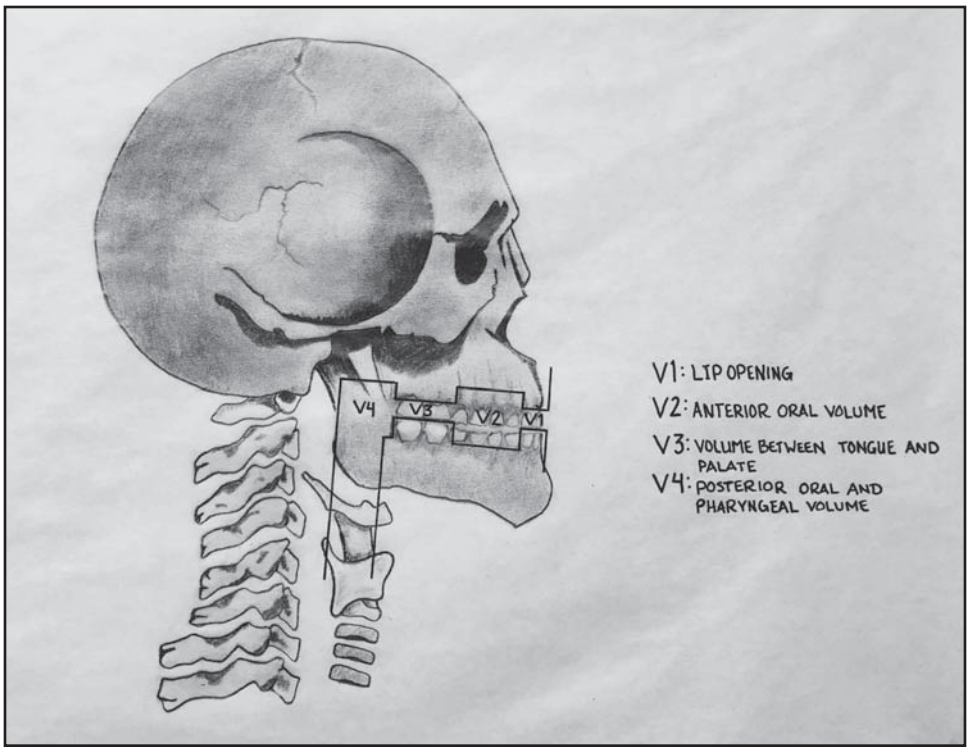

Figure 4-2. Double Helmholtz resonator as it relates to the human speech mechanism. (Image drawn by Mathew DeVore)

Source and Filter

Meaningful speech is the product of a variable volume system by which the acoustic spectrum of a source is modified by a filter. In typical use, the filter is in constant motion, varying volumes and sources according to the speaker's demands.

The driving sources, as we have learned, are of three main types. The phonatory or glottal source is a quasiperiodic, continuous series of air pulses that pass between the vocal folds and up through the vocal tract during the open phase of the glottal cycle. The fricative source is a random, aperiodic continuous source, created by forcing a relatively laminar air flow through a tight constriction, disturbing the usual flow of respiratory air molecules and creating turbulence. The third source is the plosive source, a transient burst of energy created by trapping air behind a complete vocal tract closure and releasing it as articulatory demands require. The acoustic sources of all normal speech are one of these three, and most often variations of the phonatory, or combinations of the phonatory source and one of the other two. In the source-filter model, acoustic source spectra are referred to as *input spectra*, and those of the phonetic output are referred to as *output spectra*.

The vocal tract's resonating cavities are all located superior to the glottis, and the glottis represents the closed end of the vocal tract tube (see Figure 4-2). These resonating cavities include the pharynx and the oral and nasal cavities. Smaller resonating cavities also play a resonating role and include the spaces between the teeth and outer tissues of the oral cavity, the small cavities of the larynx, the paranasal sinuses, and the cavity of the trachea. The larger cavities vary in volume according to the actions of the speaker to distinguish meaning in speech, while the smaller cavities help distinguish the personal identity of the speaker.

The resonating cavity volumes are crucial to phonetic variation, as they are said to filter the driving sound source. In contrast to our usual concept of a filter, this acoustic filter can either amplify or dampen the driving source, making bands of frequencies in its power spectrum louder or softer respectively. Since the speech-driving source is complex, this means that the resonating system either dampens or amplifies certain frequency bandwidths of the driving source frequency spectrum. Describing the role of the resonating system in these terms is important since two of our sources are aperiodic, and, thus, do not have discrete frequencies to amplify or dampen. It is patterns of amplification and dampening that, along with the nature of the driving source, are key perceptual features in the decoding of speech.