Ingo Titze, Associate Editor

Vocal Demands on Teachers

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TEACHERS ARE THE LARGEST GROUP OF PROFESSIONALS who use their voices as a primary tool of trade. As singing teachers, we are among that group, which comprises about 4% of the workforce in the United States.[1] The greatest vocal demand is placed on those teachers who lecture or discipline children in monologue fashion for 5–7 hours a day, often getting louder and more emphatic as the day wears on.

The National Center for Voice and Speech, a division of The Denver Center for the Performing Arts, in Denver, Colorado, is studying the vocal behavior of Denver public school teachers. The National Institute of Deafness and Other Communication Disorders in Washington, D.C., is funding the ten year project. A new device has been developed that measures the dose of vibration on the teacher's neck, in the sternal notch region (Figure 1). Whenever the vocal folds are set into vibration (i.e., the voice turns on), the dosimeter measures the duration of voicing. It also measures the duration of all silences, however long or short they may be.[2] The device already has been tried on classical singers.[3] Figure 2 shows a histogram of the occurrences of silence periods and voicing periods per hour for various on-off durations. Bins 1–3 (labeled across the top) show occurrences for very short durations (less than a second, as shown along the bottom), while bins 6–8 show occurrences for much longer durations (10–100 seconds). Note that short duration silences occur about as often as short duration voicings, but long duration silences occur more often than long duration voicings. These long duration silences are precious for teachers; we believe that significant voice recovery from tissue vibration and collision can take place in silences that are on the order of several minutes long, but much of the evidence is yet to be obtained. If our hypothesis is borne out, we will recommend that teachers carry out more dialogue with their students rather than engage in a perpetual monologue. Turn-taking is expected to be critical, as well as pauses and attention-getting soft and variable pitch speech.

Figure 3 (top) shows the occurrences of voicing per hour over a one week period. Data points indicate the numbers of times the vocal folds come together and move apart in one hour. Note that teachers have about 1200 occurrences of voicing per hour on weekends (Saturday and Sunday) and evening hours during the week (empty squares), while occurrences per hour weekdays at work are about 1800 (filled squares). The dark solid line is the average between work and no work.

If we compute the total accumulated percentage of voicing time in any hour (bottom graph), we find that it rises from 11% on weekends and evening

Journal of Singing, September/October 2007
Volume 64, No. 1, pp. 67–69

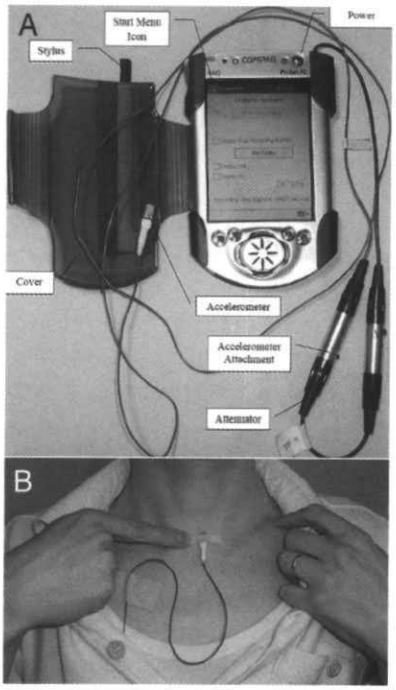

Figure 1. (A) The NCVS Voice Dosimeter, consisting of a modified Pocket PC with an accelerometer as the transducer. (B) The accelerometer is attached using hypoallergenic medical adhesive and medical tape to the sternal notch. The cabling runs underneath the clothing and the dosimeter is worn in a pack around the waist. From *The Journal of the Acoustical Society of America* 121, no. 1 (January 2007): 469–478; used with permission of the AIP.

hours to 23% during teaching hours. Thus, vocal fold collisions take place about ¼ of the time that teachers are at work. Over a million vocal fold collisions are experienced per day. This arises from the fact that, for an average 200 Hz fundamental frequency in speech, there are 200 collisions per second, 720,000 collisions per hour of continuous voicing, and 1,440,000 collisions per day with an equivalent of about 2 hours of continuous voicing (¼ of 8 hours).

As we all know, it is particularly hard for teachers to sing after speaking all day. For some singing teachers, the speaking voice and the singing voice do not match well in pitch and voice quality. Muscles get adjusted to the speaking mode and carry their patterns into the singing mode. Much is being investigated in voice therapy to blend these two voice usages. Semi-occluded vocal tract exercises, about which I have written much lately in these columns, are quite beneficial. But for those who are genetically predisposed to vocal injury, the most efficient voice production may not be enough

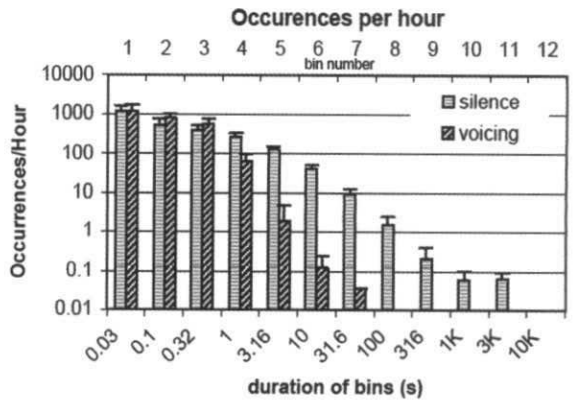

Figure 2. Ensemble averages (31 teachers) of histograms for voice and silence occurrences/hour for specific durations, in logarithmic bins. From *The Journal of the Acoustical Society of America* 121, no. 1 (January 2007): 469–478; used with permission of the AIP.

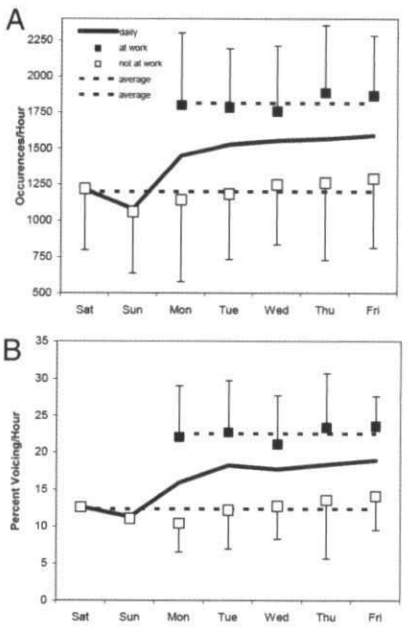

Figure 3. Ensemble averages (31 teachers) of (A) voicing occurrences/hour, and (B) voicing percentage/hour over a period of a week. A two-week stretch was averaged into an equivalent one week stretch. From *The Journal of the Acoustical Society of America* 121, no. 1 (January 2007): 469–478; used with permission of the AIP.

to overcome the inevitable problem of vibrational overdose. Amplification may help, but if excessive loudness were the whole problem, telephone workers who speak with normal loudness and close-up microphones would not fatigue vocally, yet we know that they do. Ultimately, knowing one's own limit to vibrational ex-

posure, like exposure to sun rays, is the most logical solution. Every singing teacher should keep a log of his or her vocal dose and recovery times (at least mentally, if not on paper) for rehearsals and performances.

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