

CHAPTER 19

Voice Range Profile: Phog

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PURPOSES

- To assess vocal functions in terms of pitch and loudness production.
- To provide a visual representation of an individual's vocal performance in pitch and loudness range.

THEORETICAL BACKGROUND

The presence of laryngeal pathologies can lead to changes in vocal fold mass, length, and/or tension (Colton, Casper, & Leonard, 2006). This affects laryngeal aerodynamic functions including airflow and subglottal air pressure, which have an impact on phonational frequency and intensity measures. Voice range profile is a two-dimensional graphic display of an individual's minimum and maximum phonational intensity levels across his or her total phonational frequency range, with the intensity values plotted against the frequency values (Baken & Orlikoff, 2000; Coleman, 1993; Kent, Kent, & Rosenbek, 1987). The term "voice range profile" was officially

proposed by the Voice Committee of the International Association of Logopedics and Phoniatrics in 1992 (IALP, 1992). Alternative terms used in the literature include phonetogram (Airainer & Klingholz, 1993; Akerlund, Gramming, & Sundberg, 1992), phonetography (Heylen, Mertens, Pattyn, & Wuyts, 1996), voice profile (Bohme & Stuchlik, 1995), phonational profiles (Morris, Brown, Hicks, & Howell, 1995), voice area (Schutte & Seidner, 1983), and Stimmfeld (Hacki, 1988).

The shape of a typical voice range profile obtained from a vocally healthy individual takes the form of an oblique oval (Pabon, 1991) (Figure 19-1). The lower curve of the profile, or the lower intensity contour, reflects the minimum phonational intensity levels across the individual's total phonational frequency

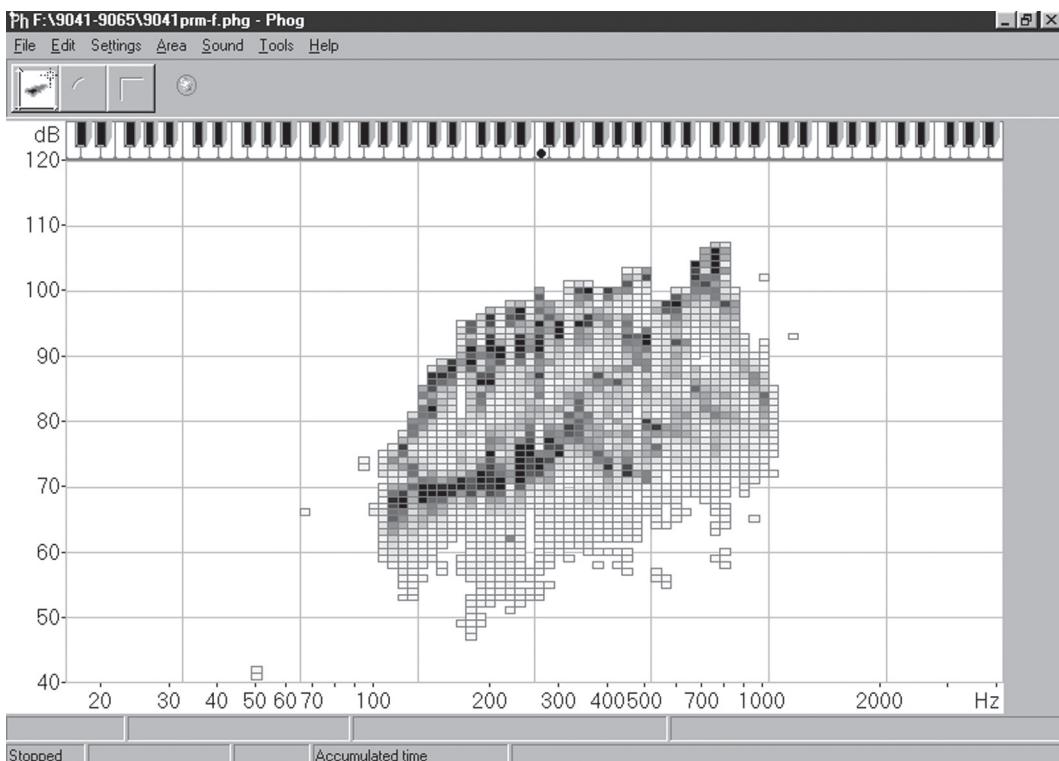


Figure 19–1. Sample voice range profile recorded from an individual with normal voice.

range. The upper curve of the profile, or the upper intensity contour, reflects the maximum phonational intensity levels across the individual's total phonational frequency range. The lower and the upper intensity contours join together at the minimum phonational frequency and the maximum phonational frequency values. Frequency measures (the maximum frequency, the minimum frequency, and frequency range) and intensity measures (the maximum intensity, the minimum intensity, and intensity range) can be analyzed from the voice range profile. The area of a voice range profile gives an indication of the individual's vocal capacity. Some authors (e.g., Heylen et al., 1998; Sulter, Schutte, & Miller, 1995) have also analyzed

the slope of the upper intensity contour and the slope of the lower intensity contour as indicators of vocal performance.

The voice range profile frequently has been used to differentiate dysphonia from healthy voices. In individuals with laryngeal pathologies, there may be:

- A reduction of maximum frequency range, with more prominent reduction in high frequencies. The presence of laryngeal pathologies increases the vocal fold mass per unit length, which limits vocal folds vibrating at high frequencies. Also, the increase in vocal fold tension associated with the laryngeal pathologies leads to an increase in vocal fold stiffness and this prevents stretching

- vocal folds to phonate at high frequencies (Colton et al., 2006). The highest possible phonational frequency level is therefore reduced (Heylen et al., 1998; Heylen, Wuyts, Mertens, De Bodt, & van de Heyning, 2002; McAllister, Sederholm, Sundberg, & Gramming, 1994).
- A reduction of maximum intensity range, with more prominent increase of minimum phonational intensities. The minimum intensity level reflects the phonatory threshold of an individual. When phonating with the minimal loudness level, the air-stream passing through the glottis would be very low. With the presence of laryngeal pathologies, the vocal fold mass per unit length increases and subsequently limits the flexibility of the vocal folds to set vocal folds into vibration at a very low air-stream (Gramming & Akerlund, 1988). It therefore is not uncommon for dysphonic individuals to find it difficult to phonate at very low intensity levels as in the vocally healthy individuals.
 - A reduction of voice range profile area due to the reduced maximum frequency and intensity ranges.

Some authors adopt the concept of voice range profile to assess and display connected speech production using a two-dimensional graphic plot (Emerich, Titze, Svec, Popolo, & Logan, 2005; Ma et al., 2007; Ternstrom, Andersson, & Bergman, 2000). Such a speech range profile provides a functional analysis of an individual's vocal performance as in daily conversations. Ma and her colleagues (2007) recently evaluated the use of speech range profile measures in classifying females with dysphonia and healthy voices. They found that the combined use of only two measures of speech range profile (speaking

frequency range and maximum speaking intensity level) could accurately classify 93.6% of the female individuals (117 out of 125 females).

DESCRIPTION

Several commercial systems are available for recording voice range profiles. These systems include the Swell's Phog from Hitech Development AB (<http://www.savenhitech.no/eng/>), Voice Profiler from Alphatron Medical Systems (<http://www.alphatronmedical.nl>), Voice Range Profile from KayPENTAX (<http://www.kaypentax.com>), and Phonetogram from Dr. Speech (<http://www.drspeech.com>). Among these systems, Phog and Voice Profiler claim to be sensitive to capturing connected speech range profiles.

This chapter uses the Phog system to illustrate how to assess voice range profile and speech range profile. Figure 19-2 shows the equipment setup of Swell's Phog and Figure 19-3 shows the main display screen of the Phog program.

EQUIPMENT AND MATERIALS

- Recording software: Swell's Phog from Hitech Development AB.
- Accessories for calibration: sound level meter, loudspeakers, ruler (for measuring mouth-to-microphone distance).
- Accessories for recording: Head-set microphone (AKG c420), standard passage such as North Wind and the Sun (International Phonetic Association, 1999) or The Rainbow Passage (Fairbanks, 1960).

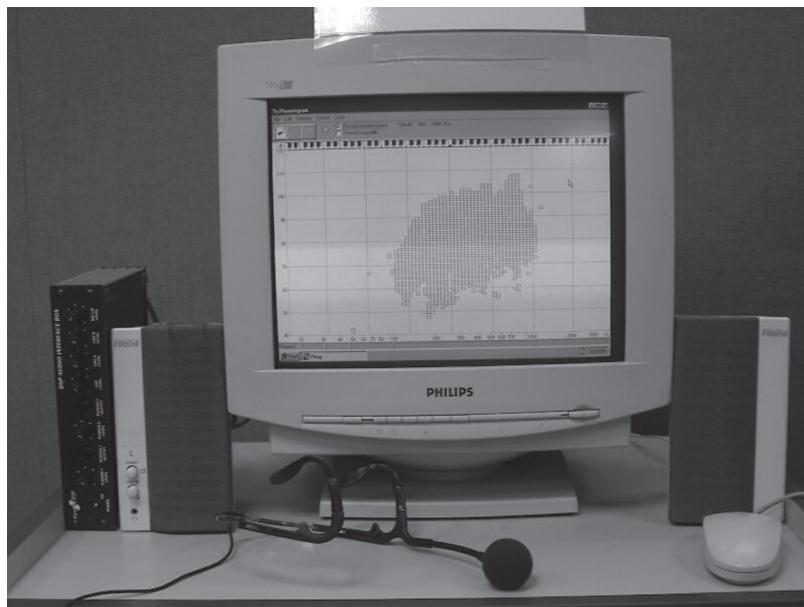


Figure 19–2. Equipment setup of the Swell's Phog.

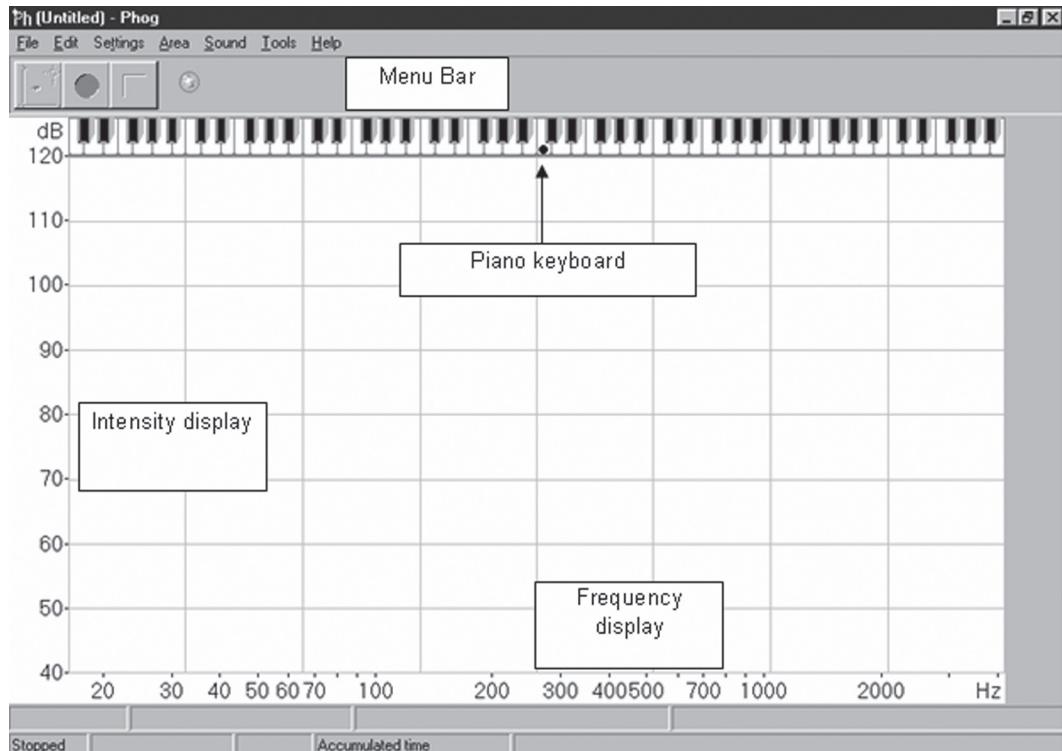


Figure 19–3. Main display screen of the Phog program.

TEST PROCEDURES

General Guidelines

- **Recording environment.** Poor acoustic conditions can affect the validity of phonational intensity levels measured. The recording should be carried out under a quiet environment with low ambient noise (less than 40 dB).
- **Recording time-of-day.** There is not enough evidence in the literature to suggest that different time-of-day has an effect on the recording of voice range profile (van Mersbergen, Verdolini, & Titze, 1999). However, when assessing voice range performance of the same individual across time, for example, before, during and after receiving voice treatment, it is recommended that all the recordings be carried out at the same time of day.
- **Mouth-to-microphone distance.** The literature has documented the use of different mouth-to-microphone distances for recording voice range profiles. The Union of European Phoniatricians (UEP) recommends the use of the 30-cm mouth-to-microphone distance for recording a voice range profile (Schutte & Seidner, 1983). Throughout the recording, a constant mouth-to-microphone distance should be maintained and the use of headset microphone is preferred.
- **Eliciting maximum phonational intensity range.** Throughout the recording, the clinician can provide the client with hand signals to encourage and prompt for the client's maximum intensity (Coleman, 1993). In addition, each testing tone should be repeated three times for more reliable recording of the softest and loudest phonations

of the speaker (Sihvo, Laippala, & Sala, 2000).

- **Eliciting maximum phonational frequency range.** The maximum and minimum phonational frequencies should be elicited by a discrete-step task in the direction of mid (habitual)-basal-to-ceiling (Zraick, Nelson, Montague, & Monoson, 2000).

Calibration

The Phog system detects the speaker's phonation through a microphone. The corresponding phonational intensity level is then displayed on the computer screen. As the intensity level of the sound signal shown by the program depends on the microphone gain and also the microphone distance from the client's mouth, the system needs to be calibrated before recording. The following calibration procedure ensures that the microphone signal is based on sound pressure level at 30 cm microphone distance (the UEP-recommended distance):

1. Start the calibration procedure by clicking on **Settings** from the menu bar and then select **Calibration**. A calibration wizard will then appear on the computer screen (Figure 19-4). Then select the calibration tone source and method. In the following steps, the calibration tone **1kHz sinusoid from phonograph** and calibration method **Ext. volume control** will be used for demonstration.
2. In the calibration wizard, input the distance that the microphone will be placed from the mouth during actual recording (the author recommends 5 cm) and type "30 cm" in the **... but pretend it is at** box.

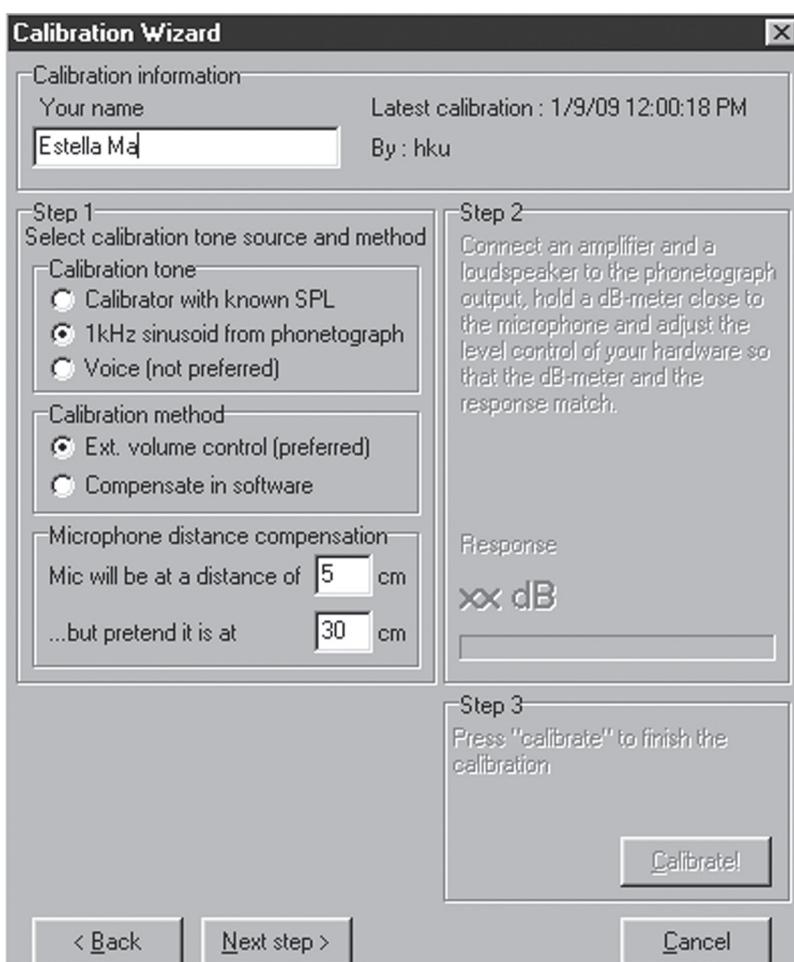


Figure 19–4. Calibration wizard.

3. When the button **Next step** is pressed, a high-frequency tone of 1 kHz will be generated by the Phog system and played through the loudspeaker. Hold the sound level meter and the microphone at the same distance away from the loudspeaker (the author recommends 30 cm which is the UEP-recommended distance for recording voice range profile; Figure 19–5). Measure the sound pressure level of the tone using the sound level meter.
4. Adjust the **MIC L/R LEVEL** knob of the DSP Mixer until the dB-level displayed on the computer screen matches that of the sound level meter within ± 0.5 dB. For example, the dB-level of the 1 kHz tone is 78.3 dB (see Figure 19–5), the dB-level shown by the Phog program on the computer screen should fall between 77.8 dB and 78.8 dB. Click on the button **Next step** once the two readings match and click on the button **Calibrate!** to complete the calibration process.