ROLE OF PHYSIOLOGICAL MECHANISM IN 
BIHAR URDU PHONOLOGY

As the title indicates, we attempt in this chapter to deal with in terms of physiological mechanism, the makeup of the phonological units of Bihar Urdu and their interrelationship, both paradigmatically and syntagmatically.

We divide the present chapter into three sections. In Section-A, we highlight the role of physiological mechanism in Bihar Urdu phonology paradigmatically. Section-B discusses the combinatory phonology of Bihar Urdu in terms of physiological mechanism. The chapter ends with concluding remarks in Section-C.

Section -A: Impact of Physiological Mechanism on the Paradigm of Bihar Urdu Phonology.

This section deals with as to how physiological mechanism makes an impact on the paradigmatic relationship of Bihar Urdu phonological units. In Section-A1, we introduce the Phonological Grid of Bihar Urdu in terms of the two variables i.e. articulators and apertures. In Section-A2, we cast light on the paradigmatic merger of ݂ with s in terms of some physiological rationale. Section - A3
emphasizes the adroit and manipulatory characteristics of various parts of the tongue in the paradigmatic makeup of Bihar Urdu phonological units. Section-A4 takes into account the suitability of the non-apical portion with greater physical mass for vowels.

Section-A1: Phonological Grid of Bihar Urdu

The articulators (cf. INTRODUCTION: Section-C1 (a)(i)), and the degrees of aperture (cf. INTRODUCTION: Section-C1(a)(ii)), combine with each other and produce at their intersections, phonological units of a language. This network of phonological units for a language is called Phonological Grid of that language.

The phonological units of Bihar Urdu, as spoken in the city of Gaya, are set up when they turn up at the intersections of the articulators and the degrees of aperture. However, it may be noted that not all the intersections of the articulators and the apertures are randomly filled by phonological units in Bihar Urdu. Their appearance on an intersection has a base in physiology of the vocal tract. The motivation for the presence of phonological units at particular intersections and for the relative frequency in words for these units, may also come from other orienting principles for phonological analysis (cf. INTRODUCTION: Section-C).
Phonological Grid of Bihar Urdu with all its phonological units is presented in Section-Al(a) below, the explanatory discussion on the Grid is taken up later in Section-Al(b).

Section-Al(a): Presentation of the Phonological Grid

As stated in the introductory remarks above, the Phonological Grid of Bihar Urdu is made up of only those units that fall at the intersections of articulators and apertures. All the four articulators, including the five-part tongue, discussed in Section-C1(a)(i)(be) of the preceding chapter operate in the makeup of phonological units in Bihar Urdu. As pointed out in Section-C1(a)(ii) of the introductory part, there are ten apertures that can be postulated for the making of Phonological Grid for Urdu spoken in Bihar (the city of Gaya). Rather than a random combination of articulators, with eight columns and of apertures with ten rows, that will give us eighty (80) phonological units, we actually have a total number of sixty one (61) phonological units in Bihar Urdu. It may be noted that some of these units are of low frequency; the physiological basis of this skewing will be dealt with in the next section (Section-B) of this chapter.
Diagram I - 1: Phonological Grid of Bihar Urdu
The Phonological Grid of Bihar Urdu in terms specified above is presented in Diagram I-1. It may be emphasized that this Grid does not merely list the phonological units; it represents the interrelationship of all the phonological units in terms of the variables of physiological mechanism.

Section-A1(b): Comments on the Phonological Grid

Phonological Grid of Bihar Urdu as spoken in Gaya presented in Diagram I-1, in terms of physiological mechanism, does not merely list the phonological units of Bihar Urdu. Rather it is presented with physiological axes, with a view to explaining the non-random character of the phonological units in Bihar Urdu. The comments, both descriptive and explanatory, on the various physiological aspects of the Phonological Grid, are presented in the subsections below:

A1(b)(i). Mechanics of Diagramming

The Bihar Urdu Phonological Grid (Diagram I-1) has been drawn in such a way that it successfully highlights the physiological characteristics of Bihar Urdu phonological units.

Here the phonological units are classified vertically in terms of articulators (cf. INTRODUCTION
Letters, both lower-case and capital, used in the diagram, represent the various phonological units of Bihar Urdu. It may be noted that V, A and N are abstract units of Voicing, Aspiration and Nasality.

The solid line connecting the letters in the diagram, shows the interrelationship between the phonological units whereas the solid line ending with arrow indicates the voicing (coming from V on aperture-1 at Glottis), the single broken line connects the voiced aspirated units of the system (aspiration comes from h on aperture-1/2 at Glottis). Double broken line connects A of aperture-2 with voiceless aspirated units at aperture-0. Single dotted line is a connecting line between nasal consonants and N on the one hand, and between the nasalized vowels and N on the other. The double dotted line connects the diphthongs ai and au to their base units at aperture -7 and y and w respectively at aperture -3.

The single dash-dot line indicates the connection of the labium with back dorsum i.e. indicates the
labio-dorsality of the pertinent phonological units. Double dash-dot line shows the division of constriction and opening of the aperture in terms of their physiological characteristics.

Arrow, in apex→teeth and apex→palate, indicates that apex is the articulator with the teeth and hard palate as the respective points of articulation.

Al(b)(ii) Phonemes versus Phonological Units

The phonological units seem to be no different from the traditional 'phonemes' in the sense that they are both established with the help of phonemic contrast through minimal pairs and subminimal pairs (cf. CHAPTER II: Section-Al). Despite the difference in terminology the Phonological Grid (Diagram I-1), where all the phonological units are given, looks very much like the 'Phonemic Inventory' of the traditional American phonemics that includes all the phonemes of a language.

It may, however, be emphasized at this juncture that the Phonological Grid of Bihar Urdu as spoken in Gaya (Diagram I-1) is basically different from the Phonemic Inventory that may be established for this dialect in terms of the distributional criteria used in American structural linguistics.
The Phonemic Inventory of a language lists all phonemes of that language. It must be pointed out here that the American structuralists present the Phonemic Inventory with reference to points of articulation/articulators and the manner of articulation/height of the tongue raised. But this is done merely for convenience of reference and not for theoretical basis. The phonemes listed in the Inventory are formally established through the distributional criteria (Harris; 1951 : 5-9 : 189 : 365). But as a short cut to analysis these phonemes are generally established through contrast in minimal and sub-minimal pairs. Thus, though meaning is a taboo in the phonemic analysis of American structural linguistics, the phonemes are actually established through the distinction of meaning. But we do not have to face this dilemma in the present research, for communication, one of our orienting principles, justifies the use of meaning in phonological analysis.

Following the traditional, informal method of contrast through minimal pairs, we can postulate fifty-three (53) phonemes (-consonantal and -vocalic) for Bihar Urdu. The Phonemic Inventory of Bihar Urdu is presented in Diagram I-2.
Consonants:

<table>
<thead>
<tr>
<th>Labial</th>
<th>Labio dental</th>
<th>Dental</th>
<th>Retroflex</th>
<th>Palatal</th>
<th>Velar</th>
<th>Glottal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plosives</td>
<td>p b</td>
<td>t d ɾ ɾ</td>
<td>c j k g</td>
<td>ph bh</td>
<td>th dh ĵh ĵh ch jh kh gh</td>
<td></td>
</tr>
<tr>
<td>Spirants</td>
<td>f s</td>
<td>x h</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nasals</td>
<td>m</td>
<td>n Ī</td>
<td>nh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lateral</td>
<td></td>
<td>l</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rolled</td>
<td></td>
<td>r</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semi vowels</td>
<td>w</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Monophthongs:

Long: iː eː aː oː uː
 ĕː ēː āː āː ĕː ēː

Short: I a U
 ĕ ā ĕ

Diphthongs: ai au
 ĕi ĕu

Diagram I-2: Phonemic Inventory of Bihar Urdu
In contradistinction to the Phonemic Inventory of a language, the Phonological Grid of that language is the network of its phonological units to be primarily established in terms of physiological mechanism and communication. The phonemic principle of distinctiveness, applied through meaning contrast, is fully utilized in the establishment of phonological units, with justification from the communicative orientation. Thus, all the fifty three (53) phonemes postulated for Bihar Urdu (Diagram 1-2), are given the status of phonological units in the dialect (Diagram I-1). But the agreement between phonemes and phonological units stops here.

As pointed out above, the fifty three (53) phonological units of Bihar Urdu are established on communicative basis through meaning contrast in minimal pair situations. But then these phonological units are thoroughly subjected to the classification in terms of physiological mechanism. That is, there is a principle of classification in the makeup of the phonological units, as presented in the Phonological Grid. On the basis of their phonetic substance, the phonological units are classified in terms of articulators and apertures.
At the same time the substances of the phonological units determine the number of physiological axis both horizontally and vertically. Thus, whereas only one axis of labial is set up, despite the presence of bilabials and labio-dental we have two distinct axes of apico-dentals and apico-palatals in Bihar Urdu.

Once the axes of articulators and apertures are established for a language, all their intersections can be filled with phonological units, whether distinctive (phonemic) or non-distinctive (sub-phonemic), subject to constraints from other physiological aspects and from other orienting principles. Thus, some non-distinctive (non-phonemic) positional variants whose phonetic substances fall on the intersections of articulators and apertures, are elevated to the status of full-fledged phonological units. (There will be no sub-categorization of other allophonic variants, whether positional or free, without a principle of classification). The axes of articulators and apertures established for Bihar Urdu, yield eighty (80) intersections. To be sure, these intersections are not randomly filled. But we do have following non-distinctive (non-phonemic) positional variants, which fill the various intersections of articulators and apertures.
Parenthetically, it may be pointed out that in traditional phonemic analysis, the phones [ŋ], [ñ], (along with [n]) are considered allophones of the phoneme /n/; the phone [l] (along with [l]) is taken as allophone of the phoneme /l/; the flaps [ɾ] and [ɾh] which are in complementary distribution with the stops [d̪] and [d̪h] respectively, are treated as positional variants of the phonemes /d̪/ and /d̪h/. Finally, as the short vowels [ɛ], [ẽ], [o] vary freely with their long counterparts [eː], [ẽː], [oː], the former are considered allophones of the phonemes /eː/, /ẽː/, /oː/ respectively.

All the positional variants presented above have been given full status of phonological units (cf. Diagram I-1).
We can conclude this subsection by saying that the Phonological Grid is made up to highlight the interrelationship of its units. That is, the network of phonological units shows their value relationship. But at the same time, phonetic substance of the phonological units is also taken into account in their classification in the Grid. This is done with a view to giving equal importance to substance and value in linguistic analysis.

Al(b)(iii) The Status of mh, nh as Phonological Units

In the Phonological Grid presented in Diagram I-1, we have set up both mh and nh as single independent phonological units in Bihar Urdu. But it may be noted that controversy surrounds these aspirated nasals (and some aspirated liquids) about their status in Urdu phonology. The point of contention is whether we should regard the aspirated nasals (and some aspirated liquids) as unit phonemes or as clusters with h or as having the component of the prosody of aspiration in Modern Standard Urdu. Without going into the details of the argument, it may be mentioned that we have taken mh and nh as single phonological units in Bihar Urdu, on the pattern of the aspirated stops. For, like the latter, the aspirated nasals are also produced by the "single stroke effort" (cf. Firth; 1957: 61-62.)
Finally, it may be pointed out here that the frequency of \( mh \) and \( nh \) is very low in words. The two phonological units occur in one monosyllabic word each (cf. Glossary: Items 768 and 765) and in a few polysyllabic words. However, it may be noted that the words in which \( mh \) and \( nh \) appear are very frequently used.

**Al(b)\{iv\}\{alif\}: The Status of V, A and N as Phonological Units**

The status of \( V, A \) and \( N \) as phonological units of Bihar Urdu, as shown in Diagram I-1 is somewhat different from that of all other phonological units. Unlike other units, \( V, A \) and \( N \) do not stand for particular phonological units that occur in the speech chain in Bihar Urdu. Instead, they represent \( V(\text{voicing}), A(\text{spiration}) \) and \( N(\text{asality}) \) respectively. At the same time, it may be noted that they are derived from combinations of articulators and apertures like the actual phonological units of the Grid.

Although all phonological units are abstractions, the \( V, A \) and \( N \) represent a higher degree of abstraction than the other units in the Phonological Grid.
The makeup of V, A and N is taken up one by one below:

V: This phonological unit falls on the intersection of the axis of Glottis vertically and that of aperture-1 horizontally.

All the supraglottal phonological units of apertures-3 through 8 are produced in combination with the V(ooicing). The V(ooicing) also combines with the relevant supraglottal articulators at aperture-0 to produce voiced stops and nasals in Bihar Urdu (cf. Section-A2(b)). This link of V(ooicing) with the voiced phonological units in Bihar Urdu is approximately shown in the Grid (cf. Diagram I-1).

A: This phonological unit falls at the intersection of Glottis and aperture-2.

The supraglottal voiceless aspirated stops at aperture-0 are produced in combination with the A(spiration) in Bihar Urdu. This link of A(spiration) with the voiceless aspirated phonological units is properly shown in the Phonological Grid of Bihar Urdu (cf. Diagram I-1).

N: This phonological unit falls at the intersection of the articulator Velum and the aperture-3. Due to
this lowering of velum, air is free to pass through the nasal cavity as well as through the oral cavity.

All the nasal consonants and the nasalized vowels in Bihar Urdu are produced in combination with the N(asality).

The N(asality) at aperture-3 combines with the relevant articulators at aperture-0 to produce the nasal consonants, both unaspirated and aspirated. The nasalized vowels of Bihar Urdu are produced by the medium and the two-part dorsum at aperture-4 through eight again in combination with the N(asality). The link of the N(asality) with both the nasal consonants and nasalized vowels is properly indicated in Diagram 1-1.

(b) Production of V(oicing), A(spiration) and the Voiced h

A glance at Diagram I-1 will show that in Bihar Urdu apart from V and A, voiced h is also produced at the Glottis.

The production of A, V takes place at two natural positions whereas that of voiced h at an unnatural position, assumed by the practically parallel vocal folds (Diagram I-3).
Diagram I-3: Configuration of the Vocal Folds in the Production of \( V, A \) and the Voiced \( h \).
V: In the production of V(oicing), the vocal folds form a narrow slit at aperture-1. The folds vibrate as the air from the lungs forces them apart and the muscular tension pulls them back together, producing V(oice).

The production of V(oicing) is natural, for it is utilized for sound production by humans and other species, for non-linguistic expression. Voicing is also used in singing.

A: Vocal folds at aperture-2 have a triangular configuration, little smaller than the one utilized in normal breathing. This configuration of the glottis can produce A(spiration) only when there is sufficient rush of air from the lungs, more than used in normal breathing or the production of V(oice) at aperture-1.

The production of A(spiration) is also natural, for it is used by humans and other species for respiration.

Voiced h: The glottal configuration for voiced h is also triangular. The area of this triangle is just about half of the triangle used in the production of A(spiration). This very unusual (and unnatural) configuration for the production of the voiced h is
utilized in many Indian languages including Urdu. As for the aspiration and the voiceless aspirates, the rush of air from the lungs is necessary for the production of the voiced h and the voiced aspirates. To be sure, besides being used as a phonological unit, the voiced h also combines with the relevant supraglottal articulators at aperture-0, to produce voiced aspirated stops. The aspirated nasals of aperture-0 plus 3, and the aspirated rh at aperture-3 are also produced in combination with the voiced h in Bihar Urdu. This link of voiced h with the aspirated units is also appropriately indicated in the Phonological Grid (cf. Diagram I-1).

Al(b)v: Labio-dorsal Phonological Units: Units with the Two Articulators

In the makeup of some phonological units in Bihar Urdu, the articulator labium combines with the articulator back dorsum at the apertures of opening (3 through 6). That is, the phonological units such as the semi-vowel w and the vowels u:, ū:, o:, ō: etc placed in the column of back dorsum in the Grid (Diagram I-1), are simultaneously produced by the two articulators: Back dorsum and Labium. That labium is employed as an additional articulator for the back
dorsal vowels and semi-vowel is not accidental. There is definite acoustic rationale for the simultaneous use of the two articulators (cf. CHAPTER IV: Section-B).

Al(b)(vi): Units at Two Points of Articulation with the Same Articulator

The apico-dental and the apico-palatal phonological units as presented in the Phonological Grid in Bihar Urdu (Diagram I-1), are the units produced by a single articulator, namely, apex in contact with different points of articulation, that is, the 'teeth' and the 'palate' respectively.

The Apex-teeth and the Apex-palate are recognized as relevant vertical axes, solely because most of the phonological units (particularly the stops) produced at the two points of articulation, are characterized by distinctiveness and recognized as opposing phonemes.

The distinction between the apico-dental and the apico-palatal units is traditionally recognized as the distinction between the 'dental' and the 'retroflex' consonants (cf. Diagram I-2).
Al(b)(vii): Phonetic Variants at Two Points of Articulations with the Same Articulators

(alif) Labio-labial versus labio-dental

In Bihar Urdu Phonological Grid (Diagram I-1), we observe that both the labio-dental fricative f and the bilabial stops and nasals (p, b, m etc) have been placed under the articulator, Labium. Thus, the phonological units under labium have two points of articulation, namely, the lower lip and the lower edges of the upper teeth. This placement of units with two points of articulation, on a single axis is justified for several reasons. Firstly, we are classifying the phonological units of Bihar Urdu in terms of the various articulators. The unit f and the other units in the labial column are produced by the single articulator, Labium. Secondly, there is no labio-dental axis in opposition to the bilabial one in Bihar Urdu. In the previous section, we set up two separate axes, apico-dental versus apico-palatal with one articulator and two points of articulation, only because the phonological units on the two axes were in contrast with each other. But this is not the case with the labio-dental and the bilabial consonants dealt with here. For, we do not have a bilabial fricative ḫ in Bihar Urdu in opposition to the labio-
dental fricative \( f \). Thirdly, the lower edges of the upper teeth are ideal target for the fricatives at aperture-1. While the upper lip, as point of articulation, provides an air tight closure for the stops (and nasals) at \( \emptyset \)-aperture, the perforated surface of the upper teeth is most suited to serve as point of articulation for the fricatives, where friction is required. Thus, we have a physiological rationale for the phonological unit \( f \) to be a labiodental*.

\( \text{(be)} \) Apico-dental \textit{versus} Apico-alveolar

Some of the phonological units at the Apex-teeth axis also show a variation in the points of articulation. The points of articulation for the units \( s, l, r, n, \) and nh range from upper teeth to alveolar ridge. These units are clearly apico-dental when they occur before the apico-dental stops. Elsewhere, these units may vary from apico-dental to apico-alveolar. Inasmuch as, we do not have distinction between the apico-dental and apico-alveolar consonants, we set up only one axis, that of Apex-teeth for Bihar Urdu.

* Ftn. When Indo-European Tenues become fricative in Germanic, the IE* \( p+\tilde{f} \) through the intermediary stage of \( \tilde{\phi} \).
As for the point of articulation range from teeth to alveolum for the non-stop consonants under the apico-dental series, we may present a paradigmatic (or a communicative) rationale. As may be evident from the Phonological Grid (Diagram I-1), apico-dental stops are distinctively appeared to apico-palatal ('retroflex') stops in Bihar Urdu. The point of articulation difference (teeth versus palate) is therefore meticulously maintained for the two stop series. In contradistinction to apico-teeth stops, the apico-dental s has no counterpart at the apico-palatal axis. The unit s is therefore free to extend its phonetic range from teeth to alveolum. The same argument applies to the unit nh at the apex-teeth axis.

As for the remaining apico-dental units, namely, n, l, r, they are all opposed to the apico-palatal ('retroflex') units ñ, l̃, r̃. But it may be noted that the retroflex counterparts are low in frequency of occurrence in words and appear only before the apico-palatal ('retroflex') stops. (Parenthetically, it may be pointed out that the opposition between n, l, r and ñ, l̃, r̃ is non-distinctive). As the 'functional load' of ñ, l̃, r̃ is low, these apico-palatal units do not always stand in sharp contrast to the apico-dental n,
1, r. The latter phonological units can also vary in their points of articulation from teeth to alveolum.

Final(b)(viii): Units Formed with the Combination of Two Apertures

Finally, four more phonological units of Bihar Urdu that need comments are the ones which are formed by the combinations of two apertures. The four units are the diphthongs, ai and au and their nasalized counterparts āi and āu.

As shown in Diagram I-1 the 'diphthongs' ai, au and āi, āu like traditional 'affricates' do not fall on a single aperture. They too are formed by combination of two apertures. The diphthongs begin with the larger opening at aperture-7 and move towards the smaller opening at aperture-3.

The 'diphthong' ai is the combination of the vowel a (at the intersection of the articulator Front Dorsum and aperture-7) and of the semi-vowel y (at the intersection of Medium and aperture-3). Likewise, the diphthong āi is formed by the combination of ā and the semi-vowel y.

The 'diphthong' au, on the other hand, is a combination of the vowel a (front dorsal at aperture -
7) and of the semi-vowel w (back dorsal-cum-labial at apertures-3). Similarly, the 'diphthong' ſu is formed by the combination of ſ and the semi-vowel w.

It is to be noted here that even though we are following traditional analysis regarding physiological and acoustic characteristics of the components of the diphthongs, it requires further research. We do not need to do this research here as this is beyond the scope of the present study.

Section - A2: Merger of ſ with s

The Grid presented in Section-A1 is characterized by the presence of only two fricatives s and x at aperture-2, whereas there is complete merger of the Classical Urdu sibilant ſ with the sibilant fricative s at the same aperture. To be sure, the frequency of even x is very low as opposed to s. (Cf. Section-B2(c).)

The merger of ſ with s can be shown diagrammatically as follows

\[ ſ \longrightarrow s \]

The merger requires some justification. This justification can be made in terms of communicative as

*Ftn. In Indo-European only s survived.
well as physiological rationale. The communicative rationale will be taken up in Chapter 2. However, here we provide the physiological rationale for this very unusual skewing.

Physiologically, of the various vertical axis, the apico-dental axis is the most stable whereas medial is the least stable in terms of hierarchy of adroitness of the supraglottal articulators (Section-A3). So, there is always a tendency to preserve the units at apico-dental axis as well as to lose the units from medial. Thus, the medial fricative / which is paradigmatically close to apico-dental s merges with it to strengthen further its position at aperture-2.

Section-A3: Relative Adroitness of Articulators:
Paradigmatic Makeup of Phonological Units

Here we make an attempt to highlight the preference of the apex as an articulator over other articulators for apertures-0 through 3. This we do in terms of the adroitness of the various parts of the tongue and of labium (i.e., supraglottal articulators) in the production of the phonological units at apertures-0 through 3(cf. INTRODUCTION: Section-B1(a)(i)(be)). Accordingly, we divide the entire section into following three subsections.
Section-A3(a): Units at Aperture-Ø: Stops and Nasals

This subsection shows the exact number of Bihar Urdu phonological units articulated at aperture-Ø presented in Table I-4. Later comments on this table are given.

<table>
<thead>
<tr>
<th></th>
<th>Apical</th>
<th>Labial</th>
<th>Dorsal</th>
<th>Medial</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stops</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>Nasals</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>6</td>
<td>5</td>
<td>5</td>
<td>27</td>
</tr>
</tbody>
</table>

Table I-4: Bihar Urdu Phonological Units at Aperture-Ø

Comments on Table I-4:

(i) The number of the units compared here are of those which fall at the intersections of aperture-Ø and the articulators, namely, Labium, Apex, Medium and Dorsum i.e. of the units called stops and nasals.

(ii) The scale of hierarchy of adroitness of the various articulators shows that apex stands at the top owing to its extra flexibility, then comes dorsum and finally medium. Labium stands somewhere near the dorsum but definitely below the apex and above the medium (cf. INTRODUCTION: Section-C1(a)(i)(be). According to this hierarchy we expect the number of
phonological units produced by the apex to be maximum at apertures - 0, 1, 2, 3.

(iii) A rapid view of the table presented above confirms that there is a valiant support in favour of apical stops as well as apical nasals produced at aperture-0. Of the total number of 20, there are 8 apical stops (t th d dh; t th d dh) and 4 labial (p ph b bh), 4 medial (c ch j jh) and 4 dorsal stops (k kh g gh). Furthermore, of the total number of 7, 3 are apical nasals (n, nh, ṇ) whereas 2 labial nasals (m, mh) and 1 dorsal (ṅ) and 1 medial nasal (ṁ). Thus, a strong tilt in favour of apical stops and apical nasals is quite apparent from the number of phonological units presented in Table I-4.

Section-A3(b): Units at Aperture-2: Fricatives

Table 1-5 which we present below takes into account the number of Bihar Urdu phonological units produced at aperture - 2:

<table>
<thead>
<tr>
<th></th>
<th>Apical</th>
<th>Labial</th>
<th>Dorsal</th>
<th>Medial</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fricative</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

Table I-5: Bihar Urdu Phonological Units at Aperture - 2
Comments on Table I-5

(i) The number of fricatives considered here are of those which appear at the intersections of aperture-2 in combination with the articulators called Apex, Medium, Dorsum and Labium.

(ii) In terms of adroitness, we predict apex, the most adroit articulator owing to its great flexibility, to produce the maximum number of phonological units at apertures-∅ through 3, followed by dorsum and medium. However, use of labium for the production of units would be somewhere near the dorsum but definitely less than apex and more than the medium (cf. INTRODUCTION : Section-C1(a)(i)(be)).

(iii) A quick look at the table presented above confirms our predictions. Of the total number of 2 fricatives, 1 is apical fricative (s) and 1 dorsal fricative (x). But, we do not find labial fricative or medial fricative at aperture-2. Moreover, even though we do have dorsal fricative x in Bihar Urdu, its frequency is extremely low as compared to that of apical fricative s which is highly frequent in Bihar Urdu. All this confirms that the fricative s is the most favoured fricative of Bihar Urdu as it is produced with the help of apex which is the most adroit articulator.
(iv) There is one more physiological rationale behind this favouring of s already discussed in Section-A2, above.

Section-A3(c): Units at Aperture - 3: Liquids

In this subsection we cast light on the production of phonological units at aperture - 3 in terms of the hierarchy of adroitness of the various articulators. This we do by taking help of the Table I-6 presented below.

<table>
<thead>
<tr>
<th>Apical</th>
<th>Labial</th>
<th>Dorsal</th>
<th>Medial</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquids</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Table I-6: Bihar Urdu Phonological Units at Aperture - 3

Comments on Table I-6:

(i) Here we compare the number of the labial (w), apical (l r lr rh), dorsal (w) and medial (y) liquid.

(ii) As we have noted earlier, apex is the most adroit articulator of all supraglottal articulators, namely, labium, dorsum and medium (cf. INTRODUCTION: Section-Cl(a)(i)(be)) and we expect apex to be responsible for the production of highest number of phonological units at apertures-0 through 3.
(iii) The table presented above confirms the favouring for apical liquids. Of the total number of 8, 5 (the highest number) are apical liquids as compared to 1 labial, 1 dorsal and 1 medial liquid. A two-way contrast at the axis of apico-dental and apico-palatal is quite striking. It shows a very strong favouring for apicals in Bihar Urdu.

Section-A4: Vowels and the Non-apical Portion of the Tongue

In this section, we will be concerned with the suitability of the non-apical portion of the tongue for the production of vowels. The vowel system of Bihar Urdu reflects total skewing in favour of 'medial' and 'dorsal' vowels. This can be shown with the help of Diagram 1-7 (cf. Diagram I-1).

This strong favouring for 'medial' and 'dorsal' articulation in the production of Bihar Urdu vowels as shown by the Diagram 1-7 can be explained in terms of some physiological rationale. (Cf. INTRODUCTION: Cl (a)(i)(be).) In opposition to apical portion of the tongue, which is triangular in shape, non-apical portion are roughly four dimensional in shape. The non-apical portions like "medium" and "dorsum" have greater physiological mass than has the apex. It is this shape and size of the non-apical portions which
play an important role in modifying the shape of the oral cavity in the articulation of vowels. To make a good resonant chamber which is needed for the units articulated at high apertures, heavier mass is required, which help in producing and distinguishing vowels. So, accordingly, we get only "medial" and "dorsal" vowels in Bihar Urdu.

To sum up Section-A as a whole:

(1) Phonological Grid of Bihar Urdu is made up of sixty one (61) units, which fall on the intersections of articulators and apertures. As it is clear from Diagram I-1 not all intersections are randomly filled.
(2) Of sixty-one (61) phonological units, fifty three (53) are distinctive phonemes and eight (8) are non-distinctive positional variants.

(3) The eight (8) non-distinctive (non-phonemic) positional variants, whose phonetic substances fall on the intersections of articulators and apertures, are elevated to the status of full-fledged phonological units.

(4) The Phonological Grid is made up to highlight the interrelationship of its units. That is, the network of phonological units shows their value relationship.

(5) At the same time, phonetic substance of the phonological units is also taken into account in their classification in the Grid. This is done with a view to giving equal importance to substance and value in phonological analysis.

(6) The merger of medial $\&$ with apico-dental $s$ has physiological justification, besides the communicative one. The medial fricative $\&$ involves the least adroit articulator, the medium of the tongue whereas $s$ is produced by the most adroit articulator, the apex of the tongue. As a result, $\&$ merges with $s$. 
(7) The number of apical units is remarkably high in Bihar Urdu Phonological Grid. This is explicable in terms of the relative adroitness of the supraglottal articulators. The apex standing at the top on the scale of adroitness due to its extra flexibility produces maximum number of units.

(8) The non-apical portion of the tongue with its greater physical mass is most suitable for vowels. As a consequence, we have to have only medial and dorsal vowels.

Section-B: Role of Physiological Mechanism in Combinatory Phonology

Here we will highlight the role of physiological mechanism in the syntagmatic aspect of the phonological units of Bihar Urdu under three subsections below.

Section-B1: Impact of the Amount of Energy Utilized on the Combinations of Units

As the title itself indicates, here we will be concerned with as to how the amount of energy utilized by the apertures motivate the combinations of units. In this connection, we will be dealing first with the CVC, CVCC and CCVC combinations of units taken up in Section-B1(a) and then with the initial clusters of
Bihar Urdu in Section-Bl(b). Section-Bl(c) deals with the aspiration.

Section-Bl(a): CVC, CVCC and CCVC Combinations of Units

We present Table 1-8 below by taking into account the total frequencies of CVC, CVCC and CCVC combinations of units. Later (explanatory) comments on this table are given.

<table>
<thead>
<tr>
<th></th>
<th>CVC</th>
<th>CVCC</th>
<th>CCVC</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>1651</td>
<td>59</td>
<td>06</td>
<td>1716</td>
</tr>
<tr>
<td>%</td>
<td>96.21</td>
<td>3.44</td>
<td>0.35</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 1-8: CVC Combinations versus Consonant Clusters

Comments on Table 1-8:

(i) The CVC, CVCC and CCVC words are considered for frequency count in their totality.

(ii) Different apertures (Ø through most open) require different amount of energy for the production of the phonological units. The aperture-1 requires the greatest amount of energy to pass the air through the resulting narrowing. It is followed by aperture-½ and aperture-2. Next in line is aperture-Ø and then aperture-3. The units articulated at these
Apertures are relatively easier to articulate. From aperture-3 onwards there is a further decrease in the amount of energy required for the articulation of phonological units. With the rise of apertures, there is a gradual decrease in the amount of energy required for the articulation of phonological units. And the combinations of units articulated with lesser amount of energy is preferred over those that are produced with greater amount of energy. That is, the combinations that husband the source of energy are preferred to those that dissipate it.

(iii) A quick glance at the table confirms our expectations. Of the 1716 instances of the total monosyllabic words of Bihar Urdu, 1651 (approximately 96%) are CVC combination of words and only 59 (approximately 3%) and 06 (nearly 1%) are CVCC and CCVC combinations respectively. That is, CVC combinations are preferred over other combinations. The higher frequency of occurrence of CVC structure confirms that the units articulated at apertures 0, 1, 1 1/2, 2, or 3 prefer to combine with higher apertures, because the units articulated at higher aperture require lesser amount of energy in their articulation. In other words, the combinations that conserve the energy are preferred.
(iv) It may be noted here that CVC combinations are preferred over the consonant clusters in terms of human behaviour also (cf. CHAPTER III: Section-B1).

Section-B1(b): Initial Clusters

Table I-9 dealing with the frequencies of initial consonant clusters and comments on this table are presented below.

<table>
<thead>
<tr>
<th></th>
<th>Stops</th>
<th>Nasals</th>
<th>Fricatives</th>
<th>Liquids</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No.</strong></td>
<td>6</td>
<td>100</td>
<td>6</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td><strong>%</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Stops</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Nasals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fricatives</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Liquids</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table I-9: Initial Consonant Clusters

Comments on Table I-9:

(i) As stated above, the initial consonant clusters in Bihar Urdu are subjected to frequency count.

(ii) Here we consider sixteen combinations of consonant clusters like stop ($\emptyset$) + stop ($\emptyset$), Stop ($\emptyset$)
+ nasal (Ø), Stop (Ø) + fricative (l), stop (Ø), liquid (3) etc in the initial position of the words.

(iii) As discussed in the preceding section, different apertures (Ø through most open) require different amount of energy for the production of the phonological units. The aperture-1 requires the greatest amount of energy to pass the air through the resulting narrowing. It is followed by aperture-1½ and aperture-2. Next in line is aperture-Ø and then aperture-3. The units articulated at these apertures are relatively easier to articulate. From aperture-3 onwards there is a further decrease in the amount of energy required for the articulation of phonological units. With the rise of apertures, there is a gradual decrease in the amount of energy required for the articulation of phonological units. And the combinations of units articulated with lesser amount of energy is preferred over those that are produced with greater amount of energy. That is, the combinations that husband the source of energy are preferred to those that dissipate it.

(iv) The table presented above confirms our expectations. Of the 6 instances of the total initial consonant clusters, all 6 (100%) combinations are of
There is a total skewing in favour of this combination in the initial position of Bihar Urdu. It clearly shows that the units articulated at aperture-0 prefer to combine with higher apertures, because the units articulated at higher aperture require lesser amount of energy and a change of aperture from 0 to 3 conserve the source of energy. This conservation of energy is preferred physiologically. Consequently, we get only this combination in the initial position of Bihar Urdu.

Section-B1(c): Amount of Energy and Aspiration

The amount of energy to be utilized by the aspirated units affects their aspiration part as well as their frequency of occurrence which we will be considering into two subsections.

Section-B1(c)(i): Aspirated Monosyllabic Words of Bihar Urdu

In this subsection, we go through the two types of monosyllabic words which have undergone deaspiration in word final position.

(alif): Monosyllabic Words with Initial Unaspirated Units

Here deaspiration in the final position is exemplified with the help of the following Bihar Urdu
monosyllabic words, unaspirated initially. The comments on these words are given after the exemplification.

<table>
<thead>
<tr>
<th>Standard Urdu</th>
<th>Bihar Urdu</th>
<th>Item No.*</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>uːbh</td>
<td>uːb</td>
<td>9</td>
<td>be fed up</td>
</tr>
<tr>
<td>ñaugh</td>
<td>aug</td>
<td>56</td>
<td>doze</td>
</tr>
<tr>
<td>ñaugh</td>
<td>ñaugh</td>
<td>69</td>
<td>doze</td>
</tr>
<tr>
<td>paːch</td>
<td>paːc</td>
<td>112</td>
<td>vaccination</td>
</tr>
<tr>
<td>baːch</td>
<td>baːc</td>
<td>275</td>
<td>pick out</td>
</tr>
<tr>
<td>biːt(h)</td>
<td>biːt</td>
<td>287</td>
<td>dung (especially of birds)</td>
</tr>
<tr>
<td>ŋaːdh</td>
<td>ŋaːn</td>
<td>334</td>
<td>bind</td>
</tr>
<tr>
<td>ŋaːdh</td>
<td>ŋaːdh</td>
<td>326</td>
<td>bind</td>
</tr>
<tr>
<td>jiːb(h)</td>
<td>jiːb</td>
<td>863</td>
<td>tongue</td>
</tr>
<tr>
<td>ŋ jiːbh</td>
<td>ŋ jiːbh</td>
<td>864</td>
<td>tongue</td>
</tr>
<tr>
<td>kaːch</td>
<td>kaːc</td>
<td>965</td>
<td>skim</td>
</tr>
<tr>
<td>saːth</td>
<td>saːt</td>
<td>1402</td>
<td>in company</td>
</tr>
<tr>
<td>ῥ saːth</td>
<td>ῥ saːth</td>
<td>1402</td>
<td>in company</td>
</tr>
<tr>
<td>hath</td>
<td>hat</td>
<td>1508</td>
<td>obstinacy</td>
</tr>
<tr>
<td>ῥ hath</td>
<td>ῥ hath</td>
<td>1510</td>
<td>obstinacy</td>
</tr>
</tbody>
</table>

*Ftn. For form class and further details of meaning, see Glossary.
Comments

(i) In the words illustrated above, deaspiration in the final position has taken place. But in many words aspiration has alternately been retained too.

(ii) There is a physiological rationale behind the deaspiration. Aspirated units which are based on $h$ of aperture 1 1/2 and $A$ of aperture-2 utilize a great deal of energy like the units at aperture-1. Units of $\emptyset$- aperture due to their explosion and that of aperture-3 also require much energy. That is, the combination of aspiration ($h$ and $A$) with the units of apertures – $\emptyset$ and 3 makes the combination highly energy consuming. In other words, aspirated units occurring in a syllable or a word require a great deal of energy and are therefore disfavoured physiologically.

(iii) The disfavouring of aspirated units
discussed above is much more strong in the final position of the word due to communicative factor. Word final position carries minimum communicative load (cf. CHAPTER II: Section-B2(i)(i)(alif)). So, the features like aspiration which involve some complexity and are difficult to produce both physiologically and in terms of the involvement of an extra articulator, larynx (cf. CHAPTER III: Section-B2(i)(i)(alif) are mostly avoided in word final position which is least important position from communicative point of view since the need to keep distinction apart is very low in this position. This is why the monosyllabic words illustrated above lose their aspiration in word-final position only.

(b) Monosyllabic Words with both Initial and Final Aspirated Stops

Here we present in a tabular form the monosyllabic words of Bihar Urdu aspirated both initially and finally and in which deaspiration has taken place in word final position. The comments on these words are given after their illustration.

<table>
<thead>
<tr>
<th>Standard Urdu</th>
<th>Bihar Urdu</th>
<th>Item No.*</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>bhi:k(h)</td>
<td>bhi:k</td>
<td>363</td>
<td>begging</td>
</tr>
<tr>
<td>bhu:k(h)</td>
<td>bhu:k</td>
<td>367</td>
<td>hunger</td>
</tr>
</tbody>
</table>

*Ftn. For form class and further details of meaning see Glossary.
<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>dhiːt(h)</td>
<td>dhiːt</td>
<td>557</td>
<td>shameless</td>
<td></td>
</tr>
<tr>
<td>ṭhath</td>
<td>that</td>
<td>624</td>
<td>last</td>
<td></td>
</tr>
<tr>
<td>thaːth</td>
<td>thaːt</td>
<td>631</td>
<td>roof (on which thatch is laid)</td>
<td></td>
</tr>
<tr>
<td>ṭhath</td>
<td>roof (on which thatch is laid)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>theːth</td>
<td>theːt</td>
<td>635</td>
<td>real</td>
<td></td>
</tr>
<tr>
<td>ṭheːth</td>
<td>636</td>
<td>real</td>
<td></td>
<td></td>
</tr>
<tr>
<td>chath</td>
<td>chat</td>
<td>773</td>
<td>name of a Hindu</td>
<td></td>
</tr>
<tr>
<td>chaːch</td>
<td>chaːc</td>
<td>789</td>
<td>buttermilk</td>
<td></td>
</tr>
<tr>
<td>ṭchaːch</td>
<td>790</td>
<td>buttermilk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>jhuːth</td>
<td>jhuːt</td>
<td>914</td>
<td>lie</td>
<td></td>
</tr>
<tr>
<td>jhāːjh</td>
<td>jhāːj</td>
<td>923</td>
<td>cymbal</td>
<td></td>
</tr>
<tr>
<td>ghaːgh</td>
<td>ghaːg</td>
<td>1156</td>
<td>wily</td>
<td></td>
</tr>
<tr>
<td>jhuːjh</td>
<td>jhuːj</td>
<td>915</td>
<td>fight</td>
<td></td>
</tr>
</tbody>
</table>

**Comments**

(i) In the above examples, in the monosyllabic words deaspiration in the final position takes place. In several words the aspiration has alternately been retained.

(ii) In the above Bihar Urdu monosyllabic words deaspiration takes place of the final aspirated stops instead of the initial ones. That is, Grassman’s Law in a reverse order, is at work here. This Grassman’s
Law in reverse order is a clear manifestation of physiology as well as of communication.

(iii) Physiologically, as stated earlier, aspirated units which are based on h of aperture 1 1/2 and A of aperture-2 utilize a great deal of energy like the units of aperture-1. Units of Ø-aperture due to their explosion and of aperture-3 also require much energy. That is, the combination of aspiration (h and A) with the units of aperture-Ø and 3 makes the combination highly energy consuming. Now, two aspirated units occurring in a syllable or in successive syllables require a great deal of energy for their pronunciation in a row which makes the pronunciation very difficult. Therefore, the occurrence of two aspirated stops in a syllable is highly disfavoured. Thus, we expect one of the aspirated stops to drop its aspiration in the syllable.

(iv) Grassman's Law suggests the deaspiration of the initial aspirated stops. But again, physiologically, aspirated units are disfavoured in the final position and favoured in the initial position of the word, as for the aspirated units we have to exhale the air which we get available in the lungs. In the
initial position we have more air available in the lungs than in the final position. As a result, in Bihar Urdu of the two aspirated stops (initial and final), final aspirates lose their aspiration. That is, Grassman's Law in a reverse order takes place.

(v) The deaspiration in the final position gets reinforcement from the communicative factor also. Word final position carries minimum communicative load (cf. CHAPTER II: Section-B2(b)(i)(alif)). So, the features like aspiration which involve some complexity and are difficult to produce both physiologically and in terms of the involvement of an extra articulator, larynx (cf. CHAPTER III: Section-B2(a)(i)(be)) are mostly avoided in word final position where the need to keep distinction apart is very low. As a consequence of this, the words presented above lose their final aspirations instead of the initial ones.

Section-B1(c)(ii): Aspiration and Voicing

Here we emphasize physiologically the complexity of aspiration over voicing with the help of the frequencies of aspirated/unaspirated and voiced/voiceless units in the initial and final positions of the CVC words presented in the Table I-10. Comments on the table are given after presenting the table.
### Table I-10: Voiced/Voiceless and Aspirated/Unaspirated Stops in the Initial and Final Positions of the CVC Words

<table>
<thead>
<tr>
<th></th>
<th>Voiced</th>
<th>Voiceless</th>
<th>Total</th>
<th>Unaspirated</th>
<th>Aspirated</th>
<th>No.</th>
<th>%</th>
<th>No.</th>
<th>%</th>
<th>No.</th>
<th>%</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>554</td>
<td>514</td>
<td>1068</td>
<td>100</td>
<td>707</td>
<td>361</td>
<td>33.80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final</td>
<td>533</td>
<td>68.95</td>
<td>240</td>
<td>31.05</td>
<td>773</td>
<td>144</td>
<td>18.63</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1087</td>
<td>59.04</td>
<td>754</td>
<td>40.96</td>
<td>1841</td>
<td>505</td>
<td>27.43</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Comments on Table I-10:**

(i) As shown in the table, here aspirated/unaspirated and voiced/voiceless units are counted in terms of their frequencies in the CVC word initial and final position.

(ii) The units whose frequencies are considered are p ph b bh t th d dh t th ð dh c ch j jh k kh g gh.

(iii) The aspirated and voiced stops involve an additional articulator, larynx, in their production as compared to their unaspirated and voiceless counterparts respectively. Therefore, the aspirated and voiced stops in comparison with their unaspirated and voiceless counterparts are disfavoured phonological units as they involve more complexity in terms of human behaviour (cf. CHAPTER III: Section-B 2(c)).
(iv) In terms of communicative intent, we may expect aspirated and voiced stops despite their being complex to compete well with the unaspirated and voiceless stops in the initial position of the word which carries maximum communicative load (cf. CHAPTER II: Section-B2).

(v) But, physiologically, aspirated stops are more complex than the voiced stops. In the production of voiced stops, only vocal folds, which are very sensitive and very mobile, vibrate. Hence, voicing does not require much energy. On the contrary, in the production of aspirated stops puff of breath is emitted from the lungs and pushed through the larynx with triangular configuration of the glottis, before rushing to the oral cavity. This requires a great deal of energy. Moreover, aspirated stops are the units of aperture-Ø combined with h of aperture $\frac{1}{2}$ and A of aperture-2 which require high amount of energy resulting in their disfavouring physiologically. Thus, we expect aspirates to be more disfavoured than voiced units owing to this large amount of energy requirement.

(vi) Even a quick glance at the table confirms our expectations. In Bihar Urdu, in the initial
position of the 1068 occurrences, 707 (approximately 66%) and 554 (nearly 51%) are unaspirated and voiceless stops respectively whereas 361 (approximately 34%) and 514 (nearly 49%) are aspirated and voiced. Similarly, of the 773 final stops, 629 (approximately 81%) are unaspirated and 553 (nearly 69%) are voiceless stops whereas only 144 (approximately 19%) and 240 (nearly 31%) are aspirated and voiced stops respectively.

Thus, the occurrences confirm the disfavouring for aspirated and voiced stops over unaspirated and voiceless stops. The occurrences also confirm that aspiration having 34% in the initial and 19% in the final position of the word is more disfavoured than voicing which has 49% in the initial and 34% in the final position of the word.
Section-B2: Relative Adroitness of Articulators:

Frequency Count

As hinted by the title itself, the present section emphasizes as to how adroitness of the various articulators influences the syntagmatic distribution of Bihar Urdu phonological units. This influence of adroitness of the various articulators on the distribution of units can be highlighted into four subsections.

Section-B2(a): Frequency Count of the Stops

In this subsection, we present Table I-11 which shows the frequency of stops in terms of articulators and their adroitness.

Comments on Table I-11:

(i) Stops are considered for frequency count in the initial and final position of the CVC words.

(ii) The stops considered here are both voiceless and voiced besides being aspirated and unaspirated. They are p ph b bh, t th d dh, c ch j jh, k kh g gh. The articulators are supra-glottal i.e. apex, labium, front-dorsum and medium.

(iii) As discussed in Section-A3 of the present chapter, for apertures $\emptyset - 3$ the articulators are
<table>
<thead>
<tr>
<th></th>
<th>Apico-</th>
<th>(Apice)</th>
<th>Apico-</th>
<th>Labial</th>
<th>Front-</th>
<th>Medial</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>dentel</td>
<td>palatal</td>
<td></td>
<td></td>
<td>dorsal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Initial</td>
<td>169</td>
<td>1291</td>
<td>122</td>
<td>312</td>
<td>240</td>
<td>225</td>
<td>1068</td>
</tr>
<tr>
<td>No.</td>
<td>54.17</td>
<td>48.42</td>
<td>42.21</td>
<td>72.73</td>
<td>52.75</td>
<td>63.20</td>
<td>53.56</td>
</tr>
<tr>
<td></td>
<td>18.50</td>
<td>42.29</td>
<td>21.60</td>
<td>15.14</td>
<td>27.81</td>
<td>16.95</td>
<td>100</td>
</tr>
<tr>
<td>No.</td>
<td>45.03</td>
<td>51.58</td>
<td>57.79</td>
<td>27.27</td>
<td>47.25</td>
<td>36.80</td>
<td>46.44</td>
</tr>
<tr>
<td>Final</td>
<td>143</td>
<td>310</td>
<td>167</td>
<td>117</td>
<td>215</td>
<td>131</td>
<td>773</td>
</tr>
<tr>
<td>No.</td>
<td>45.03</td>
<td>51.58</td>
<td>57.79</td>
<td>27.27</td>
<td>47.25</td>
<td>36.80</td>
<td>46.44</td>
</tr>
<tr>
<td>Total</td>
<td>312</td>
<td>601</td>
<td>289</td>
<td>429</td>
<td>455</td>
<td>356</td>
<td>1841</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Table I-11: Stops in terms of Articulators in the Initial and Final Positions of the CVC Words
preferred in the order of hierarchy of adroitness: apex, dorsum, medium, labium comes somewhere near the dorsum but definitely below the apex and above the medium (cf. INTRODUCTION: Section-Cl(a)(i)(be)). The apex is the most flexible or adroit articulator. Due to its extra-ordinary flexibility it can be raised to form a complete closure against the edge of the upper teeth, against the alveolar ridge or against the hard palate. So, in hierarchy of adroitness, it has an edge over labium, dorsum and medium. Considering these facts we expect that a preference will be given to apical units over all other units. Even a cursory glance at the table confirms our expectations. Of the total 1841 number of words, 601 (32.65%) are apical stops which are the most favoured units. Non-apicals, on the other hand, are less preferred with 429 (labial), 455 (front-dorsal), 356 (medial) occurrences.

(iv) The non-apical stops would be additionally disfavoured in the final position of the word than in the initial position where they would compete well with the apicals due to high communicative load in the initial position (cf. CHAPTER II: Section-B3(d)). The figures in the table conforms to our predictions. Of the total occurrences of 1068 CVC words in the initial
position, 312 (29.21%) are that of labials, 240 (22.47%) of front dorsals, 225 (21.07%) of medials, whereas 291 (27.25%) that of apicals. In this position non-apicals compete well with apicals. In word final position, in contrast, of the total 773 occurrences, 117 (15.14%) are that of labials, 215 (27.81%) of front dorsals, 131 (16.95%) of medials and 310 (42.29%) that of apicals. That is, non-apicals are additionally disfavoured over apicals in word final position which is communicatively less important. Thus, the relative frequencies of Bihar Urdu stops just mentioned expose high disfavouring for non-apicals and the striking preference for apicals with only one exception where labial has an edge over apicals in word initial position. The rationale for this preference of labials is coming from some other orienting principle (cf. CHAPTER V: Section-A1).

Section-B2(b): Frequency Count of the Nasals

Table I-12 presented here shows the frequencies of nasals in the initial and final positions of CVC words. Comments are given immediately after presenting the table.
Table I-12: Nasals in terms of Articulators in the Initial and Final Positions of the CVC Words

Comments on Table I-12:

(i) Nasals are subjected to frequency count in the initial and final position of CVC words.

(ii) m, n, ñ, are the nasals considered here.

(iii) Of all the supraglottal articulators, we expect apex to be mostly in combination with aperture-Ø, 1, 2, 3 because of its high degree of adroitness. It should be followed by labium, dorsum and medium (cf. INTRODUCTION: Section-C1(a)(i)(be)). That is, we expect apical units to have an edge over non-apical units.

(iv) The frequencies in the given table is clearly in favour of our predictions. Of the total number of 411 CVC words of the bottom row (total), 205
(49.88%) are that of apicals and 174 (42.34%) that of labials and 32 (7.75%) pf front dorsal. Furthermore, of 240 CVC words in the final position, 136 (56.67%) are apicals, 72 (30%) labials, 32 (13.33%) front dorsals. So, we see that the frequencies of various nasals in terms of articulators reflect a clear skewing in favour of apical nasals which is in accordance with the physiological rationale discussed above.

(v) Note that contrary to our expectations, labial nasal ′m′ has an edge over apicals in word initial position. The rationale for this preference is coming from some other orienting principle (cf. CHAPTER V: Section-A2).

(vi) Note further that the occurrence of apico-palatal ′n′ and medial ′ŋ′ is limited to non-initial and non-final positions only. This is because they are so called positional variants.

Section-B2(c): Frequency Count of the Fricatives

The frequencies of the fricatives in terms of the hierarchy of adroitness of the supraglottal articulators in the the CVC words are presented in Table I-13. Comments on the table are given after presenting the table.
Table 1-13: Fricatives in terms of Articulators in
the Initial and Final Positions of the CVC Words

Comments on Table 1-13:

(i) We count here the frequencies of fricatives in the initial and final position of the CVC words.

(ii) The frequencies of the fricatives counted here are that of f, s, x.

(iii) Due to relative adroitness of the articulators, some of them would be more preferred than the others in the syntagmatic distribution of the phonological units articulated at aperture - 0 through 3. To be more explicit, apex is the most adroit articulator and we expect it to be involved in the production of large number of phonological units in Bihar Urdu.

(iv) The frequency count presented in the table above confirms our expectation. The bottom row
(total) of the table shows that of 269 words, 256 (95.17%) are apical fricative in comparison with 12 (4.46%) and 1 (0.37%) of labial and front dorsal respectively. It is worth noting that both in word initial and final position the frequency of occurrences for apical is much higher than that for non-apicals. Thus, the frequency count shows a striking tilt in favour of apico-dental fricatives and this is what we expect in terms of adroitness of the articulators.

(v) Note that there is no instance of medial fricative in Bihar Urdu as this fricative has merged with apico-dental s. The rationale for this merger comes from physiological mechanism (cf. Section-IA2) as well as from communication dealt with in Chapter 2. The merger further increases the frequency of s.

Section-B2(d): Frequency Count of the Final Clusters

Here we concern ourselves with the retention and elimination of the final clusters with voiced stops and their respective homorganic nasals presented in Table I-14. Comments on the table are given after presenting the table.
<table>
<thead>
<tr>
<th>Name of the clusters</th>
<th>Standard urdu After V:</th>
<th>Standard urdu After V</th>
<th>Bihar Urdu After V:</th>
<th>Bihar Urdu After V</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>- mb</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>- nd</td>
<td>14</td>
<td>3</td>
<td>17</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>- nĎ</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>- ņ j</td>
<td>7</td>
<td>1</td>
<td>8</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>- ņ g</td>
<td>18</td>
<td>9</td>
<td>27</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

|              | 43                     | 14                     | 57                 | 5                  | 10       | 15       |

Table I-14: Final Clusters of Voiced Stops with Their Homorganic Nasals

Comments of Table I-14:

(i) Here we deal with voiced stops forming final clusters with their respective homorganic nasals.

(ii) The final clusters taken here are -mb, -nd, -nĎ, - ņ j and - ņ g. The cluster - mb has been included in the table to show that there is no word for this cluster in Bihar Urdu.

(iii) Physiologically, there is a tendency to conserve the energy. Thus, the combinations of units
utilizing greater amount of energy are always disfavoured. The stops articulated at aperture-0 consume high amount of energy and thus prefer to combine with higher apertures (3, 4, 5 onwards), because the units articulated at higher aperture require lesser amount of energy. The clusters involving stops, articulated at aperture-0 and nasals again articulated at aperture-0 are quite disfavoured combinations. They are more disfavoured in the final position which carries minimum communicative load (cf. CHAPTER II: Section-B2(c)). So, they are expected to be simplified in the final position.

(iv) Of the final clusters, the apical clusters are likely to be preserved most. For, the apical axis, physiologically, is most favoured. That is, for apertures-0 through 3, the apex of the tongue is most preferred articulator in terms of hierarchy of adroitness and has an edge over labium, medium and dorsum. Given these facts phonological units produced with the help of apex or falling on the apical axis are likely to be preserved.

(v) The bottom row (total) of the table given here is clearly in favour of our predictions. Thus, of the total 57 instances, only 15 clusters survive in
Bihar Urdu and 42 clusters get simplified. That is, 42 voiced stops are eliminated after their homorganic nasals as voiced stops are the last phonological units. Moreover, of the 15 clusters retained in Bihar Urdu, 11 are apical clusters (7 apico-dental (-nd) and 4 apico-palatal (-nd). That is, there is a remarkable skewing in favour of apical clusters.

To summarize Section-B as a whole:

1. The amount of energy utilized by the various apertures while producing phonological units makes an influence on the combination of phonological units. The combinations that husband the source of energy are preferred to those that dissipate it. As a result of this, (i) CVC combination of words and (ii) stop (aperture-∅) + liquid (aperture-3) combination in word initial position, are the most favoured combinations because they require lesser amount of energy in their articulation (iii) Aspiration consuming greater amount of energy is a disfavoured feature physiologically. (2) The overall frequency of stops, nasals and fricatives show that apical stops, nasals and fricatives are the most favoured units because they make use of the most adroit articulator i.e. apex of the tongue.
Section-C: Summary and Conclusions

In this chapter, an attempt has been made to examine the role of physiological mechanism in Bihar Urdu phonology. This has been done by taking into account physiology's role in the non-arbitrary distribution of Bihar Urdu phonological units both paradigmatically and syntagmatically.

Section-A is restricted to the role of physiological mechanism in Bihar Urdu phonology paradigmatically. In this section, we have introduced and discussed the Phonological Grid of Bihar Urdu (Diagram I-1) which is the network of Bihar Urdu phonological units falling at the intersections of the articulators and the apertures, the two physiological axes. This section also deals with the physiological merger of \( z \) with \( s \), the impact of adroitness of the various articulators on the number of phonological units and suitablity of the non-apical portion of the tongue with greater physical mass for vowels.

Section-B examined the role of physiological mechanism in combinatory phonology of Bihar Urdu. Here we highlighted the impact of different degree of amount of energy consumed by the apertures on the combinations of units. Even more significantly, we
have examined the influence of the adroitness of the various articulators on the frequency of various phonological units.

To conclude: (1) Phonological Grid of Bihar Urdu (Diagram I-1) is a systematic presentation of all its phonological units on the basis of articulators and apertures. That is, the phonological units, presented in the Grid, are physiologically motivated. The phonetic substance of these units is determined by their articulatory characteristics. (2) Furthermore the network of phonological units, presented in the Grid also highlights the interrelationship of these units. That is, the Phonological Grid also indicates the phonological value of the units. Thus, equal weightage is given to the phonetic substance and phonological value in the present analysis of Bihar Urdu. (3) A total number of sixty one (61) units have been set up by combining eight (8) articulators, singly or in combination with ten (10) degrees of aperture. Of these sixty one (61) phonological units fifty three (53) are distinctive phonemes and eight (8) are non-distinctive positional variants. (4) Some non-distinctive (non-phonemic) positional variants whose phonetic substances fall on the intersections of articulators and apertures are
elevated to the status of full-fledged phonological units. (5) Due to the fact that medial fricative \( \tilde{b} \) involves the least adroit articulator medium of the tongue, it merges with \( s \) which, on the other hand involves the most adroit articulator, the apex of the tongue. (6) Non-apical portion of the tongue owing to its greater physical mass for vowels is the most favoured articulator. As a result of this, the vowels of Bihar Urdu are either medial or dorsal. (7) The combinations of units that utilize greater amount of energy are always disfavoured over combinations of units consuming lesser amount of energy. Thus, we have in word initial position only stop (aperture-0) + liquid (aperture-3) combinations which require less amount of energy in their production as compared to other combinations in word initial position (8) For apertures 0 - 3, the articulators are preferred in order of hierarchy of adroitness. In terms of this hierarchy apex stands at the top on the scale of adroitness and has a clear edge over dorsum, medium and labium. Both the number of units in the Grid and the frequency count of these units strikingly show that apex is the most adroit and thus most favoured articulator.