllable has minimal SMI.

Note that RWS and LWS explains everything that OMP can and many more. RWS and LWS therefore may contribute to making the universal framework of phonology.

5. RESYLLABIFICATION

The syllable boundaries are inserted before and after a syllable in the lexical representation as discussed in chapter 3. But since the lexical representation is the input of phonological rules and the phonological rules sometimes change the sequence of segments, there rises the necessity of rearranging syllable boundary after the rule application.

Hooper (1972: 525) sees it and asserted the necessity:

(55) The syllable can be formally and universally defined by a rule which inserts such syllable boundaries between certain sequences of segments. This rule must apply persistently throughout the phonological component, changing the position of the syllable boundary as the sequence of segment change.

In this chapter two kinds of resyllabification rules will be dealt with: one is motivated by the stress assignment in English, another by the universal tendency to avoid the onsetless syllables.
5.1 Stressed syllable rearrangement

In English, most of the phonological rules are very sensitive to syllable structure (cf. Kahn(1976), Hoard(1971) and Selkirk(1982, 1984), but stress assignment often results in the change in syllable boundary.\textsuperscript{14} The stressed syllable attracts more clusters than the unstressed as observed by Bailey (1978 : 254):

\textit{(56)} It has been noticed that... the larger the cluster, the more likely more consonants are to cluster with the heavier-accented nucleus.

Kaye and Lowenstamm(1981 : 122) hold the similar opinion:

\textit{(57)} Ultimately we must distinguish stressed and unstressed syllables. We note that stressed syllables show a wider diversity of syllable types and stressed syllables may have a greater degree of markedness.

This can be easily proved phonetically. When we pronounce \textit{happy} very slowly without giving stress, we can see that the /p/ is aspirated, and that there is a clear syllabic demarcation between /\textipa{hæ}/ and /\textipa{pi}/. But when we stress the first syllable, it becomes /\textipa{hæp}/. This means that the stressed syllable attracts more segments.

Further data reveal the characteristics of the stressed syllables. Look at the following examples:

\textit{(58)}

a. dis\textipa{tem}er miscal\textipa{cul}ation dis\textipa{com}fit
b. dis\textipa{turb} pro\textipa{sp}ective sust\textipa{ain}

Both (58a) and (58b) contain /sC/ cluster. But note that (58a) words are made by adding prefix to the existing words: This means that there are internal word boundaries between the prefixes and words. But the words in (58b) do not have such word boundaries. This difference between (58a) and (58b) results in the difference of syllabification as in (59):

\textit{(59)}

a. dis $\textipa{tem}er$ mis $\textipa{cal}culation$ dis $\textipa{com}fit$
b. di $\textipa{sturb}$ pro $\textipa{spec}ective$ su $\textipa{stain}$

(irrelevant syllable boundaries are disregarded.)

This seems to be true even after stress assignment. The phonetic evidence is that normally

\textsuperscript{14} The stressed syllable readjustment may be the part of the BSC(basic syllable composition) rules suggested by Selkirk (1984 : 25).
the C in (59a) /sC/ sequence is aspirated which, according to Kahn (1976) and many others, reveals that the C is syllable initial.

With such informations, we can conclude that stressed syllable has more consonant clusters in coda but not in onset. This is contrary to our syllabification principle (RWS) in that the stressed syllable arbitrarily increase the SMI. But the increased SMI is correctly what the stress influence is (cf. (57)):

(60) Stressed Syllable Rearrangement

Stressed syllable attracts as many coda consonants as is permissible by EST, AT, and DSF.15

Since the stressed syllable rearrangement is a little bit different from syllabification in the underlying representation, we may express it in terms of phonological rule as in (61):

(61) Coda maximalization rule (CMR)

where 2+4 (C$_s$* + X) is the maximally permissible coda cluster

Note that the CMR is different from Kahn’s (1976: 564) ambisyllabification rules (Rule III & Rule IV) in a couple of ways. First, the resyllabified segments are not dominated by two syllable nodes. They must be moved out of the earlier syllable and into the stressed syllable. Secondly, the movement should not be blocked by EST, AT, and DSF. Kahn’s(565) ambisyllabification yields such awkward initial cluster as (ft), which is not permissible in CMR.

Thirdly, Kahn’s ambisyllabification of such word as aspen with the first syllable /tPs/ violates the cannonical stressed rime filter(cf. fn. 15), while CMR renders the syllable with branching rime constituent /tPsp/, as aspen’s first syllable.

15) The obligatory nature of CMR can be explained by Lass'(1984: 259) surface cannonical stress filter:

```
  *o
  /
  R

  V
  C

  P

  C
```

(At least one R-constituent must branch in the stressed syllable.)
5.2 Copying resyllabification

The second type of resyllabification is motivated by the universal principle of syllable structure that makes a coda consonant the onset of a following onsetless syllable.

As first approximation, compare the pronunciation of my and eye. Superficially the pronunciation of my and eye differs only in that eye does not have m in onset. But notice there is some difference between the pronunciation of eye and m-less my. Eye has its own onset segment. In order to pronounce eye, we have to closed the glottis just before the release to make /ay/ sound, thereby making glottal stop /?/ as its onset.

Truely this glottal stop insertion is motivated by natural tendency to avoid onset-less syllable.16) Our CMR, however, makes the stressed syllable attract the onset segment of the following syllable to its coda, Thereby it renders onset-less syllables.

The same can happen in the inter-word relations. Compare the pronunciation rocket and Rock it. In a slow speech, the former may be /ra $ kit/, while the latter is /rak $ it/. But in a normal speech, their pronunciation is exactly the same.

This is the phenomenon that Kahn (1976: 567) captured in his Rule V (Trans Word boundary Ambisyllabification). But the term ambisyllabification causes a lot of controversies in the linguistic field.17)

We will see it from a little bit different perspective. A copying process will be introduced in this section. The point of the copying resyllabification is that the coda consonant of syllable is copied in the onset of the next onset-less syllable. This can be justified (following Fujimura and Lovins'(1977) concatenation principle) by the phonetic realization of the copied segment.

Suppose there is a sequence of CVj*C*V2. By CMR, the C* becomes the coda of the first stressed syllable. Now the V2 is onset-less. There must be a way to provide onset to the second syllable. The solution for this is to let the V2 copy the coda of the preceding syllable, C* before it.

Then the sequence will be CV1 C* $ C* V2. Phonetically C* is realized by the combination

16) This is universal in that this process lowers SMI. Note that onsetless syllables have higher SMI than the syllables with one onset segment, if other things being equal.

17) This may be exemplified by Bailey's remark(1978: 253): “There seems to be no valid use for the term AMBISYLLABIC, employed by some writers to denote a segment syllabified with both preceding and following nuclei. Except for phonetically long, but phonologically geminate, segments. This does not seem to occur, consonants going with one vowel or the other.”
of the phonetic properties of $C^*$ of the coda and $C^*$ of the onset of the next syllable.

For example, suppose the $C^*$ has R and Q as its allophones. $C^*$ is phonetically realized as R syllable-initially and as Q syllable-finally. Then the syllabification would render CVQ $RV$. In actual utterance, Q and R is collapsed to make, say, X. X will have dominant phonetic characteristics of both Q and R.

The observations so far motivates the following rule:

(62) $\phi \rightarrow C^*/C^*$ [syllabic]

As speech speed increases, we may find another type of copying rule. Look at the following examples:

(63) a. Did you /di juw/ miss you /mi suw/
    b. Miss mayor /mi smeyar/
       This knife /tl snayf/

Alveolar sounds are retracted by the presence of palatal sound, only if the two sounds are tautosyllabic. The /dy/ and /sy/ in (63a) must be tautosyllabic in order to be realized phonetically as /j/ or /s/ respectively. Further note that in (63b), all the nasals are devoiced. This does not happen when the nasals are syllable initial.

To accommodate (63), the rule (62) may be expanded as in (64):

(64) Copying resyllabification rule (CRR)
    $\phi \rightarrow C^*/C^*$ [sonorant]

Note that the CRR is only optional. This means that CRR works only at the speed faster than normal.

Secondly, the CRR must refer to the well-formedness condition. the copied segment should not violate EST, AT, and DSF. Even in the fast speech, $t$ in fat master will never be copied before $w$ because /tm/ initial cluster is excluded.

Thirdly, the main purpose of the CRR, as noted earlier, is to prevent the onsetless syllable

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18) For example, compare the followings in normal speech speed situation:
   a. train /'creyn/ vs hot $S$ rain /'hat reyn/
   b. presidential vs President Yal

19) In this regard, Kaye & Lowenstamm (1981: 114) and Selkirk (1981: 368) propose the structure preserving principle:
   The Principle of Syllabic Structure Preservation:
   Rules of resyllabification should not produce a syllable that does not occur in lexical representation.
in the surface phonetic representation. But there may be other options that can be employed instead of CRR, such as glottal stop insertion or even linking $r$.

6. Conclusion

So far, we have investigated the problem of syllable structures and syllabification.

It was found out that syllable is not merely a linear string of segments but is hierarchically structured with stratified constituents such as onset, rime, peak, and coda. This hierarchical theory of syllable structures correspond to the basic assumptions of non-linear phonological theories.

Each constituent in syllable has its own limits in taking segments under its domination. For example, if there is two segments in onset, the first must be obstruent, and the second may be either voiceless obstruent or sonorant. The onset should not contain four or more consonants. If three, the first is /s/, the second is voiceless obstruent, and the third is sonorant. There can not be more than two segment in peak. These are captured by postulating expanded English syllable template along with two auxilliary templates, where all the constituents carry the specification of the features that they can dominate. All the syllables must be non-distinct from the templates to be well-formed.

It was also found out that certain form of deep structure filter is absolutely necessary for those sequences that conform to templates but are not acceptable syllables. The filters specifies that there can not be more than 3 consonants in coda, that the third must be coronal. If there are two segments and the second is not coronal, then the first must be /s/, that if the last two are obstruents, they must match in voicedness, and many similar regulations in onset and rime.

It was also suggested to introduce surface structure filter, in line with Shibatani(1973), to totally eliminate the appearance of unacceptable sylables in the surface phonetic representation.

Moreover, when a word contains two or more syllables, it is not easy to demarcate the syllable boundaries. In this paper, rightward and leftward strategies are introduced to replace the existing onset maximalization principle to make the theory universally applicable.

Further, syllable may change in the process of rule application. The notion of resyllabification was introduced to accomodate the situation. Two different resyllabification
is recognized in this paper. The first is stressed syllable rearrangement. Since the stressed syllable attracts more coda maximalization rule was needed. The second type of resyllabification is motivated by the universal tendency to avoid onsetless syllable. syllable take onset segment by copying from the coda-final segment of the preceding syllable.

To sum up, there are well-formedness conditions such as EST, AT, and DSF as well as two different rules that makes syllable boundary readjustment. And though not explained in detail, in this paper, we need surface structure filter that may block the yielding of unacceptable syllables by the phonological component.

It may be an interesting proposal to specify the different levels of resyllabification as in (65):

More studies are desired in the field of morpho-phonemic variations as well as English word formation that also affect the shift of the syllable boundaries.

So far, the discussion presents highly constrained and sufficiently generalized theory of syllable that lays foundation for further studies that need reference to the syllable structure.
such as meter assignment, intonation pattern and even the phonetic variations.

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음절구조와 경계에 관한 연구

음절에 관한 연구는 음성학 연구와 더불어 깊은 역사를 가지고 있으나 최근의 단선 음운론적 접근 방법에 있어서는 음절구조 및 경계에 관한 연구가 동반되지 못한 폐차전적 차이가 나타나 있다. 그러나 자립문절 음운론 및 문론음운론의 대두로 70년대 후반부터 음절이 차지하는 비중이 점차 커져가고 있다. 이렇게 새로운 연구가 생겨난 음절에 관한 연구는 여러 학자에 의해 여러가지로 발전되어 다소 혼란한 양상을 보이고 있다.

이에 따라 본 논문에서는 지금까지의 음절에 관한 여러가지 접근을 정리해 보고 현재의 복합 음운론 연구에 가장 적합한 음절 이론을 제시해 보았다. 본고에서 음절은 단순한 음소의 연결체가 아니라 계층적 구조를 지니는 것으로 밝혀졌으며 음절의 적격 구조 조건이 그 계층적 특성을 자체의 제약과 연결 제약등에 의해 체계화 될 수 있음을 알게 되었다.

아마도 음절의 문제도 함께 고려함으로써 이제까지 알자 체계에서만 필요하다고 생각되었던 문건이 이성적 차이를 설명하는 데 큰 도움을 주고 있음을 알게 되었다. 이 같은 음절 경계 구분을 함에 있어서 유독 구라가 도입되고, 이를 이용한 분절법을 체계화 하여 제시하였다. 이로 음년 규칙의 적용으로 알맞아 음절 내부의 음소 배열이 바뀌게 될 경우가 있음을 토대로 조사해 보고 이를 위하여 음절 경계 제 조건에 관한 두 가지 규칙을 도입함으로써 음절의 음성적 특성에 이르기까지의 음절 이론을 체계적으로 정립하였다.

이렇게 하여 정립된 본고의 이론은 음열 배정문제에 매우 효과적으로 사용될 수 있어 연구의 체계화에 일익을 달달할 수 있을 것이다.