Acoustic Phonetics Counseling

By Dennis A. Colucci, AuD, MA

The distribution of speech signals in a free field is nothing less than chaotic. From this chaos, the auditory scene is analyzed, with the acoustic properties and distinctive features of speech being extracted for linguistic interpretation. Although many factors comprise communication—such as vocal effort, phoneme confusion, and interpreting suprasegmentals—the distance between the speaker and the listener is important, not only for the hearing impaired or patients with an auditory processing disorder, but also for their cohorts with normal auditory skills.

Counseling patients on their hearing level and providing them with metastrategies for communication success is productive and supports a better outcome. It encourages collaboration and shares the responsibility for communication with the patient and does not leave it to the electronics alone.

A frequent experience in the clinic comes from patients who, after first being fitted with hearing aids, cannot understand why they have difficulty hearing their spouse from the kitchen or an upstairs balcony, or have difficulty hearing in a classroom. A simple explanation on speech and room acoustics can help to resolve this dilemma and, at the same time, provide solutions.

PHONEME ACOUSTICS

The utterance of speech is a complex dynamic process, with voiced sounds having most of the power and unvoiced sound having most of the information for nontonal languages, but with about half the power. This happens, first, because phonemes are created by alterations in the size and length of the vocal tract being used (glottis to lips), and second, because place and manner shape individual distinctive features and modify the output power, and thus the intensity. For example, the loudest phonemes are central vowels such as /Λ/ (as in but) because they are created by the largest vocal cavities and an opened mouth with a mid-tongue position. This results in less filtering, equally spaced formants, no antiformants as seen in fricatives such as /s, f, th, h/ or nasals /m, n, ng/, and substantial air volume. On the other hand, in the absence of phonation, once the oral cavity is reduced in size and air flow is restricted, the sound power is governed by the last filtering device used such as the teeth, tongue, and lips (Figure 1).

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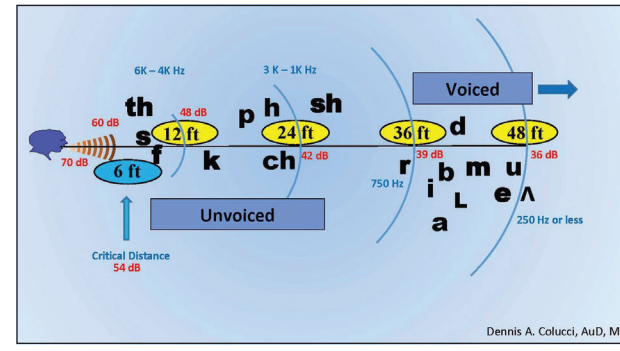

Figure 1. This is a conceptual representation of energy loss by distance for phonemes from a male voice at a normal vocal effort in a non-reverberant room. Voiceless consonants are placed in the sound field based on their center frequency and at an approximate intersect where the sound intensity could be 15 dB SPL or less. The decibel readings are the LTASS in dB SPL at various distances from the sound source based on the inverse-square law (1/distance2) (http://bit.ly/1ogt8lv).

The critical distance marker is calculated for a classroom that is 35 × 40 × 10 feet (14,000 ft^3/396 m^3) for 25 to 30 students with a reverberation time of 750 msec (http://bit.ly/1X6hGXl).

Corresponding frequency markers are placed along the axis to approximate the tone range for the phoneme groupings. Notably, the voiced signals have longer wave lengths and more power and, therefore, can travel at greater distances, making up the general perception of loudness across the continuum, whereas unvoiced speech sounds have limited power, restricting their contribution to speech discrimination at a distance.

EXPECTATIONS, LISTENER PERFORMANCE

As a result of the gradual downturn in auditory function, many patients misalign the communication rules and expect their hearing aids and cochlear implants to work at superhuman capabilities. For the most part, patients should have high expectations for performing well with amplification, especially in their own homes. As the size of a room increases, the distance between the speaker and listener expands, or the noise floor from HVAC or other environmental sources increases; however, word clarity suffers. Although room size cannot be easily controlled and background noise is not always abatable, reminding patients to close the distance between the speaker and listener has significant merit, especially when it is possible to function within the critical distance.

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