Chapter: Six

Sonority, Optimality, Binding principle and phonotactics: Evidence from Assamese Consonant cluster

6.0 Introduction:

An attempt has been made in this chapter to analyze the permitted and prohibited consonant cluster in Assamese in the framework of Optimality theory and thereby trying to correlate this phenomenon with the notion of phonological strength asymmetries. In literature it has been reported that the syllable is a complex constituent, which is constrained both in linear and hierarchical terms with sonority playing a pivotal role in its internal organization, especially in the patterning of the segments that constitute the syllable. To what extent the constraints on syllable shape and sonority sequencing succeed in capturing segment sequencing in linguistic forms is a topic of inquiry in this topic under discussion.

The syllable has assumed a prominent position in phonological theory that represents not only phonologically significant groupings of segments. It is also needed to account for pervasive crosslinguistic similarities among permissible segment sequences that are crucially recurrent. Ladefoged and Maddieson (1996) claim that syllable is an abstract phonological constituent without clear phonetic correlates. Stetson's (1928) chest pulse theory that was once considered as the standard physiological characterization of the syllable—was shown by Ladefoged (1967) to be largely unsubstantiated. Parker (2002) claims that even segmental sonority which is instrumental in explaining the internal organization of the syllable— is highly phonologized. The original motivation for the postulation of the concept of syllable was to account for segment phonotactics (Kohn, Selkirk 1984). However this perspective was challenged by Steriade (1999a) and Blevins (2003) according to whom segment phonotactics ought to be string based rather than syllable based. The standard view was that of positional faithfulness view, that is the distribution of consonantal place and laryngeal features are subject to neutralization in certain environments, that is the coda position in a syllable. According to this standard theory certain regularities in the sequential distribution of segments are best stated as syllable based constraints. Steriade and Blevins go to the extent of claiming that the instance of neutralization cannot be attributed to coda constraints or any other constraints that make reference to syllables. Their basis of claim is that phonotactics
can be rooted in perceptibility and they have phonetic rather than structural basis. Blevins (2003) argues that string based phonotactics are primary in phonological systems and the syllabifications, that is, the majority of phonotactic constraints are best stated as feature sensitive, string based constraints independent of syllable structure. Although it has been found that the phonetic bases of string based phonotactics may not be transparent owing to phonologization, in majority of cases they remain surface true and reflect the unmarked sound pattern. Where surface true, Blevins argues, these string based phonotactics should be encoded in terms of language specific inviolable constraints. Nevertheless, the importance of syllable in segment sequencing cannot be ignored completely although all segment phonotactics cannot be explained with reference to only syllabic account. Yip (1991) proposes constraints on string adjacent segments, known as cluster constraints which operate in tandem with syllable based constraints.

As this section focuses on the possible onset cluster in Assamese phonotactics from the perspective of sonority sequencing and OT constraints it is quite convenient to have a brief discussion on the theme of constraints on syllable shape, syllable and optimality framework, the notion of sonority and sonority distance within onset consonant cluster.

In the next section I am going to discuss the notion of sonority which has been playing a crucial role in the patterning of segmental sequences in the internal syllabic design.

6.1 Sonority and crosslinguistic phonotactics:

Sonority and its relevance pertaining to the organization of syllables has been widely reported in literature ranging from the early works of Sievers (1881), Jesperson (1904), Saussure (1916), as well as Vennemann (1972), Kiparsky (1979, 1981), Hooper (1976) to Steriade (1982). Sonority is a notion which can define the characterization of segment sequencing within syllables including the characterization of both peaks and margins. Sonority of a segment is generally represented by means of a scale that corresponds to an ordering of segments ranging from those which have higher sonority value, i.e. vowels, to those which have lower sonority value, i.e. stops, as displayed below (Clements 1990):
By taking into account the above scale the organization of segments within a syllable exhibits a following pattern: the nucleus is occupied by the most sonorous segment while the less sonorous ones occur towards the margin. Thus the notion of sonority is instrumental in characterizing the crucial aspects of syllable internal segment sequencing. Clements (1990:299) claims: “sequences of syllables display a quasiperiodic rise and fall in sonority, each repeating portion of which may be termed a sonority cycle.”

The main use of the sonority hierarchy is to account for restrictions on sound sequences, particularly within and between syllables. In the case of consonant clusters, sonority sequencing restrictions prefer a rising sonority slope in complex onsets and a falling slope in heterosyllabic sequences. This notion of sonority hierarchy is initially came into fore on the basis of cross linguistic observation. For the hierarchy to take on explanatory value, it needs to be defined in terms of factors that are that are independently known to shape the design of phonological systems. As fas as the general consenseus is concerned the relevant factors are phonetic in nature that involve some notion of articulatory aperture, acoustic intensity or audio- perceptual salience. However, till up now a satisfactory phonetic definition of sonority
in these parameters has been surprisingly elusive. However it can be argued in the perspective of Clements (1990) that sonority can not be correlated to any unitary physical property but can be viewed as a cover term for a collection of independent acoustic properties that contribute to an overall dimension of perceptibility or auditory perceptual salience. Price (1980) suggests that three such components are involved: presence versus absence of a clear formant structure, presence versus absence of periodicity, and steady state versus transient formant patterns, each of which might be thought of as contributing to overall acoustic intensity.

The issue as how sonority is to be represented in the grammar came up with two alternative views: the one view is held by phonologists such as Venemann (1972), Hooper (1976:205-207) Selkirk (1984a) and others, according to which sonority should be incorporated into the grammar as a multi valued feature with integers as standardly assumed values. Whereas another view holds the argument that sonority classes can be characterized by the major class features (Kiparsky 1979, 1981, Clements 1990, Zeck 1988, among others). It implies that the values for the major class features yield the sonority classes on the ground that major class features are independently required and having both major class features and multivalued feature [sonority] in grammar would lead to duplication.

This notion of sonority can be addressed in the light of constraint based approach of Optimality theory. It is difficult to describe the phonological processes such as aspiration and glottalization that are instrumental in the organization of segmental sequencing in the phonotactics of a language without reference to the prosodic constituent called syllable. So, in the next section I am going to address the issue of syllabification and OT constraints.

6.1.1 Syllable in optimality:

Phonological representations and syllable are best represented in output oriented frameworks of Optimality theory (OT), which can be defined as a theory of constraint interaction in grammar developed in Prince and Smolensky (1993) and further modified in McCarthy and Prince (1995a). It is no exaggeration to say that the role of syllabification has played a
significant role in establishing OT and intum, OT has contributed a lot to our understanding of the role of syllable. Syllable has helped in establishing the notion of OT in the sense that it can neatly illustrate simple factorial typologies but also because it does involve different interacting modules such as segments, sonority, moras, syllabification, edges and stress.

Syllable has been analysed not only in rule based approach but also by constraint based OT approach. Rule based approach include structure building rules responsible for the construction of nuclei, onset and codas (Kahn 1976, Steriade 1982, Clements and Keyser 1983, Levin 1985, Hayes 1989a). However, with the outcome of OT the emphasis in phonological theory has shifted from the rules to representation that finds its manifestation in the form of either templates or constraints. Below is presented how the possible range of syllable shapes and syllable inventories is characterized by a set of output constraints, in the spirit of Prince and Smolensky’s (2004) OT account. Following are the constraints on the basis of which we can be able to capture the basic syllable shapes, as well as their relative markedness.

Constraints on syllable forms: (after Prince & Smolensky 2004)

(6/2)

a) NUC Syllables must have nuclei
b) ONS Syllables must have onsets
c) – COD Syllables may not have a coda

From the above constraints the universal CV syllables have emerged as the least marked by virtue of satisfying all these constraints on a syllable shape and hence its unmarked status is derived in the theory. Whereas the syllable type V violates ONS, CVC violates –COD and VC violate both ONS and –COD. The above constraints on syllable forms belong to the general class of markedness constraints in OT. They interact with faithfulness constraints: MAX, which prohibits segments deletion, and DEP, which prohibits segments insertion as stated formally below:
Faithfulness constraints: (from McCarthy & Prince 1995a)

a) MAX An input segment has a correspondent in the output. (NO deletion)
b) DEP An output segment has a correspondent in the input. (No epenthesis)

The syllable inventories found in the world languages can be characterized through interaction between markedness and faithfulness constraints. If only markedness constraints predominate, all syllables in languages will display CV pattern as this syllable shape satisfies all the constraints. However, other syllable types are also allowed under the pressure to preserve input segments. The range of syllable inventories can be captured with the help of faithfulness constraint as mentioned above. ONS and -COD don't conflict with each other and hence it is difficult to rank them directly. It results in four general rankings between ONS, -COD and the faithfulness constraints. \{MAX, DEP\} indicates that atleast one of MAX and DEP must be in the ranking position indicated.

Basic syllable rankings:

a) CV ONS, -COD >> \{MAX, DEP\}
b) CV,V -COD>>\{MAX,DEP\}>>ONS
c) CV, CVC ONS >> \{MAX,DEP\}>>-COD
d) CV,CVC,V,VC \{MAX,DEP\}>> ONS,-COD

Even the complex margins are regulated by the markedness constraints *COMPLEX ons and *COMPLEXcoda stated below:

a) *COMPLEX ons Syllables must not have more than one onset segment.
b) *COMPLEX coda Syllables must not have more than one coda segment.
In the light of the above constraints syllables can be ranked in the following ways:

(6/6)

Syllable rankings with *COMPLEX constraints

a) CV *COMPLEXons, (*COMPLEXcoda), ONS, - COD>> {MAX,DEP}

b) CV, V *COMPLEXons,(*COMPLEXcoda),ONS,COD>>{MAX,DEP}>>ONS

c) CV,CVC *COMPLEXons,*COMPLEXcoda,ONS>>{MAX,DEP}>>-COD

d) CV,CVC,V,VC *COMPLEXons,*COMPLEXcoda>>{MAX,DEP}>>ONS,-COD

These constraints drive home three generalizations:

a) only onsets may be complex
b) only codas may be complex
c) both onsets and codas may be complex

As, for instance, the ranking {MAX,DEP>>*COMPLEXcoda,-COD licenses any number of coda consonants including none. In contrast, the rankings ONS>>{MAX,DEP}>>*COMPLEXons yields one or more onset consonants. The latter case is shown below:

<table>
<thead>
<tr>
<th>/CCVC/</th>
<th>ONS</th>
<th>DEP</th>
<th>*COMPLEXons</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCV,V</td>
<td>*!</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>CV.CV.CV</td>
<td>**!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCV.CV</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

Table No 6/a: Representation of ONS>>{MAX,DEP}>>*COMPLEXons
Thus, the syllable inventories can be characterized by the different rankings of the set of constraints presented above. These constraints are also instrumental in characterizing phonological processes driven by syllable well formedness.

### 6.1.2 Constraints on sonority distance:

Sonority sequencing is of syntagmatic in nature: the sonority value of a segment does not only depend on its structural role within the syllable but also on the sonority of its neighbours. Hence the concept of sonority sequencing can be acclaimed as relational concept, as is apparent in the following statement (based on Selkirk 1984a:116):

\[(6/7)\]

**Sonority sequencing generalization (SSG)**

For every pair of segments $s$ and $z$ in a syllable, $s$ is less sonorous than $z$ if

- a) (i) $s < z < \text{Nucleus}$
  
  or (ii) $\text{Nucleus} > z > s$

- or b) (i) $s < z$ and $z$ is the nucleus

  or (ii) $z > s$ and $z$ is the nucleus

These constraints on sonority distance may impose restrictions on the rise or fall in sonority which go beyond the minimal requirements of SSG. This is proposed by Prince and Smolensky’s (2004) natural hierarchy of margins, which is the mirror image of the peak hierarchy. The best margins are crosslinguistically found to be obstruents, followed by nasals and liquids, with vowels being the worst margin candidates. Below is given the sonority hierarchy of onsets:

\[(6/8)\]

**Hierarchy of onsets:** $\text{ONS/O} > \text{ONS/N} > \text{ONS/L}$

### 6.1.3 Sonority distance from onset to nucleus

Constraints on syllabic thresholds bring home the point that syllable nuclei are more sonorous than onsets. But onsets may tend towards low sonority beyond the minimal
requirement of being less sonorous than the neighbouring nucleus. Thus OV is better than NV, which in turn is better than LV. Such observation brings the important role of low onset sonority in the overall sonority profile of the syllable into relief. Such observation is enriched by the research findings from child language grammar found by Gnanadesikan (2004). In this study it has been found that in consonant cluster simplification, the surviving consonant is lower in sonority than its competitor yet any consonant can occupy a simplex onset regardless of its sonority. The same case of cluster simplification is documented in Pali, the consonant that is eliminated is more sonorous than the one that survives and the one which stays is linked to the onset. This preference for low sonority onset can be represented by Prince and Smolensky's (2004) hierarchy of onsets. This hierarchy of onsets yields markedness constraints on onset sonority, as proposed in de Lacy (2001). The set of onset sonority constraints, with fixed rankings, makes obstruents onsets the least marked, and liquid onsets the most marked.

(6/9)

*ONS/L >> *ONS/N>>*ONS/O

These constraints captures the sonority rise at the left edge of the syllable, as stated in SSG. It also captures the tendency towards lower sonority onsets beyond the requirements of SSG. Even it has also been reported by de Lacy (2001) and Smith (2003) that in some languages, high sonority segments are entirely banned from the onset. In Seoul Korean, for instance, word initial syllables may not begin with liquids and word internally; liquids in the onset are also linked to the coda. The ranking *ONS-L >> IDENT-I0 [approx]>> *ONS/N insures that nasal onsets will be protected but liquid onsets will be eliminated.

6.1.4 Sonority distance within a complex onset:

SSG states the relative sonority within complex onsets. In a bi consonantal onset cluster, the second consonant should be more sonorous than the first. However in Spanish [pn] and [ml] are not possible onset sequences despite the fact that the second consonant is more sonorous than the first one (Harris 1983). Such cases can be interpreted in the light of Minimal Sonority Distance (MSD) imposed on a pair of onset segments (Vennemann 1972, Hooper 1976, Steriade 1982, Selkirk 1984a, Levin 1985, Baertsch 2002). [p] is separated from [l] by two intervals, while only one interval separates [p] from [n] and [m] from [l]. Because the minimal sonority distance in Spanish is atleas two intervals, [pl] and [pr] are possible onset
clusters, while [pn] and [ml] are not. Any two consonants that are at least two intervals apart can form a complex onset.

6.1.5 The range of values of MSD

Sequences with flat sonority are given the value MSD0, sequences with steepest rise, MSD2 and those with a less steep rise, MSD1.

Minimal Sonority Distance (MSD)

<table>
<thead>
<tr>
<th>MSD</th>
<th>Clusters</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSD0</td>
<td>OO, NN, LL</td>
</tr>
<tr>
<td>MSD1</td>
<td>ON, NL</td>
</tr>
<tr>
<td>MSD2</td>
<td>OL</td>
</tr>
</tbody>
</table>

In literature it has been reported that Chukchee, which allows ON, NL, and OL onset clusters, provides an example of a language with the minimal sonority distance MSD1; clusters of lesser distance are broken by epenthesis (Bogaras 1922, Levin 1985). Scatton (1983) claims that Bulgarian allows OO, NN, LL, ON, NL and OL onset clusters and thereby exemplifying a language whose minimal sonority distance is MSD0. The minimal sonority distance for Spanish is MSD2 as it allows only OL onset clusters (Harris 1983, Baertsch 2002). Baertsch (2002) suggests that the two members of the onset cluster may be subject to different sonority requirements.

6.1.6 Sonority distance in syllable contact

The optimal syllable shapes are further subject to syllable contact (SC), which favours a sonority fall across syllable boundaries (Hooper 1976, Vennemann 1988, Davis 1998, Baertsch 2002, Gouskova 2001, 2004). Below is given the scale that evaluates syllable contact. Sequences of flat sonority are given the value SCO, sequences of rising sonority have positive values and those that fall in sonority have negative values. Syllable contacts with positive values are highly disfavoured.
Syllable contact (SC)

<table>
<thead>
<tr>
<th>SC+2</th>
<th>OL</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC+1</td>
<td>ON, NL</td>
</tr>
<tr>
<td>SC 0</td>
<td>OO, NN, LL</td>
</tr>
<tr>
<td>SC-1</td>
<td>LN, NO</td>
</tr>
<tr>
<td>SC-2</td>
<td>LO</td>
</tr>
</tbody>
</table>

Syllable contact effects are explicitly shown in the studies of both Kirgiz and Sidamo (Gouskova, 2001). Both these languages exhibit preference for clusters in the negative range of this scale and prohibition for clusters in the positive range. However, in contrast to these restrictive type of cases, languages like Turkish permit all types of heterosyllabic clusters (Baertsch and Davis 2001).

6.2 Assamese phonotactics and initial onset consonant cluster

Vowel Phonemes

Inventory

a. Short

<table>
<thead>
<tr>
<th></th>
<th>Front</th>
<th>Central</th>
<th>Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>Close</td>
<td>i</td>
<td></td>
<td>u</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Close-mid</td>
<td>e</td>
<td></td>
<td>o</td>
</tr>
</tbody>
</table>

147
Table No 6/b: Assamese short vowel phonemes

b. Consonant Phonemes

Inventory:

<table>
<thead>
<tr>
<th>Articulation Place →</th>
<th>Bilabial</th>
<th>Alveolar</th>
<th>Alveolar</th>
<th>Palatal</th>
<th>Velar</th>
<th>Glottal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manner ↓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plosive</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>p b</td>
<td>t d</td>
<td></td>
<td></td>
<td>k</td>
<td>g</td>
</tr>
<tr>
<td></td>
<td>pʰ bʰ</td>
<td>tʰ dʰ</td>
<td></td>
<td></td>
<td>kʰ gʰ</td>
<td></td>
</tr>
<tr>
<td>Nasal</td>
<td></td>
<td>m n</td>
<td></td>
<td></td>
<td>η</td>
<td></td>
</tr>
<tr>
<td>Fricative</td>
<td></td>
<td></td>
<td>s z</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ɦ</td>
</tr>
<tr>
<td>Approx</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>w j</td>
</tr>
<tr>
<td>Lat Appr</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>l</td>
</tr>
</tbody>
</table>

Table No 6/c: Assamese consonant phonemes

148
Out of the above Assamese consonant phonemes listed above in the table the approximants /w/, /j/ and velar nasal /y/ can not occur in word initial onset position.

(6/11)

Below are given the examples of the phonemes in word initial position:

/p/: pani (water)

/b/: bali (sand)

/pʰ/: pʰrokal (bright)

/bʰ/: bʰat (rice)

/t/: tariṅ (date)

/d/: dorphon (mirror)

/tʰ/: tʰikona (address)

/dʰ/: dʰjan (meditation)

/k/: kol (banana)

/kʰ/: kʰin (thin)

/g/: gōrō (cow)

/gʰ/: gʰôn (thick)

/m/: môn (mind)

/n/: nirnōi (decision)

/s/: sari (four)

/z/: zuta (shoes)

/x/: xah (courage)

/h/: hah (duck)

/r/: rati (night)
\(/l/ : \text{lora (boy)}\)

\(*/wh/, */j/ and */h/ are banned in word initial position by the rules of Assamese phonotactics.

6.2.1 Branching onsets in Assamese:

Now in this section consider the instances of branching onsets permitted in Assamese phonotactics in word initial position:

(6/12)

Consider the following Assamese words:

1. Stop + Liquid

\(/pr/ \quad \text{pran 'life'}\)

\(\text{prem 'love'}\)

\(/pl/ \quad \text{plawon 'shower'}\)

\(\text{plawito 'filled with water'}\)

\(/br/ \quad \text{br\text{\textsuperscript{\textcircled{}}hmand\text{\textsuperscript{\textcircled{}}} 'universe'}\)

\(/b^\text{\textcircled{}}\text{\textsuperscript{\textcircled{}}r/} \quad \text{bro\text{\textsuperscript{\textcircled{}}om 'illusion'}\)

\(/bl/ \quad \text{blauz 'blouse'}\)

\(/tr/ \quad \text{troyudox 'thirteenth'}\)

\(\text{tritiyo 'third'}\)

\(/\text{dr}/ \quad \text{dro\text{\textsuperscript{\textcircled{}}j\text{\textsuperscript{\textcircled{}}} 'substance'}\)

\(\text{dristi 'vision'}\)

\(/kr/ \quad \text{krom 'serial'}\)

\(\text{kromannoye 'gradually'}\)

\(/kl/ \quad \text{klanto 'tired'}\)
The unpermitted initial consonant cluster comprising of stop and liquid are */tl/ and */dl/ although they conform to the principle of sonority hierarchy.

2. Nasal + Liquid

*/mr/  
mrityu  ‘death’

mrigo  ‘deer’

*/ml/  
mlan  ‘pale’

*/nj/  
njai  ‘justice’

In Assamese phonotactics the alveolar and velar nasal can not constitute the cluster with liquid in initial onset position of a syllable. So the prohibited patterns are */nr/, */nl/, */ŋr/ and */ŋl/.

3. Fricative + Liquid

*/st/  
srom  ‘labour’

sristi  ‘creation’

srinpo  ‘peak’

*/hr/  
hridopi  ‘heart’

In Assamese phonotactics there are only two fricatives /s/ and /h/ which can function as the initial member of a cluster comprising of fricative and liquid.
The prohibited patterns are:

\[*/zt/, */zl/, */hl/\]

4. Fricative + Stop

\(/st/\)  
```
stmb\o  'pillar'
stn    'breast'
stut\i  'prayer'
```

\(/st/\)  
```
st\a\n    'place'
st\a\nij\o 'local'
```

\(/sp/\)  
```
sp\r\n    'touch'
spriha 'desire'
```

\(/sp/\)  
```
sp\o\l\i\n 'ashes'
```

\(/sk/\)  
```
skrin    'screen'
```

\(/sk/\)  
```
sk\o\l\i\n 'degradation'
```

This is the special property of the Assamese post alveolar fricative /s/ that can function as the initial member of a consonant cluster followed by voiceless stops. But it cannot make cluster with the voiced plosives of Assamese. So, the prohibited shapes in Assamese consonant cluster phonotactics are: */sd/, */sbl/, */sg/.

5. Fricative + Nasal

\(/sm/\)  
```
sm\o\x\n    'graveyard'
```

\(/sn/\)  
```
sn\i\d\o  'calm'
```

```
s\a\n    'bathe'
```

The post alveolar fricative /s/ can form consonant cluster with bilabial and alveolar nasal as initial member of the consonant cluster. The velar nasal /\l/ never becomes the member of any
consonant cluster. What is interesting to note that other fictive sounds /z/ and /h/ are not allowed in Assamese phonotactics to be the members of a consonant cluster with nasals. Hence the prohibited consonant clusters are: */sn/, */zm/, */zn/, */zn/, */hm/, */hn/, */hn/.

On the basis of the above illustration the possible word initial Assamese onset clusters are outlined below (6 i) Here ‘+’ indicates that the cluster is allowed as an onset; ‘_’ that it is not possible.

<table>
<thead>
<tr>
<th></th>
<th>j</th>
<th>v</th>
<th>l</th>
<th>r</th>
<th>p</th>
<th>t</th>
<th>k</th>
<th>pʰ</th>
<th>tʰ</th>
<th>kʰ</th>
<th>b</th>
<th>d</th>
<th>g</th>
<th>bʰ</th>
<th>dʰ</th>
<th>gʰ</th>
<th>m</th>
<th>n</th>
<th>ɳ</th>
<th>s</th>
<th>z</th>
<th>h</th>
</tr>
</thead>
<tbody>
<tr>
<td>p</td>
<td></td>
<td></td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>b</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>pʰ</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>bʰ</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>t</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>tʰ</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>d</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>dʰ</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>k</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>g</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Table No 6/d: Permissible and prohibited word initial onset clusters in Assamese

From the chart showing word initial consonant cluster a generalization can be drawn that the only permitted word initial clusters are those that show a rise in sonority. In Assamese phonotactics, obstruents and sonorants combine quite freely to constitute two member onsets within the limits set by the universal sonority sequencing principle. Word initial clusters such as /pl, gl, pr, tr, dr, gr/ are found but such as */l, r/, etc, where the sonority relations are
reversed, are not present in the phonotactics of Assamese. So, it can be argued that sonority constraints play an important role in the patterning of segmental distribution in the phonotactics of a language.

The data presented in (6/12) 1, 2 and 5 conform to the principle in sonority hierarchy. Kenstowicz (1994) claims that the construction of complex onsets and codas is guided by a sonority sequencing principle which requires onsets to rise in sonority toward the nucleus and codas to fall in sonority from the nucleus. This is best manifested in the data as stated above.

It is interesting to show here in this context that in a hierarchy of complex onset cluster obstruent clusters are the least marked and the liquid clusters are the most marked. In Assamese word initial syllables cannot begin with liquids and nasals. This phenomenon is supported by cross linguistic evidence in the world languages. It can be represented in the following schemata:

The set of onset sonority constraints, with fixed rankings, makes obstruents onsets the least marked, and liquid onsets the most marked. This hierarchy of onsets yield markedness constraints on onset sonority, as proposed in de Lacy (2001).

(6/13)

\[
*\text{ONS/L} >> *\text{ONS/N} >> *\text{ONS/O}
\]

These constraints captures the sonority rise at the left edge of the syllable, as stated in SSG. It also captures the tendency towards lower sonority onsets beyond the requirements of SSG. Even it has also been reported by de Lacy (2001) and Smith (2003) that in some languages, high sonority segments are entirely banned from the onset.

In Assamese, the ban on liquids as the first member in word initial cluster can be represented by using the constraints in OT framework in the following way:

(6/14)

\[
*\text{ONS-L} >> \text{IDENT-I0 [approx]} \text{ insures that liquid onsets will be eliminated.}
\]

But word initial syllables in Assamese are allowed to begin with nasal consonants. It can be shown by the following ranking of the OT constraints:
Moreover, what is seen from the above tableau in (6) on Assamese onset consonant cluster is that the second member of the cluster agrees in terms of feature [voice] with the first member of the cluster. It can be formulated in the following fashion in the form of a constraint: Given a consonant cluster C1C2, if C1 is voiced, then C2 must be.

Nasals in Assamese can function both as the initial and second member of a consonant cluster. It functions as the initial member while forming cluster with liquid as shown in (2) and second member when the initial member of the cluster happens to be voiceless post alveolar fricative /s/.

In Assamese phonotactics the voiced plosives cannot qualify to be the members of an initial consonant cluster in a word with fricative. In contrast, the voiceless plosives /p/, /pʰ/, /t/, /tʰ/, /k/, /kʰ/ are found to be the constituents of the cluster as shown in data (6/A).

Aspiration also plays a significant role in the patterning of initial consonant cluster. Only the unaspirated voiceless plosives and voiced aspirated as well as unaspirated plosives can be the initial member of the consonant cluster. The aspirated voiceless plosives can never be the initial member of the consonant cluster in Assamese.

In the next section I am going to address the phonotactic patterns of word initial clusters in Assamese in the framework of Government theory, Binding parameter and Optimality theory. Here an attempt is made to provide a justification as why stops and nasals can function as the word initial cluster whereas liquids fail to be the first member of a word initial cluster in the backdrop of segmental complexity involved in governing relations. To what extent the intrinsic make up of the segment is responsible in the patterning of the phonotactics of a language is a topic of inquiry in this section.

6.2.2 Some observations in the patterning of Assamese phonotactics in the light of Government theory, Binding parameter and Optimality theory:

Word initial onset cluster in Assamese can be formed by combining either stop + liquid or nasal+liquid. But liquid does not have the potential to be the initial member of the onset
cluster. As, for instance the following are not the onset cluster in Assamese permitted by the phonotactic constraints in Assamese: *rp, *rt, *lp, *rk, *rm, *lm

The ungrammaticality associated with these above onset clusters can be addressed in the light of constituent government relationship (Harris 1990). As we have already discussed, constituent government is characterized by Directionality and Strict Locality Condition. The syllabification of adjacent segments is determined by the governing relations and it is the constituent government which determines what constitutes a well formed branching constituent. In the examples stated above the stops and nasals are functioning as governors and the liquids as governees. As, for illustration consider the following onset branching:

(6/16)

pr, ml

Here in this onset cluster the approximant is governed by the stop and in the latter the liquid by the nasal. In these examples, a downward complexity slope is enforced between a governor and a governee. The reasons as why p governs r can be answered from the internal make up of the two segments. Whereas the voiceless bilabial stop has two internal elements constituting its structure the approximant possess only one internal component, as is evident from the representation below:

```
x   x
   |
U°  R°
   |
?°  |
   p  r
```

Figure No 6/A: Representation of internal make up of ‘p’ and ‘r’

In the same way, from the analysis of the onset branching in initial position in Assamese, it is observed that nasals can precede liquids but not vice versa. This distributional asymmetry is instrumental in providing explicitly the ability of the nasal to govern the liquid. This ability
cannot be assigned to charm value as both segments are neutrally charmed. The asymmetry here is motivated by the Complexity Condition: nasals containing three elements have priority over liquids, which contain two or sometimes only one element. Thus if we argue in lines of Harris (1990) it is to be noted that sonority is structurally encoded where a correlation can be established between sonority and segmental complexity. As we have seen in the above illustration of Assamese data plosives govern liquids on the ground that plosives are more complex than liquids in terms of internal components involved in representation. According to Harris (1990) the more sonorant a segment, the less complex its representation. But Rice (1992) has argued that greater sonority implies greater complexity. For convenience, consider the following representations for coronal stops, nasals and laterals under the rubric of two theories:

i) Harris (1990) interpretation:

<table>
<thead>
<tr>
<th>Coronal stop</th>
<th>Coronal nasal</th>
<th>Coronal lateral</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>R°</td>
<td></td>
</tr>
<tr>
<td>R°</td>
<td>?°</td>
<td></td>
</tr>
<tr>
<td>h°</td>
<td>N+</td>
<td></td>
</tr>
<tr>
<td>H-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Here, ? = occlusion; R° = coronal; h° = noise and H- = stiff vocal cords

Figure No 6/B: Representation of coronal stop, nasal and lateral in the framework of Harris (1990)
ii) Rice (1992) interpretation:

Here, SL = Supralaryngeal; AF = Air Flow; SV = Sonorant Voice

Figure No 6/C: Representation of coronal stop, nasal and lateral in the framework of Rice(1992)

From the above representation it is evident that laterals have more SV structure than nasals and in that scale stops can be placed at the bottom in terms of the number of SV structure. Thus the sonority profile within an onset is thus met only if the second consonant has more SV structure than the first. For convenience consider the following representation:

Figure No 6/D: Representation of stop and lateral
This issue can also be analyzed within the framework of syllable based approach couched within OT framework. Here I am taking the instance of the split margin approach to syllable structure which takes in to consideration Margin hierarchy of Prince and Smolensky (1993), that gives preference to segments of low sonority. This constraint is applicable to singleton onsets or to the first member of an onset cluster and it is known as M1 hierarchy. In the same way, the M2 hierarchy applies both to the second member of an onset and a singleton coda. It differs from M1 hierarchy in the sense that it gives preference to consonants of high sonority.

(6/17)

M1 hierarchy (preference given to consonants of low sonority)

*M1/r >> *M1/l >> *M1/ Nas >> *M1/obs

(6/18)

M2 hierarchy (preference given to consonants of high sonority)

*M2/obs >> *M2/ Nasal >> *M2/l >> *M2/r

These constraints stated above have bearings upon the functionally grounded onset sonority implications. Crosslinguistically it is observed that word initial onsets prefer segments of low sonority value. The instances of Assamese data adhere to the crosslinguistic preference for low sonority onsets which has been documented in literature. This preference is clearly discerned when a choice has to be made between two different available onsets. Steriade (1982, 1988); McCarthy and Prince (1986) have shown that in Sanskrit reduplication, it is the lowest sonority member of the onset cluster that is reduplicated. In the same way the preference for low sonority onsets can be supported from the literature of cluster simplification in child language phonology. In Gnanadesikan (1995) and Barlow (1997) it is reported that children always show a preference for low sonority onsets in phenomena such as cluster simplification (blue > [b:u:], sky > [gai], snow > [sou]). This preference for low sonority onsets is assigned functional motivation too. The auditory system is particularly sensitive to rapid changes in spectral patterns (Stevens 1989; Ohala 1992; Delgutte 1997; Warner 1998). Delgutte (1997) claims that a low sonority onset is preferred because it is more distinct from the syllable nucleus than a high sonority onset would be.
This functional motivation for low sonority onsets is implemented within Optimality Theory (Prince and Smolensky 1993; McCarthy and Prince 1995) as a family of constraints of the general type *ONSET/X, where X is a variable that ranges over each step of the segmental sonority scale. This assumption is the modified version of the *MARGIN/X subhierarchy of Prince and Smolensky (1993) which applies to margin or non peak segments within the syllable. The individual *ONSET/X constraints are in a universally fixed ranking determined by the sonority scale, with the highest rank given to the constraint against the most sonorous onset.

(6/19)

The *ONSET/X subhierarchy assumed here is shown below:

*ONS/GLIDE>>*ONS/RHOTIC>>*ONS/LATERAL>>*ONS/NASAL>>*ONS/VOICED

OBST>>*ONS/VCLSOBST

Smith (2003) claims what is appealing about the *ONSET/X subhierarchy is that, as this subhierarchy is based on the sonority scale and the perceptual preference for low sonority onsets, it is functionally grounded. However, in some languages it has been observed that, the onset sonority restrictions are specific to the word initial syllable. Hence, a special version of *ONSET/X which is positionally relativized to the initial syllable as stated below:

(6/20)

[*ONSET/X]σ1 The left most “onset segment” in the initial syllable does not have sonority level X.

Assamese initial consonant cluster can be analysed in the following manner:

DEP, the constraint against epenthesis (McCarthy and Prince 1995), is ranked above all [*ONSET/X]σ1 constraint except [*ONSET/GLI]/σ1. Hence the potential glide onset can compel the insertion of a segment.

Consider the Assamese example ‘njon’

Initial glide onsets are avoided: njon
Moreover, in Assamese phonotactics it has been seen that oral stop clusters are not seen in onset position, but stop or sonorant clusters are present. Under a sonority account it can be attributed to a preference for a greater sonority distance between the two members of a cluster. This pattern exhibited in Assamese phonotactics is in consonance with the cross linguistic observation which confirms that clusters of oral stops are more marked than fricative stop or sonorant stop clusters (Kawasaki, 1982). This can be justified on the basis of perceptual cue based approach. Ohala (1992) and Steriade (1999) claim that the markedness asymmetry has to do with differing perceptual distances based on the collection of auditory acoustic parameters. It is because information about the identity of the first of two contiguous consonants is more readily detectable when that segment is distinct in manner from that second then when it is not.

Although it has been observed that in Assamese lateral and rhotic onsets are allowed in word initial position, they don’t have the potential to be the first member of the consonant cluster. But nasals can be the member of such clusters. Such observation can be implemented within Optimality theoretical framework in the following way:

(6/21)

a) *ONS-L >> IDENT-10 [approx] insures that liquid onsets as the first member of a consonant cluster will be eliminated.

b) Word initial consonant clusters in Assamese are allowed to begin with nasal consonants. It can be shown by the following ranking of the OT constraints:

IDENT-10 [approx] >> *ONS/N
6.3 Assamese phonotactics, Binding principle and OCP constraint:

In Assamese phonotactics we have observed that some clusters are not permitted to occur in word initial position. The cluster types are */tl/, */dl/, */sl/, */zl/, etc. Cross linguistically these clusters have been found marked although these homorganic sequences with their rising sonority make good onset clusters. It can not be analysed in the framework of sonority. These exceptions can be attributed to independent place restrictions and have nothing to do with sonority at all (Selkirk, 1982). Hence sonority account would have to give way to any alternative that managed to subsume these place based restrictions under some general analysis of cluster phonotactics. However, it is to be noted in this context that while there is a general agreement about the role of sonority in determining syllabification of consonants, the restriction imposed by the place of articulation is subject to controversy. Steriade (1982), Selkirk (1984), Brackel (1983) have claimed that the feature [coronal] can form part of the sonority scale. Clements (1990a:313) argues that place is not a part of the sonority dimension, as in a single language coronals appear to be both higher and lower in sonority than other places of articulation. On the basis of dual patterning it can be argued that constraints on place follow from independent constraints in the grammar. The place of two consonants can be either identical or non identical. Clements (1990) shows that labials and dorsals have equivalent amount of structures, while coronals have less structure. As discussed in this chapter Assamese allows tautosyllabic syllabification of /pr, pl, br, bl, b\textsuperscript{r}, tr, dr, kr, gl, gr, g\textsuperscript{r}/ These clusters satisfy the sonority profile of an onset as the second consonant of the sequence has more sonorant structure than the first. However, there are some constraints against consonants sharing place of articulation: tautosyllabic */tl,dl,lr,zl/ sequences are not allowed in Assamese. This observation is applicable in almost all the languages of the world. See, for instance, Clements & Keyser (1983), Borowsky (1986), Kaye et al. (1988). Given the sonority dimension alone, these clusters should have been permitted as the first consonant has less SV structure than the second one. Hence the cause of the exclusion of such clusters can not be attributed to Government in terms of sonority, but follows from constraints on place restrictions. Tautosyllabic clusters such as */tl,dl/ adhere to the principle of sonority sequencing and thus can not be excluded by sonority constraints. Instead they are excluded because they have identical Place structure. Following Bures (1989) I am going to use the Binding principles in order to deal with the issue of place restriction in the consonant cluster of Assamese phonotactics. Binding is defined on independence of place structure. Binding can be defined in the following fashion:
6.3.1 Binding principle and Assamese phonotactics

A bound consonant contains dependent structure, i.e. identical Place structure to the consonant that binds it or no Place structure.

Binding is not allowed within an onset (i.e. a consonant can not be syllabified into an onset if it shares place with the adjacent syllabified consonant.

A consonant must be bound for Place heterosyllabically (i.e. a consonant may be syllabified into a rhyme if it is non distinct in Place from the following onset). (parametric).

The cause for the non occurrence of coronal cluster in Assamese phonotactics can be explained with regards to both government and binding principles. Following Rice (1992) I would like to argue that an onset cluster comprising of stop followed by lateral is syllabifiable as it adheres to the principle of government as well as binding. As, for instance, consider the Assamese cluster: /pl/

```
  P    I
 ROOT  ROOT
  |    |  \  \\
 Place  Place  SV
    |    \\
     Lateral
```

**Figure No 6/E: Internal structure of the cluster /pl/**

The internal structure of the above consonant cluster suffices to the requirements imposed by the conditions of government within sonority profile and the binding principle. Kaye et al (1985, 1988, 1990) while discussing on the issue of syllabification of adjacent consonants, defines government as a relation in which a consonant A governs an adjacent consonant B if A has less SV structure than B. It can be formulated in the way: A can govern B in an onset if
and only if A and B differ by a SV type nodes. Between syllables, A governs B if B has more SV structure than A or A has no more than $\alpha-\beta$ steps more SV structure than B, where $\alpha>\beta$; $\beta>\Theta$. By taking in to consideration these two principles of government and binding the consonant cluster /pl/ is well formed as far as the phonotactic rules of Assamese are concerned. If we interpret the internal mechanism of /pl/

Government: OK as /l/ has more Sv structure than /p/ and thus is governed.

Binding: /p/ and /l/ differ in place of articulation, and thus /l/ is not bound.

Hence, the syllabification is well formed.

But the prohibited consonant cluster such as */dl/ can be accounted for in the light of binding principles.

![Diagram of /pl/ structure]

Figure No 6/F: Internal structure of the cluster /dl/

This cluster under consideration adheres to the criteria of government as the second consonant has more SV structure than the first one. But /l/ shares the place of articulation with /d/ and therefore it is bound and thereby violating the binding principle.

The reason for the non occurrence of these sorts of clusters can be assigned to OCP coronal constraint within Optimality theoretical module:

### 6.3.2 OCP constraint and Assamese phonotactics

OCP-COR constraint implies that two segments having coronal and continuance values cannot occur in adjacent position.
The dispreference for coronal onset cluster cross linguistically cannot be explained by sonority conditioning. There are many types of restrictions on segment sequencing that cannot be explained in terms of perceptual distance but simply lie outside the ambit of sonority. Coronal clusters such as /tl/ and /dl/ are marked and the reason does not lie in articulatory difficulty but related perhaps to homorganicity. The basic reason seems to be that the members of each of these pairs are perceptually too similar (Kawasaki, 1982; Ohala, 1992). Ohala (1992) claims that in tl/dl clusters the reduction in amplitude created by the lateral’s medial oral stricture is likely to attenuate spectral cues to the place of the stop, thereby impairing the detectability of contrasts with other stop + l clusters (in particular kl/gl clusters).

6.4 Word final consonant cluster in Assamese:

The only possible consonant cluster which can occur in word final position are:

(6/21)

/nd/  ‘kand’ (cry)

/ndh/  ‘kandh’ (shoulder)

‘randh’ (cook)

‘bandh’ (tie)

‘gondh’ (smell)

The other consonant clusters are not permitted in word final position in Assamese phonotactics. It adheres to the principle of sonority hierarchy and post nasal voicing. As far as the sonority hierarchy principle is concerned, it tends to decrease from the nucleus to the right margin of the syllable. It is explicitly observed in the above Assamese data under
consideration. Word final consonant cluster in Assamese can never end in nasals and liquids. The permitted segments in word final cluster position are alveolar voiced obstruent and alveolar aspirated voiced obstruent which are assigned low sonority value.

6.5 sC cluster in Assamese phonotactics:

sC cluster has been a topic of discussion in the phonological literature. Cross linguistically it has been observed that s- obstruent cluster is the falling sonority cluster which does not adhere to the principle of sonority sequencing generalization. Broselow (1992) speculates that the difference between rising sonority clusters and s-obstruent clusters lies in their structure: s-obstruent clusters are complex segments and by virtue of their nature cannot be broken up by epenthesis. s+ stop clusters can be treated as adjunct clusters where /s/ is not syllabified under the onset portion of a syllable, but rather is a direct dependent on the syllable. As we have seen the data, presented in (6/12)4, do not conform to the notion of sonority hierarchy, that is, onsets should rise in sonority value towards the nucleus. These instances are characterized by sonority fall towards the nucleus. The sonority value assigned to the voiceless post alveolar plosive /s/ is greater than the voiceless obstruents. So as far as the principle of sonority hierarchy in complex onset cluster is concerned /s/ should be preceded by voiceless obstruents so that it can show the sonority rise towards the nucleus. But in the data the reverse trend is exhibited thereby violating this principle. This special representational nature of sC sequence, especially which violates the principle of sonority sequencing principle has become a topic of inquiry through out the last two decades (Fudge 1969, Vennemann 1982, Selkirk 1982, Kaye 1992, Goad and Rose 2004, Boyd 2006). Within the set of sC cluster, an asymmetry in the sonority profile of its members is observed. Whereas the s+liquid clusters adhere to the principle of sonority sequencing principle s + stop sequences violates the principle given that the sonority sequencing within the cluster decreases and then increases towards the peak of the syllable. In addition, another argument revolves around the asymmetries observed across sC and non sC clusters (stop plus liquid sequences). While latter are uncontroversially and typically syllabified as onsets (Goad and Rose 2004, Boyd 2006), sC sequences are assigned special status in grammar because of their idiosyncratic behaviour with respect to a variety of phonological phenomena (Goad and Rose 2004). The syllabification of onset clusters with s are interpreted in different ways. Below are given some interpretations.
a) $s$ as Branching onset  (Carlisle 1988, Major 1996, 2001, Ohala 1999)

\[
\sigma
\]

\[
\xrightarrow{\text{ONS}} R
\]

\[
X \quad X \quad X
\]

\[
s \quad t \quad o
\]

b) $s$ as Complex segment  (Selkirk 1982, Lamontagne 1993, Van de Weijer 1996)

\[
\sigma
\]

\[
\xrightarrow{\text{ONS}} R
\]

\[
X \quad X
\]

\[
s \quad t \quad o
\]

b) $s$ as Adjunct  (Barlow 2001, Barlow and Dinnnsen 1998, Kaye 1989, Kenstowicz 1994)

\[
\sigma
\]

\[
\xrightarrow{\text{ONS}} R
\]

\[
X \quad X \quad X
\]

\[
s \quad t \quad o
\]
c) s as Extrasyllabic (Appendix) (Goad and Rose 2004, Fikkert 1994, Levin 1985, Giegerich 1992)

\[
\begin{array}{c}
\sigma \\
\downarrow \\
\text{ONS} & \text{R} \\
\downarrow & \downarrow \\
\text{X} & \text{X} \\
\downarrow & \downarrow \\
\text{s} & \text{t} & \text{o}
\end{array}
\]

In opposition to the branching onset approach the other alternative approaches ranging from complex segment approach to extrasyllabic approach aim at eliminating the SSP violations via the assignment of abstract representations. From markedness relations approach it has been observed that s + liquid cluster is less marked than s + stop sequence as in the latter the SSP is violated.

In Assamese phonotactics, we have seen in the tableau representing permissible word initial cluster that homorganic clusters such as /tl/, /dl/ are disallowed in word initial cluster on the ground of violationg OCP coronal constraint, but clusters such as /sl/, /sn/ and /st/ exist in the language despite being homorganic coronal clusters. Further /s/ is the only sound that may be followed by a nasal in word initial clusters. Fleischhacker (2000, 2001) focuses on the special perceptual properties of sibilant initial clusters. McCarthy and Prince (1994) claim that syllable contact determines the site of epenthesis when no other constraints can make the decision, either because syllable contact is high ranked or because its effects surface in the Emergence of the Unmarked schema. Moreover, sonority sequencing constraints such as syllable contact treats s-obstruent clusters differently from obstruent- sonorant clusters. s-obstruent clusters have falling sonority; hence epenthesis at the edge is possible and preferred. Consider the Assamese example:

\(6/23\)

\(\text{skul} > \text{is.kul}\)
In the above example of loan word in Assamese, epenthesis occurs at the edge. The crucial assumption here is that the default site of epenthesis in loan words is at the edge. It is observed that edge epenthesis violates NO CODA and ONSET whereas the dispreferred internal epenthesis satisfies NO CODA, ONSET and SYLLABLE CONTACT. In order to justify this edge epenthesis Gouskova (2001) talks about the constraint CONTIGUITY, that is defined below:

CONTIGUITY: elements adjacent in the input must be adjacent in the output. This constraint ensures edge epenthesis when SYLLABLE CONTACT is not at stake. SYLLABLE CONTACT implies sonority must not rise across a syllable boundary (Davis 1998, Hooper 1976, Murray and Vennemann 1983, Vennemann 1988).

Consider the following tableau given below:

<table>
<thead>
<tr>
<th>/skul/</th>
<th>*COMPLEX</th>
<th>DEP</th>
<th>SYLLABLE CONTACT</th>
<th>CONTIGUITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>is.kul</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>si.kul</td>
<td></td>
<td>*</td>
<td></td>
<td>*!</td>
</tr>
</tbody>
</table>

Table No 6/f: Representation of the phenomenon of epenthesis at the edge in Assamese

In the above tableau SYLLABLE CONTACT is not violated and hence, CONTIGUITY ensures that edge epenthesis is optimal. So from this tableau it is revealed that SYLLABLE CONTACT determines the epenthesis site: at the edge for falling sonority clusters and internal epenthesis for rising sonority clusters. This outcome can be expected as long as SYLLABLE CONTACT is ranked above CONTIGUITY, although its ranking in relation to DEP is not crucial. This pattern is termed as the Emergence of the Unmarked effect.

In the analysis of the Assamese data on word initial sC cluster it has been seen that s + lateral is not allowed whereas s + nasal is allowed. This phenomenon violates Minimal sonority
distance principle (MSD) (Clements 1990, Selkirk 1984, Baertsch 1986, Carlisle 2006). MSD implies certain requisites on sonority distance imposed on syllable structure, demanding a maximal rise in sonority between two or more members of the syllable. In MSD of complex onset, the second segment in an onset cluster prefers a more sonorous segment "one with the maximal and most evenly distributed rise in sonority (adapted from Clements 1990: 303).

In general, the MSD captures the observation that onsets are maximally low in sonority (e.g. Jakobson's 1941 Principle of Maximal Contrast, which results in the following markedness hierarchy with regards to onsets, going from the least to the most marked structure: stops < fricatives < nasals < liquids < glides). The arguments in favour of the MSD as a tool to establish markedness relationships in sC clusters are based on at least two factors. Firstly, the MSD reflects in a subtle way the universal tendency for syllables to follow the canonical CV structure. Having a higher level of sonority, the second element in the sC cluster will resemble the more sonorous peak, resulting in a high sonority distance between /s/ and the following consonant plus vowel sequence. Secondly, there is considerable evidence from L1 acquisition that supports the preference for less sonorous onsets. In the presence of sC clusters, for instance, the most common strategy to syllabify this complex structure is to simply delete the more sonorous segment (underlined in the examples that follow) and preserve the element with the least amount of sonority (Sonority-based selection; e.g. Chin 1996, Gnanadesikan 2004, Goad and Rose 2004, Ohala 1996, 1999, Pater and Barlow 2003): /st/op □□[t]op, /sl/eep □□[s]eepl. The markedness relationships between the sC clusters under investigation have now been established based on the principles of sonority sequencing and the minimal sonority distance between onset members. This results in a hierarchy in which /sl/ is less marked than /sn/, which are both in turn less marked than the SSP-violating /st/ cluster. By allowing s+nasal sequences and disallowing s+lateral sequences Assamese has violated MSD principle. The minimal sonority distance in Assamese is 1.

6.6 Sonority and its criticism:

The main objection to sonority as a notion relies mainly on its inadequate explanation on phonetic parameters. In addition to the question mark over its phonetic status, sonority is potentially problematic in at least three other respects: the first issue revolves around its representational status. It is very difficult to represent the sonority value of a segment in SPE framework. An obvious solution is to adapt feature theory in such a way that sonority
specifications can be directly built into representations. As, for instance, multi-valued sonority feature replaces major class features (Hankamer and Aissen, 1974; Selkirk 1982; Parker 2002). The other approach attempts to redefine familiar features in such a way that a segment’s sonority is directly reflected in the number of plus values it bears (Clements 1990) or in its specificational complexity. Sonority as a notion governing phonotactic patterns across languages is subject to penetrating light of scrutiny. Most constraints cannot be explained within the framework of syllable structure and lie outside the ambit of sonority profile. The obstruent devoicing in syllable codas is unrelated to sonority, since devoicing makes the coda less, rather than more sonorant. Another example is the common constraint which requires obstruent clusters to agree in voicing. This constraint is applicable not only within syllable constituents but across syllable boundaries in many languages (e.g. French, Russian, Catalan etc), thereby bearing ample testimony to the fact that it can be entirely independent of syllabification. Clements (2006) claims another constraint that often violates the Syllable contact principle (sonority drops maximally across syllable boundaries) is the prohibition of the complex onset clusters.

6.7 Conclusion:

Sonority and segment sequencing in Assamese onset consonant cluster provides a new impetus to the issue of cross linguistic design of the arrangement of segments with special reference to the concepts such as onset well formedness conditions, syllable contact law and Margin hierarchy approach etc. To what extent the constraints on syllable shape and sonority sequencing succeed in capturing segment sequencing in linguistic forms is a topic of inquiry in this chapter. Which onsets a particular language tolerates will be determined by the ranking of the Onset Well formedness (OWF) constraints with respect to faithfulness constraints or to a constraint against syllable codas, or to a constraint against rising sonority across a syllable boundary. Dubach (2003) argues for a universally and intrinsically ranked set of OWF constraints against specific onset clusters, in which constraints against onset clusters with falling sonority (e.g. *σ[sonorant ~ obstruent [the symbol ~ means “immediately followed by”]) are ranked above those against onset clusters with steep rising sonority (*[stop > Nasal] which in turn are ranked above those against onset clusters with steep rising sonority (e.g. * [stop > Liquid]). Further there are separate OWF constraints for the various prosodic categories such as *f[stop > Nasal], *f[stop> Nasal] *w [stop > Nasal]. The Assamese data on consonant clusters also adheres to the principle of these ranking of
constraints. In Assamese phonotactics, σ[stop>Liquid] clusters are permitted, but the constraints σ*[stop > Nasal] and *σ[sonorant > obstruent] are strictly maintained. Thus in Assamese phonotactics of consonant cluster in word initial position the ranking of the constraints can be represented in the following fashion:

\[(6/24)\]

*σ[sonorant > obstruent] >> ..., >> σ*[stop > Nasal] >> ... >> σ*[stop > Liquid]

In this chapter, we also have discussed the unpermissible cluster comprising of liquids and obstruents the justification of which is given in the framework of government phonology. In addition the binding principle shows adequately as why two coronal segments fail to constitute a permissible word initial cluster in Assamese phonotactics which is also addressed in the background of coronality constraint within Optimality theoretic module. This chapter also brings home the point that word final consonant cluster in Assamese never ends in liquids or nasal but in aspirated voiced stops and it has been discussed in this section. Word final consonant cluster adheres to the principle of SSG and post nasal voicing.

In Asamese phonotactics it is seen that homorganic clusters such as /tl/, /dl/ are disallowed in word initial cluster on the ground of violationg OCP coronal constraint, but clusters such as /sl/,/sn/ and /st/ exist in the language despite being homorganic coronal clusters. Further /s/ is the only sound that may be followed by a nasal in word initial clusters. In the analysis of the Assamese data on word initial sC cluster it has been seen that s + lateral is not allowed whereas s + nasal is allowed. This phenomenon violates Minimal sonority distance principle (MSD). From such patterning a generalization can be drawn in the framework of markedness relations resulting in a hierarchy in which /sl/ is less marked than /sn/, which are both in turn less marked than the SSP-violating /st/ cluster. Moreover, sonority sequencing constraints such as syllable contact treats s-obstruent clusters differently from obstruent- sonorant clusters. S-obstruent clusters have falling sonority; hence epenthesis at the edge is possible and preferred, as illustrated in (6/23).