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BREATH IS NOT THE CARRIER OF SPEECH

Ingo R. Titze

National Center for Voice and Speech, The University of Utah; Department of Communication Sciences and Disorders, The University of Iowa

Introduction

In general communication theory, where a signal is delivered over distances with a carrier, there are principles that may be useful to re-shape our thinking about speech transmission. If a signal is carried from point A to point B, there is usually a sender, a medium for transmission, and a receiver. An electromagnetically transmitted signal (e.g., speech heard from a radio) requires no medium other than a vacuum to set up a carrier. This carrier is a high-frequency oscillatory “tone,” although way beyond our auditory range. We dial in this carrier with the number we select on the radio dial (e.g., 100 Mega Hertz on an FM dial). The signal we care about (speech or music) is not the carrier itself, but a modulation of the carrier, either an amplitude modulation (AM) or a frequency modulation (FM). Your radio receiver de-modulates the signal from the carrier and plays the modulation over the loudspeaker.

There appears to be a deep-rooted tradition in speech training that breath is the carrier of speech. As an example, Linklater (1976, Chapter 7) shows illustrations of breath flow with labels such as “sound sighs forward over the tongue” and “sound should not fall onto the tongue.” There is no question that breath initiates vocalization and provides the energy to produce sound. There is also no question that the breath we take, spontaneous or planned, is deeply connected to our emotions, the thought we wish to convey, and the urgency and fluency with which we convey it. What is at question is the role that breath plays in carrying the sound to the listener, once the sound is produced. What is further at question is the value (and reliability) of breath sensations we experience in our airways during phonation. The airflow we feel has little to do with the acoustic waves that propagate in our vocal tract and are emitted from our lips. The best analogy is water waves propagating on a river. If we toss a rock into the river, a surface wave will propagate rapidly (as a growing circle) in all directions. The slow moving water, which is like the breath stream in vocalization, has little effect on the speed or direction of the wave. Obstacles and boundaries do have an effect, however. It is the shape of the river bed (the boundaries) that guides the waves, not the moving water. Likewise, it is the shape of the airway (the vocal tract) that guides the sound, not the breath. The key question is: how is a verbal message coded by air and tissue movement and how does it get to the listener? I offer some principles and hope that some debate may follow.

Carrier-modulation principles for speech

An acoustically transmitted signal involves a medium and a carrier. The medium must be more than a vacuum, namely space filled with a compressible substance like air. A wave is created by compressing the air. The medium can be slowly-moving or stationary. The carrier is a “tone,” namely voice (or voicing). The carrier frequency is the fundamental frequency, which carries the modulations that characterize speech: frequency and amplitude modulations (basic elements of prosody), modulations of higher partials (for vowels and consonants), and periods of silence (pauses).

A rule of thumb in modulation theory is that the carrier frequency should be at least 10 times greater than any modulation frequency. This rule is generally met in speech. Phonemes are produced at a rate of about 10 per second, while f_0 in speech is generally above 100 Hz (more than 100 cycles per second). Prosodic variations (melody, rhythm, pauses) also do not vary faster than 10 notes, accents, or pauses per second.

Pauses and unvoiced consonants would be considered a problem in communication theory. They interrupt the carrier, which violates a second rule of thumb in modulation theory: the extent of modulation should never be 100 %. A pause is a 100 % modulation, reducing either the carrier amplitude or the carrier frequency to zero. Thus, breath taking would be considered a loss of the carrier for speech, an excessive modulation.

Implication for speech training

Breathing is a biologically required modulation of the true carrier of speech: voicing. We manage breathing as an interruption of the carrier, tuning it on and off for a group of words. During phonation, steady airflow emitted from the mouth carries no auditory speech signal. While breath does set up the conditions for self-sustained vocal fold oscillation, and therewith helps the carrier to be established, voicing should be on top of the hierarchy in getting the message to the listener. Thus, practicing breathing without voicing has limited value. There is a belief that the order of attention in speech training should be breathing first, voicing second, resonance third, and articulation last. More current thinking is that breathing, voicing, and resonance are taught simultaneously because the systems are highly interactive. Daniel Ling taught this concept in the 1970s, well documented in his book “Speech and the Hearing-Impaired Child.” The sensations of breathing alone do not help deaf children to internalize speech proprioceptively, but the sensations of voicing do. Feeling the buzzing sensations of acoustic energy, as Lessac (1997) taught, are more reliable than the hissing sensations of turbulent air. Getting breathing, resonance, and articulation well-coordinated is almost automatic when the focus is on strong, sustained vocalization. Everything else is a modulation thereof. It has been shown that speech training for Parkinson’s patients (e.g., the Lee Silverman Voice Training approach, (LSVT®) works on the same principle (Ramig, 1995). Improved voicing brings about, as a bi-product, improved breathing and articulation. Improved breathing (by itself) does not necessarily entrain the other processes. In a recent book (Titze and Verdolini-Abbott, 2012) we devote several chapters to the interaction between breathing, valving, and voicing.

Getting back to the analogy of water waves propagating on a river, interruptions in the movement of water can be used to set up the repetition of waves. Rather than tossing stones into the river repeatedly, a paddle wheel can be driven by the moving stream to create periodic waves. However, as mentioned earlier, once the waves are propagating, the movement of the water does little to help or hinder the movement of the waves.

In summary, I do not wish to minimize the importance of breath as the primary impulse for, and the energy source behind speech. All acoustic energy comes from aerodynamic energy produced by the pulmonary system. However, what is conveyed to the listener is optimized by effectively converting the energy of the breath to acoustic energy. Any sensations of sound or vibration, inside or outside of the body, are more helpful than sensations of air movement. To their credit, Linklater (1976) and Lessac (1997) emphasize acoustic sensations in a major way, as do most speech trainers.

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