CHAPTER V: Acoustic Base of Shopal Urdu Phonology

Our very ability to hear is based on the physical phenomena of sound, and these phenomena set some unavoidable limitations to the sense of hearing. Our whole mechanism of speech is also dependent on the physical phenomena of sound; since speech is intelligible only in physical terms, so it is necessary to look at this side of a language. To understand fully the physical nature of speech sounds we must know both the positions of the various parts of the vocal tract and the corresponding resonant frequencies. This demands extensive amount of laboratory work. Due to certain unavoidable circumstances, we could not carry experimental work on this important aspect of phonological analysis, and our comments on acoustics are thus based on received knowledge. Furthermore, we have dealt with only one aspect of Shopal Urdu Phonology in terms of acoustics, which is rounding of back-dorsal ('back') vowels and the converse unrounding of medial ('front') vowels. We give acoustic rationale for the rounding of back-dorsal vowels. We give acoustic rationale by providing formant frequencies of English unrounded and unrounded vowels.

In Shopal Urdu (as in many other languages, including English), medial vowels do not have labial interplay that is "unrounded" whereas back dorsal are produced with labial interplay or are rounded. All the back dorsal vowels u, u:, o: in Shopal Urdu are rounded the
same thing happens in standard Urdu, English and Hindi and many other languages. On the other hand medial vowels i, i:, o, are unrounded same is the situation in Urdu, Hindi, and English. The answer of this skewing is neither physiology nor psychology but the acoustic need to do so. Therefore we have made an attempt to explain them in acoustic terms, that is why we have set acoustic medium as the fifth orienting principle, though as said earlier in this chapter our comments on acoustics are based on received knowledge.

**Acoustic Rationale for lip Rounding of Jack Dorsal Vowels:**

Interplay of labium for back dorsal vowels makes them more difficult (involve one more articulator that is labium), and this is against human behavior orientation discussed in Chapter II/A3. But still all the three back dorsal vowels have labial interplay. Further, all the three medial vowels donot have labial interplay.

The above said skewings can only be explained with the help of an acoustic rationale.

Acoustically, vowels can be described as voiced speech sounds resulting from a sound modified by a resonant cavity. In course of their production vocal tract exhibits at least two or three well-defined resonants 'vowel formant'. Each vowel sound is characterized by an acoustic spectrum with peaks at a number of points on the frequency scale, these spectral peaks or frequency
bands, where the acoustic energy is concentrated is called formant. Each vowel is characterized by a series of such formants of which the lowest two or three are most important for identification of specific vowels. The lowest two formants called $F_1$, $F_2$ play a characteristic role in forming and modifying the quality of a vowel. As a rule, in order to be distinct and acoustically clear, each vowel should have well-spaced first and second formants. The changes in the frequency of formant 1 and formant 2 are the result of the ways of openings and size of the various cavities. Front, back, we can find direct relationship between the frequencies of formants and articulatory position of vocal organs (tongue, lip). Through various backward/forward and upward/downward movements of the tongue and rounding of the lips, we can observe the change in the volume of and opening of the front and back cavities, and as we know their size and volume is a determining factor in modifying the frequencies for the formant 1, 2. Certain points are to be made in this connection:

1. Tongue fronting raises second formant by decreasing the front cavity volume.
2. Lip rounding lowers the second formant (by increasing the front cavity volume).
3. Tongue lowering raises the first formant (by decreasing the back cavity volume).

Now we present spectra for various vowels of English adopted from Peter Ladefoged (1962: p. 96-97)
Diagram V-1: Spectra of F1, F2 with Exemplifying words of English vowels; (adopted from Ladefoged)
in Diagram IV-1. The vertical axis represents frequencies from 0 to 2500 and the horizontal shows time. The diagram may thus first be thought of as showing the first and second formants for a series of vowels as spoken one after other. The manner of representing vowel formants resembles the display of a sound spectograph.

As the figure IV-1 shows different vowels of English are clearly distinguished from each other by the location on the frequency scale for the first and second formants. As pointed out earlier, the characteristics of F1, is determined by the resonant cavity which is formed behind the tongue (pharynx). F1 is also characterized by height of the tongue. F2 is determined by the resonant cavity in front of the tongue (mouth). Thus we measure the frequencies of F1 and F2 on spectograms, it is similar to measuring the resonance notes of the back and front cavities. Obviously the shape and size of those two cavities are different for each vowels, as a result différent F1, F2 result and eventually different vowels.

If we look at the formant frequencies of English vowels, we can see that first formant for iː and uː is lowest and nearly same a little higher for i, u and moderate for e, ɔː, ɔː, and æ. For iː, uː, æ, ɔː, and e frequency of F1 is same. Given this situation the cues of F1 are not enough for us to distinguish iː, i, æ etc. from uː, u and ɔː.

For the second formants there is regular fall of the formants, iː has highest second formant frequency
and u: has lowest, so because of F2 vowels i:, u: become clearly distinct vowels. Second formants for i, u are different and the same can be said for the second formants of i-u. Likewise second formants of e-ɔ: and e and ɔ are also different. There is thus no difficulty in the identification of the vowel i: from u:, i from u etc. This acoustic distinction is possible only because of lip rounding. Lip rounding derives frequency of F2 lower, by increasing the volume of the front cavity (from back dorsum to lips). As we have pointed out earlier that the tongue fronting and consequent reduction in the front cavity raises the second formant, but by rounding the lips the second formant frequencies are decreased. It is because rounding of lips increases the volumes of front cavity and that of total cavity and so F2 decreases.

If there was no lip rounding than the F2 for u:, u, ɔ, ɔ: would have gone either higher or near to the F2 of i:, i, e, æ and there would have been difficulty in distinguishing u: from i:, u from i etc. Thus, liprounding enlarges and closes the front cavity and lowers F2. But it is to be questioned why only the back vowels are rounded? The answer is due to lack of symmetry in the vocal tract.

There is less space for back (that is back dorsal) vowels than for the front (medial) vowels (cf. Chapter I, Section C1). For back vowels the chamber is from back dorsum to larynx, and for front vowels from medium to larynx. The chamber is bigger for front vowels than for the
back vowels, so less distinctions of vowels are possible at the back. In order to make the back vowels acoustically distinct from each other and that of front vowels it is necessary to increase the size of the resonance chamber for back vowels. When we pronounce the back vowels with rounded lips we form two chambers (1) Dorsum (back) to larynx (2) (back) dorsum to lips, which increases the size of resonance chamber. Therefore, lip rounding becomes an essential character for back vowels.

It is clear from the above discussion of English vowels that rounding of lips is an acoustic need for the back vowels. It is in acoustic terms that we can explain their rounding and converse unrounding for the front vowels.