Chapter II
Impact of Human Factor in the Phonology of Modern Standard Hindi
CHAPTER – II

IMPACT OF HUMAN FACTOR IN THE PHONOLOGY OF MODERN STANDARD HINDI

In the present chapter, we will be making an attempt to evaluate the impact of the human behavior orientation on the paradigmatic makeup and syntagmatic distribution of phonological units in Modern Standard Hindi.

The human beings resort in their daily activities to their underlying behavioral characteristics: the human intelligence and laziness. As repercussion of these traits, human beings seek a minimax solution between minimum effort and maximum accomplishment.

It is to be pointed out here that human beings utilize their intelligence or problem solving abilities to infer the meanings of even complex expressions, with the help of situation and context. The human laziness refers to the economy effort, that is, a general avoidance of the use of a greater degree of precision than is necessary for accomplishment of any given task. It is to be noted that, the phonological skewings which are resultant of the two traits, human behavior may not be specific to a particular language, in fact, their general characteristics may recur from language to language. As noted earlier, the particular skewing, readily observable favorings and disfavorings as encountered in the
phonology of Modern Standard Hindi are explained in terms of the quadruple orientations of Columbia School Phonological theory. In the present chapter, we deal with some of the phonological skewings that are clearly motivated by the human traits of intelligence (power of inference) and laziness (economy of effort).

We have divided this chapter into five sections. In section A, we take up the preference for fewer articulators over more articulators in the production and distribution of phonological units. In section B, we deal with the preference for a proximate point of articulation versus remote point of articulation. In section C, we evaluate the impact of assimilative trait of neighboring units on combinatory phonology of Modern Standard Hindi. In Section D, we make an attempt to assess the role of human behavior in the make up of the phonological grid of Modern Standard Hindi. In section E, we analyze the aperture change and combination of the phonological units. In section F, we present summary and conclusions.

Section A: Preference for Fewer Articulators over More Articulators

In view of the well-known trait of human beings to minimize and economize in all situations, it is to be anticipated that phonological units employing fewer articulators will be preferred over those using more articulators. For, the simultaneous use of
greater number of articulators requires fine and precise coordination of articulators that is disfavored due to the laziness factor of human behavior.

The human behavior orientation dictates that, in a language, the phonological units produced with fewer articulators are favored over those produced by more articulators. In view of this, we expect skewings both in the paradigmatic makeup and the syntagmatic distribution of the phonological units in Modern Standard Hindi.

In the following subsections of this section, we deal with the phonological units of Hindi that are produced by the use of an extra articulator, for example, voiceless versus voiced consonants, unaspirated versus aspirated consonants, and oral versus nasal vowels. We will deal with the three types of opposing units in subsections A1, A2, A3, respectively.

**Section A1: Glottis as an Additional Articulator Voiced: versus Voiceless Consonants**

The unaspirated stops and fricatives of Modern Standard Hindi are characterized by a distinction of voicing and voicelessness, whereas the voiceless consonants are produced by only supraglottal articulators, their voiced counterparts make use of an additional articulators, namely, the glottis, in their production. The simultaneous use of the glottal articulators makes the voiced consonants less favored than their voiceless counterparts in terms
of the number of articulators. We, therefore, expect a skewing, commensurate with the criterion, in the makeup and distribution of the voiceless and the voiced consonants in Modern Standard Hindi.

In section A1 (a) we present and evaluate the voiceless versus voiced consonant within the phonological paradigm of Modern Standard Hindi. In A1 (b) we examine the voiceless versus voiced consonants in the syntagmatic organization of the word in Modern Standard Hindi, terms of the same criterion.

**Section A1 (a): Voiceless versus Voiced Consonants in the Phonological Paradigm**

As seen in the phonological grid (Diagram 1-1), there is a distinction of voiceless versus voiced in phonological units ("stops") at aperture 0, and the phonological units at aperture 1, 1½ and 2 ("fricatives"). We present these units in a tabular form below in Table II-1.

**Table II-1**

**Voiceless versus Voiced Consonants**

<table>
<thead>
<tr>
<th>Phonological Units</th>
<th>Voiceless</th>
<th>Voiced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aperture 0 stops</td>
<td>p t ʈ c k q</td>
<td>b d ɖ j g</td>
</tr>
<tr>
<td></td>
<td>ph th ʈʰ ch kh</td>
<td>bh dh ɖh jh gh</td>
</tr>
<tr>
<td>Aperture 1 fricatives</td>
<td>f</td>
<td>v</td>
</tr>
<tr>
<td>Aperture 2 fricatives</td>
<td>s ś x</td>
<td>z ʐ</td>
</tr>
</tbody>
</table>
Comments on Table II-1

There are 21 stops in Modern Standard Hindi, 11 stops (p t t c k q; ph th th ch kh) are voiceless and 10 stops (b d d j g; bh dh dh jh gh) are voiced. This skewing in favor of voiceless units is justified in terms of the fewer versus more articulators.

It is worth noting here, that the post dorsal voiceless stop q produced by the post dorsum is the only unit at that order which is in accordance with our expectations.

There are 8 fricatives, 4 voiceless and 4 voiced at apertures 1, 1½ and 2. If we examine these phonological units more carefully at aperture 1, the parity between the voiceless fricative f and voiced fricative v is neither against nor in favor of our criteria here.

The presence of the voiced h at 1½ aperture is an important point as it provides support to the aspirated series (bh, dh, dh, jh, gh) in Modern Standard Hindi.

There are a total of 5 fricatives in Modern Standard Hindi at aperture 2.

Out of these 5 fricatives, 3 are voiceless (s š x) and 2 are voiced (z x), which is in conformity to our expectations in terms of preferring units being produced by fewer number of articulators over those that are produced by more articulators.
Nevertheless, the preference for the voiceless units) stops and fricatives) clearly show up in their frequency of usage in the word in Modern Standard Hindi.

In the following sub-sections, we analyse the frequency of occurrence of stops, fricatives.

**Section A1 (b): Distribution of Voiceless versus Voiced Consonants**

In this section, we deal with the impact of fewer versus more articulators on the frequency of usage of voiceless and voiced consonants (stops and fricatives) in the organization of the words in Modern Standard Hindi.

This syntagmatic distribution of the opposing consonants has been taken up in three subsections pertaining to (i) the consonants (both stops and fricatives) in their entirety, (ii) the stops and (iii) the fricatives.

**Section A1 (bi) Voiceless versus Voiced Consonants: Stops and Fricatives.**

In this section we make an attempt to highlight the impact of the number of articulators on the frequency of occurrence of voiceless versus voiced consonants (both stops and fricatives combined) in the monosyllabic words in Modern Standard Hindi, we present the frequencies of opposing consonants in Table 11-2.
Table 11-2
Frequency of the Voiceless and Voiced Consonants in the Monosyllabic Words

<table>
<thead>
<tr>
<th>Consonants</th>
<th>CVC</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>%</td>
<td>No</td>
<td>%</td>
<td>No</td>
<td>%</td>
</tr>
<tr>
<td>Voiceless</td>
<td>1803</td>
<td>62.20</td>
<td>581</td>
<td>62.88</td>
<td>70</td>
<td>57.88</td>
</tr>
<tr>
<td>Voiced</td>
<td>1096</td>
<td>37.80</td>
<td>343</td>
<td>37.12</td>
<td>51</td>
<td>42.14</td>
</tr>
<tr>
<td>Total</td>
<td>2899</td>
<td>100</td>
<td>924</td>
<td>100</td>
<td>121</td>
<td>100</td>
</tr>
</tbody>
</table>

Comments on Table 11-2

Comment 1: As seen in the last column in Table 11-2, of a total of 3944 consonants (stops and fricatives) used in monosyllabic words in Modern Standard Hindi. 2454 are voiceless and 1490 are voiced. This skewing fully conforms to our expectations in terms of fewer verses more articulators.

Comment 2: In the CVC words, in the Table, there are a total of 2899 consonants (stops and fricatives) used in monosyllabic words in Modern Standard Hindi. There are 1803 occurrences of the voiceless consonants and 1096 occurrences of voiced consonants. The figures are in perfect conformity with our expectations in view of the human trait of disfavoring phonological units with more articulators.

Comment 3: As shown under the syntagmatically complex CVCC words, of a total of 924 occurrences of all stops and fricatives in
these words, the voiceless consonants have 581 occurrences, whereas their voiced counterparts have 343 occurrences. Here again we get figures which show a skewing in favor of the voiceless consonants in comparison to the voiced consonants, which is what we expect in terms of fewer versus more articulators.

Comment 4: Of a total of 121 consonants (stops and fricatives) in the CCVC words, we find 70 occurrences of the voiceless consonants as opposed to only 51 occurrences of the voiced consonants, which is what we expected in terms of fewer versus more articulators.

Section A1 (bii): Voiceless versus Voiced Stops:

Here we compare the impact of fewer versus more articulator on the voiceless and voiced stops in their frequency of usage in the monosyllabic words of Modern Standard Hindi. The actual occurrences of the opposing units are presented in Table 11-3 below:

<table>
<thead>
<tr>
<th>Stops</th>
<th>CVC</th>
<th>CVCC</th>
<th>CCVC</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Voiceless</td>
<td>1384</td>
<td>58.02</td>
<td>384</td>
<td>57.31</td>
</tr>
<tr>
<td>Voiced</td>
<td>1001</td>
<td>41.97</td>
<td>286</td>
<td>42.69</td>
</tr>
<tr>
<td>Total</td>
<td>2385</td>
<td>100</td>
<td>670</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 11-3
Frequency of the Voiceless versus Voiced Stops in Monosyllabic Words
Comments on Table 11-3

Comment 1: As seen in the last column in Table 11-3, of a total of 3144 stops used in monosyllabic words, 1814 are voiceless and 1330 are voiced. These figures show that although the voiceless and the voiced stops are competitively used in the Hindi monosyllabic words, there is a clear skewing in favor of the voiceless stops over the voiced stops. However, the margin of preference is slightly lower than that for the voiceless consonants (stops and fricatives combined) over their voiced counterparts. (cf. Table II-2)

Comment 2: Among a total of 2385 occurrences of the stops in the CVC words, there are 1384 voiceless and 1001 voiced. This clear skewing in favor of the voiceless stops (with fewer articulators) and against the voiced stops (with more articulators) fully conforms to our expectations in terms of number of articulators.

Comment 3: As seen in the CVCC column, of total of 670 stops used in monosyllabic words, 384 are voiceless and 286 are voiced. This clear skewing in favor of the less complex voiceless stops and their more complexes is justified in terms of the assimilative trait of the neighbouring units.

Comment 4: Among the 89 instances of stops in the CCVC words we find 46 voiceless and 43 voiced occurrences. This clear skewing in favor of the voiceless stops and against the voiced stops can be
attributed to the preference in terms of fewer versus more articulators.

Section A₁ (biii) Voiceless versus Voiced Fricatives

In this section we evaluate the impact of the fewer versus more articulators on the voiceless and voiced fricatives in their frequency of usage in the monosyllabic words of Modern Standard Hindi. The actual occurrences of the opposing units are presented in Table 11-4 below:

<table>
<thead>
<tr>
<th>Fricatives</th>
<th>CVC</th>
<th>CVCC</th>
<th>CCVC</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Voiceless</td>
<td>419</td>
<td>81.51</td>
<td>197</td>
<td>77.56</td>
</tr>
<tr>
<td>Voiced</td>
<td>95</td>
<td>18.49</td>
<td>57</td>
<td>22.44</td>
</tr>
<tr>
<td>Total</td>
<td>514</td>
<td>100</td>
<td>254</td>
<td>100</td>
</tr>
</tbody>
</table>

Comment 1: As seen in the last column in the Table, of the total of 800 occurrences of the fricatives in the monosyllabic words, 640 are voiceless and 160 are voiced. This vast skewing in favor of the voiceless fricatives is in conformity with our expectation in terms of
the human preference for phonological units produced by fewer articulators.

**Comment 2:** In the syntagmatically simple CVC words, as seen in the Table, of the 514 occurrences of the fricatives in the monosyllabic words, 419 are voiceless and 95 are voiced. This vast skewing in favor of the voiceless fricative as against the voiced fricatives is due to the use of one more articulator namely, the glottis, used in their production.

**Comment 3:** As shown in the Table in the CVCC words with 254 fricatives, there are 197 occurrences of the voiceless fricatives and 57 occurrence of the fricatives. This clear skewing in favor of the voiceless fricatives is justified from the view point of fewer versus more articulators.

**Comment 4:** Of the total of 32 CCVC fricatives in the monosyllabic words, 24 are voiceless and 8 are voiced. This skewing is also in conformity with our expectation in terms of fewer versus more articulators.

**Section A2: Glottis as an Additional Articulator: Unaspirated versus Aspirated Stops**

The stops are characterized by the distinction of unaspiratedness aspiration. As the problem of aspiration in the aspirated stops (bʰ dʰ gʰ etc.) is a very complex one, it will be taken up in other sections. Therefore, our analysis of unaspirated versus
aspirated stops is carried out here only in terms of the number of articulators.

Whereas the unaspirated stops (p t k etc.) are produced by the supraglottal articulators (the labium, the apex, the dorsum etc) alone, the aspirated stops (ph th kh.) are produced by an additional articulator namely, the glottis. The aspiration is formed by the puff of breath coming from the lungs through a particular maneuvering of the glottal articulator.

The triangular configuration of the vocal folds forces the air through a small channel which produces aspiration as indicated by aspiration in Diagram 1-1. The aspiration so formed at the glottis is unaspirated. As a matter of fact, this aspiration brought forth by the glottal articulator, is superimposed on the unaspirated stops to produce the aspirated stops. This superimposition of aspiration makes the aspirated stops physiologically and acoustically more complex than their unaspirated counterparts. We, therefore, expect that the unaspirated stops would be favored over the aspirated counterparts would in terms of the human preference for the simpler, less complex phonological units.

We now evaluate the impact of the glottis as an additional articulator, on the makeup of the units for the unaspirated and the aspirated stops and their frequency of usage in the word in Modern Standard Hindi.
First a word about the paradigmatic make up of the opposing unaspirated and unaspirated stops. There is a parity in the number of units for the unaspirated (p t c k q) and the aspirated stops (ph th th ch kh) in Modern Standard Hindi. This parity in the number of units for the aspirated and the unaspirated stops does not indicate any favoring or disfavoring for either types, and as such, it neither validates nor invalidates our analysis. Therefore, we have to say into the syntagmatic context for the usage of the opposing unit with a view to ascertaining if the skewings observed there would conform to our expectations in terms of the human preference for phonological units with fewer articulators over those with more articulators.

In Table 11-5, the frequency of usage for the aspirated and unaspirated and unaspirated stops, as they obtain in the monosyllabic words in Modern Standard Hindi.

<table>
<thead>
<tr>
<th>Stops</th>
<th>CVC</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>Unaspirated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>905</td>
<td>80.7</td>
<td>574</td>
<td>83.80</td>
<td>82</td>
<td>92.13</td>
<td>1561</td>
</tr>
<tr>
<td>Aspirated</td>
<td>216</td>
<td>19.27</td>
<td>111</td>
<td>16.20</td>
<td>7</td>
<td>7.86</td>
<td>334</td>
</tr>
<tr>
<td>Total</td>
<td>1121</td>
<td>100</td>
<td>685</td>
<td>100</td>
<td>89</td>
<td>100</td>
<td>1895</td>
</tr>
</tbody>
</table>

Table 11-5
Frequency of Occurrence of the Unaspirated and Aspirated Stops in the Monosyllabic Words
Comments on Table 11-5

Comment 1: As seen in the last column in the Table, of the 1895 occurrences of the stops in the monosyllabic words, 1561 occurrences are unaspirated and 334 are aspirated. This vast skewing in favor of the unaspirated and against the aspirated stops may well be attributed to the human preference for phonological units with fewer articulators over those with more articulators.

Comment 2: As shown in Table 11-5, of the 1121 occurrences of stops in the CVC words, there are 905 occurrences of the unaspirated stops and 216 of the aspirated stops when monosyllabic words in entirety are compared with the unaspirated and aspirated stops, it may be observed that the skewing in favor of the unaspirated stops (with fewer articulators) is slightly lowered against the aspirated stops in the CVC words. This minute difference, however, does not affect or reduce the clear skewing in favor of the unaspirated stops in the CVC words in terms of the human trait for preference of fewer versus more articulators.

Comment 3: As shown in Table 11-5, of the 685 occurrences of the stops in the CVCC words, 574 occurrences are unaspirated and 111 are aspirated that is, there is a total skewing in favor of the unaspirated stops as compared to the aspirated stops which is attributed to preference for fewer versus more articulators.
**Comment 4:** As seen in the Table 11-5, of the 89 occurrences of the stops in the CCVC words, we find 82 occurrences of the aspirated stops and only 27 occurrences of the unaspirated stops. This vast skewing in favor of the unaspirated stops and against their aspirated stops which is attributed to the preference for fewer versus more articulators.

**Section A3: Velum as an Additional Articulator: Oral versus Nasal Vowels**

As in Modern Standard Hindi, we have both nasal consonants and nasal vowels that are produced by the velum as the nasal articulators. Although the velum is traditionally considered a point of articulator, it is noteworthy that this supraglottal organ is sufficiently adroit to open and to close the passage to the nasal cavity.

As shown in the phonological grid (Diagram 1-1), nasal consonants (m n ŋ ñ) are produced by the velum at aperture 3, in combination with the relevant oral articulators and the voicing being provided by the larynx.

As discussed earlier in section A1, the voicing/voiceless distinctions are found in the stops and fricatives. The oral articulators are shared by the voiceless and voiced consonants (stops and fricatives), the voiced consonants are produced by the larynx as an additional articulator.
The nasal consonants may seem to be more complex in that they are produced by three articulators: the relevant oral articulator, the velum (nasality) and the larynx (voicing). However, the larynx should not be considered an additional articulator in the case of the nasal consonants because it is the essential tool or the basic feature for all the phonological units at aperture 3 and above. Therefore, the nasal consonant may well be taken on par with the voiced stops in terms of the number of articulators.

Again, as seen in the phonological grid (Diagram 1-1), the nasal vowels (L:^n U:^n a:^n etc.) are produced by the velum, the nasal articulator at aperture 3, in combination with the relevant oral articulator the medium ("front"), the front dorsum ("central"), and the back dorsum ("back") at aperture 3 through 9, and the glottal articulator at aperture 1 (for voicing) but it is noteworthy that the voice) is a necessary concomitant not only for the nasal vowels, but also for their oral counterparts. Thus, both the oral and nasal vowels have on investment in voicing). The nasal vowels are however, made more complex due to the addition of nasality) in the form of an extra articulator; velum. We, therefore, expect that the oral vowels should be preferred over the nasal vowels.

We now evaluate the impact of the velum as an additional articulator on the oral and the nasal vowels in the makeup of the
vocalic units and their frequency of occurrence in the words, in
Modern Standard Hindi.

As seen in the phonological grid of Modern Standard Hindi
(Digram 1-1), there are 20 vowels consisting of 10 oral vowels.

(A I U i: u: e: o: a: ai.au) and 10 nasal vowel (Ā Ī Ū ī: ē: ō: ā: āi āu). We encounter a parity between the oral vowels (fewer
articulators) and the nasal vowels (more articulators) which goes
against our expectations.

Although the complexity produced by the velum as an
additional articulator does not show up in the paradigmatic makeup
of the nasals vis-à-vis the oral vowels, we do encounter a vast
skewing in favor of the oral vowels and against their nasal
counterparts in their frequency of usage in the words. We now
present the actual occurrences of these opposing vowels in Table
11-6.

Table 11-6
Frequency of the Oral and Nasal Vowels in the Monosyllabic
Words

<table>
<thead>
<tr>
<th>Vowels</th>
<th>CVC</th>
<th>CVCC</th>
<th>CCVC</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Oral</td>
<td>1700</td>
<td>76.81</td>
<td>325</td>
<td>69.30</td>
</tr>
<tr>
<td>Nasal</td>
<td>513</td>
<td>23.19</td>
<td>144</td>
<td>30.70</td>
</tr>
<tr>
<td>Total</td>
<td>2213</td>
<td>100</td>
<td>469</td>
<td>100</td>
</tr>
</tbody>
</table>
Comments on Table 11-6

**Comment 1:** As seen in the last column in this Table, of the 2763 vocalic occurrences in all the monosyllabic words, 2095 occurrences are oral and only 668, are nasal. This vast skewing in favor of the oral vowels and against the nasal vowels is justified in view of the use of an additional articulator, the velum, in the production of the nasal vowels.

**Comment 2:** As shown in Table 11-6, of the 2213 vocalic occurrences in the CVC words, 1700 occurrences are oral and only 513 are nasal. The figures conforms to our expectations in terms of the number of articulators.

**Comment 3:** of the 469 vocalic occurrences, as shown in the CVCC column in the Table, we find 325 oral vowels and 144 nasal vowels. The figures conform to our expectations in terms of the human trait of fewer versus more articulators.

**Comment 4:** of the 81 occurrences of vowels in the CCVC words, 70 are oral 11 are nasal. That is, we encounter a drastic skewing in favor of the oral vowels as against the nasal vowel here. Again, this rather extreme disfavoring for the nasal vowels may well be attributed to the use of the velum as an additional articulator.
Section B: Proximate Point of Articulation versus Remote Point of Articulation

Sounds produced by an articulator at the nearest point of articulation are preferred to sounds produced by the same articulator at some more remote point of articulation.

As said earlier in chapter A1, phonological units are produced by articulators singly or in combination with degree of apertures. The almost adroit point of articulation acts as passive participant in the production of phonological units. In the production of consonants (units of aperture 0, 1, 2 and 3), the articulator has to make contact with the point of articulation. The point of articulation may be an adjacent place or it may be a distant place. The contact of articulator with a remote or distant point of articulation requires fine and precise coordination, because to make a contact at a remote point of articulation, the articulator has to move farther and even to stretch, which leads to muscular tension. As we have been viewing in this chapter, precise coordinations are avoided by human beings, therefore, we anticipate disfavoring of phonological units produced by the contact of an articulator with a remote point of articulation vis-a-vis those units which are produced by the same articulator at some adjacent point of articulation.

In Modern Standard Hindi, the apex of the tongue, being most adroit articulator among all lingual articulators and labium (cf.
chapter I section C), comes in contact with two separate points of articulation, namely, dentum and palatum to produce two series of stops and liquids. When apex blocks the air at dentum the resulting units are called apico-dentals, when apex contacts by curling back to block the air palatum it produces apico-palatal units. apico-palatal units are traditionally know as “retroflex sounds”. As we know, palatum is a distant place for apex as compared to dentum. Therefore, the apico-palatal units will require fine coordination in their articulation as compared to the apico-palatal units and as such, they will be disfavored to their apico-dental counterparts.

The explanation of the skewing for apico-dental and apico-palatal consonants is taken up in two sub-sections below. In section B₁, we examine the phonological grid of Modern Standard Hindi to look for favoring or disfavoring in the number of phonological units, with regards to proximate point of articulation. B₂ proximate versus remote point of articulation and the occurrences of the phonological units.

Section B₁: Proximate versus Remote Point of Articulation and Phonological Grid of Modern Standard Hindi

When we look at the phonological grid of Modern Standard Hindi (Diagram 1-1), we find that the apico-palatal units are found at apertures 0 and 3 only, while the apico-dental units appear at 0, 2 and 3 apertures. There are total of 9 apico-dental and 8 apico-
palatal consonantal units in the phonological paradigm. We find that the number of apico-palatal units are less than their apico-dental counterparts, and this skewing is definitely due to the fact that apico-palatal consonants are produced by the contact of apex at a distant place (palatum) and requires fine and precise coordination.

There are 4 (t th d dh) apico-dental stops and 4 (t th d dh) apico-palatal stops at aperture 0. There is a parity between the two here, which is neither against nor in favor of the criterion under study.

The two nasals at aperture 0, show 1 apico-dental and 1 apico-palatal units. Here again we find a parity between the two categories.

Of the two apical fricatives (s and z) at aperture 2, both of them are apico-dental. Thus, we encounter a total skewing in favor of the apico-dental and against the apico-palatals. The absence of any apico-palatal fricatives in the phonological paradigm of Modern Standard Hindi may well be attributed to the human trait of avoiding the difficult task of producing any “retroflex sibilant” at aperture 2. It is noteworthy that the “retroflex sibilant” s did exist in Sanskrit. However, it has totally eliminated in Urdu and Hindi.

Among the 5 apical liquids at aperture 3, there are only 2 apico-dentals (l r), and 3 apico-palatals (l r rh). This disparity in the number of units between the apico-dental and apico-palatal
liquids is contrary to our expectations. It may be noted here that
the apico-palatal (l) is only a marginal phonological unit that does
not occur at all in the monosyllabic words being used for the
statistical analysis in the present study. Further, the apico-palatal
rh occurs in only a few monosyllabic words. In contrast, the apico-
dental l and r are still preferred over the apico-palatals in the light
of the above explanation.

In the light of the discussion above, we can reasonably
assume that despite some problems with regard to the number of
units, the apico-dental consonants are actually favored over the

Section B2: Proximate versus Remote Point of Articulation
and the Occurrence of Phonological Units

Now we compare the frequency of occurrences of the
opposing apico-dental and apico-palatal consonants in Table 11-7,
to evaluate the impact of the human trait pertaining to prominate
versus remote point of articulation.

<table>
<thead>
<tr>
<th>Consonants</th>
<th>CVC</th>
<th>No.</th>
<th>%</th>
<th>CVCC</th>
<th>No.</th>
<th>%</th>
<th>CCVC</th>
<th>No.</th>
<th>%</th>
<th>Total</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apico-dental</td>
<td>1508</td>
<td>75.70</td>
<td></td>
<td>643</td>
<td>87.12</td>
<td></td>
<td>113</td>
<td>89.69</td>
<td></td>
<td>2264</td>
<td></td>
<td>79.28</td>
</tr>
<tr>
<td>Apico-palatal</td>
<td>484</td>
<td>24.30</td>
<td></td>
<td>95</td>
<td>12.88</td>
<td></td>
<td>13</td>
<td>10.31</td>
<td></td>
<td>592</td>
<td></td>
<td>20.72</td>
</tr>
<tr>
<td>Total</td>
<td>1992</td>
<td>100</td>
<td></td>
<td>738</td>
<td>100</td>
<td></td>
<td>126</td>
<td>100</td>
<td></td>
<td>2856</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

Table 11-7
Frequency of Occurrence of the Apico-dental and Apico-
Palatal Consonants in the Monosyllabic Words.
Comments on Table: II-7

Comment 1: As shown in the last column of the Table above, of the 2856 occurrences of the consonants in the monosyllabic words, 2264 are apico-dental whereas only 592 are apico-palatal. We encounter, a clear skewing in favor of the apico-dental and against the apico-palatal in their overall usage of the opposing consonants in the words.

Comment 2: As seen in the column for CVC words, of the 1992 occurrences of the apical consonants, there are 1508 occurrences of the apico-dental and only 484 occurrences of the apico-palatal. This vast skewing in favor of apico-dental consonants (proximate point of articulation) is further increased as compared to the apico-palatal consonants (remote point of articulation) among the CVC in the monosyllabic words.

Comment 3: Among the 738 occurrences in the CVCC words, 643 are apico-dentals and 95 are apico-palatal consonants. This drastic skewing in favor of the apico-dental and against the apico-palatal consonants, is partly brought about by the human trait of preferring the proximate place of articulation over a remote place of articulation.

Comment 4: As seen in CCVC column in the Table above, of the 126 apical occurrences in the monosyllabic words, 113 are apico-
dental consonants and 13 apico-palatal consonants. This figure fully conforms to our expectations.

**Section C: Assimilative Trait of Neighboring Phonological Units**

The phonological units of a language are combined to form signal-meaning units (*signes*). The phonological units are marked by the distinction of articulators, apertures, points of articulation, relative adroitness of articulators and their muscular tension. Phonological units may also differ in the use of additional articulators for V(oiceing), A (Spiration), or N(asality). To exemplify, st share two features of articulation – the apex articulator and voicelessness. On the other hand, a combination of the two units g and t do not share such features, since g is a front-dorsal voiced unit whereas it is a voiceless apex unit. If two successive segments are very different from each other then fine and precise manipulation of articulators are required to distinguish these segments. However, in two successive phonological units e. g st that share some features of articulation, are combined, then, it is easier to carry on without such precise manipulation of articulators. Keeping in view general disfavoring of human beings for fine and precise coordination, we may expect favoring for the combination of phonological units, sharing same features of articulation to be favored.
The impact of assimilative trait is manifest in the combination of phonological units in the word. The fine precisely coordinated movement of articulator is avoided by making certain phonological changes in the neighboring phonological units, such as assimilation, devoicing, etc. as a result of which these neighboring segments become similar.

For the explanation of the assimilative trait in monosyllabic words in Modern Standard Hindi, we compare the occurrences of the phonological units in terms of the assimilative human traits of human beings in section C₁.

**Section C₁: Assimilative Traits and the Occurrences of the Phonological Units.**

Assimilative traits as they appear in the monosyllabic CVC and CVCC words in Modern Standard Hindi, in the occurrences of voiceless, voiced and nasalized phonological units.

1) **Initial Voiceless Stops + Final Voiceless Stops**
   
   Total Number of Words = [1384].

2) **Initial Voiced Stops + Final Voiced stops**
   
   Total Number of Words = [1001].

3) **Initial Voiceless Stops + Final Voiced stops**
   
   Total Number of Words = [1045].

4) **Initial Voiced Stops + Final Voiceless stops**
   
   Total Number of Words = [1340].
5) Initial Voiceless Fricatives + Final Voiced Fricatives
   Total Number of Words = [288].

6) Initial Voiced Fricatives + Final Voiced Fricatives
   Total Number of Words = [95].

7) Initial Voiceless Fricatives + Final Voiceless Fricatives
   Total Number of Words = [419].

8) Initial Voiced Fricatives + Final Voiced Fricatives
   Total Number of Words = [226].

The number of CVC words for occurrence of initial voiceless and final voiceless units are more than those of initial voiceless and final voiced units. Similarly, the number of initial and final voiced units is more than that of either initial voiceless and final voiced units or initial voiced and final voiceless units. Thus, in the CVC words voiceless units occur with voiceless units and voiced units occur with voiced units.

The actual occurrence of the final consonant cluster in the CVCC words of Modern Standard Hindi are now presented below.

1. Voiced Fricatives + Voiceless Stops = 51
   Voiced Fricatives + Voiced Stops = 0

2. Voiceless Fricatives + Voiced Stops = 2
   Voiced Fricatives + Voiceless Stops = 0

Thus, we find that voiceless fricatives mostly occur with voiceless stops and voiced fricatives with voiced stops.
Assimilative trait can also be seen in the occurrence of nasalized vowels in CVC and CVCC words. In CVCC words, all vowels that appear before nasal consonants are nasalized. In the CVC words too, we also encounter a favoring for nasalized vowels before nasal consonants. We present below occurrence of nasalized vowels before nasal and non-nasal consonants.

<table>
<thead>
<tr>
<th>Types</th>
<th>Number of Words</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVC</td>
<td>275</td>
</tr>
<tr>
<td>CVN</td>
<td>165</td>
</tr>
<tr>
<td>NVN</td>
<td>20</td>
</tr>
<tr>
<td>(\text{Total of CVN} + NVN = 185)</td>
<td></td>
</tr>
</tbody>
</table>

\[\text{C}^1\text{VN}^1\text{C}^2\] 131
\[\text{N}^1\text{VN}^1\text{C}^2\] 10
\[\text{NVC}^1\text{C}^2\] 1
\[\text{CV}^1\text{C}^2\] 0

\(^*\text{ftn. }N^1 = \text{C}^1\ of\ the\ CVC^1C^2\ words\)
\(^*\text{ftn. }N^2 = \text{C}^2\ of\ the\ CVC^1C^2\ words\)
\(^*\text{ftn. }C = \text{any\ consonant\ (p,\ t,\ c,\ s,\ etc.)}\)
\(^*\text{ftn. }N = \text{nasal\ consonant\ (m,\ n,\ etc.)}\)
Section D: Aperture Change and Combination of Phonological Units:

In this section, we examine the syntagmatic organization of phonological units of Modern Standard Hindi in view of the claim that in successive segments, large changes of aperture are preferred over small changes of aperture.

Phonological units cohere to form larger segments. Greater changes of aperture are likely to be preferred in successive segments. For, it provides greater freedom of movement for articulators and therefore less precision of control is required in the articulation of these segments. The segments produced by a small change of aperture, on the other hand, involves greater precision and control. Thus, therefore, there is a general disfavoring for small changes of aperture. We analyze the effect of the degree of aperture change on the combinatory pattern of Modern Standard Hindi phonological units in the monosyllabic words is taken up in the following subsection below.

Section D1: Large Aperture Change versus Small Aperture Change: CVC versus CVCC and CCVC Words:

In this section, we compare the potential and actual number of CVC, CVCC and CCVC words.

The potential and actual number for CVC, CVCC and CCVC words are presented in the Table.
Table II-8
Potential and Actual Number of Monosyllabic Words in Modern Standard Hindi

<table>
<thead>
<tr>
<th>Types</th>
<th>Potential</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\text{CVC}=C^2V=41^2 \times 20)</td>
<td>33620</td>
<td>2213 (6.58% of 33620)</td>
</tr>
<tr>
<td>(\text{CVCC}=C^3V=41^3 \times 20)</td>
<td>1378420</td>
<td>469 (0.03% of 1378420)</td>
</tr>
<tr>
<td>(\text{CCVC}=C3V=41)</td>
<td>1378420</td>
<td>81 (0.005% of 1378420)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2790460</strong></td>
<td><strong>2763</strong></td>
</tr>
</tbody>
</table>

Comments on Table : II-8

**Comment 1:** As seen in the Table, the total number of consonants for Modern Standard Hindi is 41 and the total number of vowels is 20. Given the total number of consonants (41) and vowels (20), the potential number of the CVC words is 33620 and the actual turnout is 2213 (6.58% of 33620). For CVCC and CCVC words the potential number is 1378420 but their actual number is much lower than the CVC words.

The actual number of CVC and CCVC words is 469 (0.03% of 1378420) and 81 (0.005% if 1378420), even a cursory glance at the Table for the actual and potential number for CVC, CVC and CCVC words shows a clear preference for the CVC words, because the CVC words appear in absolute majority.
**Comment 2:** The preference for the CVC words is caused by the maximum change of aperture in successive segments. In CVC words, there is a maximum change of aperture from constriction (0, 1, 2, 3) to opening (4, 5, 6, 7, 8), then back to constriction. On the other hand, in CVCC and CCVC words, the initial and the final clusters demand for small changes of aperture (from consonant to consonant). Therefore, the CVC words which involve large changes of aperture in the successive segments are preferred over the CVCC and the CCVC words in Modern Standard Hindi.

**Section E: Human Behavior Justification of the Phonological Grid of Modern Standard Hindi.**

In this section, we deal with the psychological (human behavior) factors which provide reinforcement to the validity of the phonological units in Modern Standard Hindi, which is primarily established by physiological mechanism in chapter 1, Diagram 1-1).

A common trait of human behavior in the form of a principle is;

"It is easier to learn the use of a smaller number of tools than a larger, and up to a certain point it is easier to learn to perform a given task by combining the resources of tools with which one is familiar than by learning to use a new tool" (Diver: lecture-notes).
The makeup and distribution of the phonological units of a language are thus motivated by the above principle. The discussion follows:

"It is well-known that the phonological system tends to be an organization of a relatively small number of units used in varying combinations, rather than collection of a relatively large number of non-combining phonological units" (Diver: lecture-notes).

It is to be pointed out here that, the phonological paradigm in Modern Standard Hindi consists of 61 phonological units; 41 consonantal and 20 vocalic (cf. Diagram 1-1). It is these rather smaller number of distinct units that combine and permute to form the entire inventory of signal meaning pairs (signes) of Hindi. This is one way in which human languages minimize the effort on the specific part of memory. The concept of “double articulation”, developed by Andre Martinet is utilized in the form of economy achieved in the formation of signals.

Moreover, the phonological units in their entirety are formed by the combination of a relatively small number of apertures and articulators. To be precise, we have only 9 degrees of apertures (0, 1, 1½, 2, 3, 4, 5, 6, 7, 8) and 8 articulators (tabium, apex, medium, front-dorsum, back-dorsum, post-dorsum, velum and glottis).
Furthermore, along with the psychological mechanism, the human behavior principle provides a rationale for the asymmetrical nature of the grid. The number of units produced with less effort and precision exceed those units that are more complicated physiologically and which require more precision and control in their production.

It is to be noted that though we here deal with the human behavior justification for the lack of symmetry in the number of units placed on the various intersection of the axis of articulators and apertures in the grid, it is beyond the scope of present research to explain the absence of each potential phonological unit. We will take up only those gaps or holes that are found relative to some existing phonological units in the grid (Diagram 1-1).

1. Scarcity of the Phonological Units at Aperture 1:

There are only 2 phonological units, f and v, that appear at aperture 1 as opposed to 5 units at aperture 2. For the perforated surface of the teeth is ideally suited to produce fricatives by releasing air stream through a very restricted channel whereas the palate or the lip at the place of articulation provide air tight contact which is not suitable for the production of fricatives. Therefore, members of the first degree of apertures using the teeth as place of articulation are preferred to those using the palate (or the lip) as a place of articulation.
2. **Absence of Voiced and Aspirated Stops Relative to Post-Dorsal q:**

   As seen in the phonological grid of Modern Standard Hindi (Diagram 1-1), q occurs as a voiceless, unaspirated post-dorsal stop and in the absence of its voiced or aspirate counterparts. The non-occurrence of the more complex voices stop with post-dorsal articulator can be attributed to the use of more articulators.

3. **Two Axes for Apex in Opposition to One Each for Other Articulator:**

   The human behavior interplay can also be seen in the asymmetrical use of articulators in forming the phonological units. Of all the supraglottal articulators only by the most adroit apex is conveniently used, to make dual distinct of “dental versus” retroflex consonants by the speakers of many Indian languages.

   It we look at the phonological grid of Modern Standard Hindi, it becomes clear that the apex keeps distinction of articulation at two points (dentum and palatum), on aperture 0 and 3, the use of the apex on two distinct points is attributed to the greater adroitness of apex among all the lingual articulators (medium and dorsum).

   We may therefore conclude that the human behavior orientation provides reinforcement for the validity of the
phonological grid of Modern Standard Hindi, earlier established in terms of the physiological mechanism.

**Section F: Summary and Conclusions**

In this section, we summarize our findings as a whole for this chapter.

Section A, we have taken up the impact of the human preference of fewer versus more articulators in the formation of the phonological units and their usage in the words in Hindi. We expect the phonological units of Hindi, in the production where fewer articulators are involved, to be greater in number and more frequently used *vis-à-vis* those units produced by more articulators. The three main dichotomies among the phonological units of Modern Standard Hindi brought about by the use of an extra articulator, are voiced versus unaspirated stops, and oral versus nasal vowels. And through the actual frequency counts of these opposing dichotomies of units, we have successfully demonstrated that their paradigmatic make up and the syntagmatic distribution clearly conforms to our expectations.

In section B, the second type of phonological skewing is explained in terms of the apico-palatal units being disfavored over the apico-dental consonants. It has been shown that it is easy for apex to contact dentum, at adjacent point of articulation. Thus, apico-palatal consonants require greater precision and are
disfavored to their apico-dental counterparts. The disfavoring for apico-palatal consonants have been shown by comparing number of units and frequency counts of apico-dental and apico-palatal consonants.

In section C, we have evaluated the impact of the assimilative trait of neighboring phonological units that are manifest in the combinatorial phonology of Modern Standard Hindi. As noted, the fine and precisely coordinated movement of the articulator is avoided by making certain phonological changes in the neighboring phonological units. The occurrence of phonological units is, in most cases, conditioned to their environments. Thus, voiceless phonological units occur mostly with voiced consonants. It has been amply demonstrated through the actual frequency counts that the syntagmatic distribution of phonological units is clearly motivated by the assimilative trait, and therefore this skewed distribution fully conforms to our expectations.

In Section D, we decrease the human trait of preferring large changes of apertures over small changes of apertures. It has been argued that large change of aperture requires less precision of movement, as a result they are favored over small changes of apertures because they require fine and precise movements and coordinations. We, therefore, compared the potential and actual number of CVC, CVCC and CCVC words and demonstrated clearly
that the CVC words which involve large changes of aperture are drastically favored. This is perfectly in conformity with our expectations.

In section E, we have shown that human behavior orientation provides reinforcement to the validity of phonological units in the grid (Diagram 1-1), established in terms of physiological mechanism in chapter 1. The phonological skewings in the grid have been explained in view of the human preference for physiologico-acoustically simpler, less complex phonological units. In this regard, we have argued that the absence of voiced and aspirated stops, relative to post dorsal 9, is motivated by the human behavior orientation, particularly, the human behavior preference for fewer articulators. Furthermore, we have demonstrated that asymmetrical use of articulators in the formation of phonological units can also be explained in terms of human behavior. We have also justified the use of the most adroit apex to make the dual distinction between the “dental” and the “retroflex” among the consonants (stops) and (liquids) in Modern Standard Hindi.

To Conclude:

1. The use of an extra articulator is disfavored in terms of human behavior because it requires additional efforts on the part of speaker. Thus, the phonological units produced by fewer articulators are preferred over those produced by more...
articulators, voiceless versus voiced, unaspirated versus aspirated and oral versus nasal vowels, etc.

2. The apico-dental consonants with proximate place of articulation are preferred over the apico-palatal ("retroflex") consonants with the remote place of articulation. Both in the number of units and in the frequency of usage.

3. The neighboring phonological units become similar in view of the assimilative trait to avoid the precisely coordinated movement of articulator.

4. A comparison of CVC, CVCC and CCVC, words is made through frequency counts to look that the CVC words are highly preferred. Furthermore, large changes of aperture are preferred over small changes of aperture.

5. The human behavior orientation provides reinforcement of the validity of the phonological units in the grid.