

Ingo Titze, Associate Editor

Phonation Threshold Pressure: A Measurement with Promise but Slow in Development

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COMPARISONS ARE SOMETIMES MADE between audiology and vocology, one being the study and treatment of hearing and the other being the study and treatment of voicing. Many parallels can be drawn between the disciplines. For example, both deal with a small organ (the ear and the larynx) that processes sound. Both deal with the protection and medical care of the organ, and both deal with tools of assessment of how well the organ functions.

In many ways, audiology has outpaced vocology in the area of assessment and measurement (especially standards of measurement). The reason is that hearing was always understood to be important for general survival, not just for oral-aural communication. Reception (and perception) of environmental sounds has always been regarded as critical as communicating with humans. Voicing, on the other hand, has not received the same level of importance outside the context of speech. Vocalizing for general health (by vibrating tissues), for recreation and expressing deep emotion (singing, laughing, crying), for defense (screaming, shouting), or communicating with animals, has not been regarded as an essential element of survival.

Changes are in the making. In an audiology clinic, the universally accepted first measure of hearing ability is the audiogram. This is a measure of pure-tone hearing loss (against an agreed upon standard) over a wide range of frequencies. At every frequency, the barely audible pure-tone intensity is signaled by the listener-subject. If the intensity is higher than the standard, the threshold hearing loss is recorded in decibels (dB).

Phonation threshold pressure (for voicing) was originally defined and described as oscillation threshold pressure, which is the minimum lung pressure that sustains vocal fold vibration at any given frequency.¹ It is essentially a measure of “ease of phonation.” The lower the phonation threshold pressure (PTP), the easier it is to set the vocal folds into vibration to make sound. Thus, as a curve, the PTP-gram parallels the audiogram.

So, why is the measure not routinely used in a voice clinic or a voice studio to assess the capability of an individual to speak or sing with little effort? The answer is simply technological. Lung pressure is difficult to measure directly without invasion of body tissues. A tracheal puncture is the most

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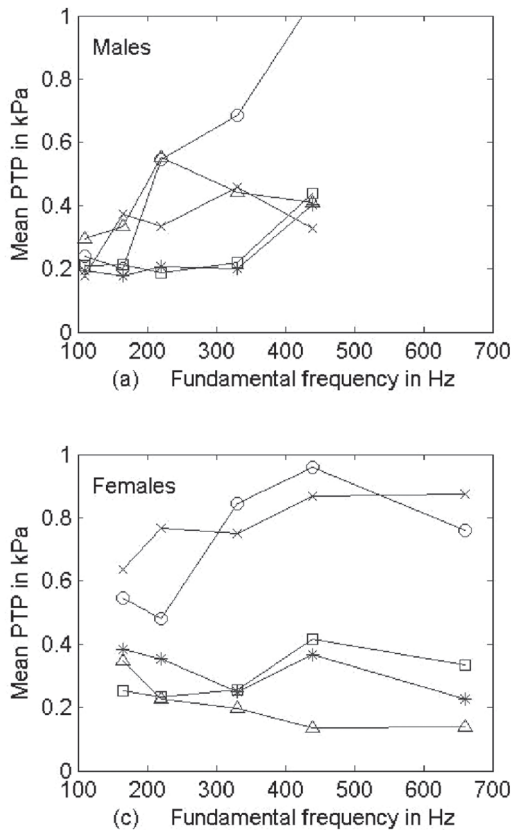


Figure 1. Oral phonation threshold pressure measured on 10 subjects: (a) five males, (c) five females (from Titze, 2009).

direct approach, but it involves skin penetration and some discomfort, as well as a risk of complication beyond the few days of healing required for the puncture wound.

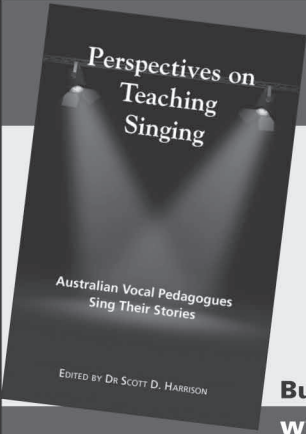
The small cannula inserted with a needle can move with repeated phonation, possibly coming in contact with other tissues and injuring them.

Current progress is in the direction of measuring an oral phonation threshold pressure (OPTP) that involves no tissue invasion of any kind. The combined use of a flow-resistant straw (described in multiple previous articles in this journal) and an electronic pressure transducer between the lips allows a rapid measurement over a wide range of fundamental frequencies.² Figure 1 shows an example of an OPTP measurement made on ten subjects.

The exploration with this technique is not complete. Primarily, validation is needed to show that oral pressure approximates lung pressure at the measurement frequencies. If OPTP does not approximate PTP, it needs to be shown that OPTP has diagnostic capabilities similar to those of PTP in terms of tissue health and overall ease of vibration, especially when the vocal tract is not occluded with a flow-resistant straw.

NOTES

1. I. R. Titze, "The Physics of Small-Amplitude Oscillation of the Vocal Folds," *Journal of the Acoustical Society of America* 83, no. 4 (April 1988): 1536–1552.
2. I. R. Titze, "Phonation Threshold Pressure Measurement with a Semi-Occluded Vocal Tract," *Journal of Speech Language Hearing Research* 52, no. 4 (August 2009): 1062–1072.



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