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Sound Generation at the Larynx: Characteristics of the Glottal Source

References

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Speakers differ in vocal-fold anatomy and in the way the glottis is adjusted to produce the quasiperiodic voicing source during vowels. These differences are reflected in the waveform of the airflow pulses through the glottis. The glottal adjustment may also influence the acoustic losses at the glottis and consequently may have an effect on the bandwidths of the formants. A partially open glottis can cause acoustic coupling between the vocal tract and the trachea, and, as a result, can introduce additional prominences in the spectrum due to subglottal resonances.

The nature of the glottal adjustment and the glottal waveform can be inferred from various measures on the spectra of vowels. Several of these measures are the following:

H1-H2: The difference between the amplitude H1 of the first harmonic and H2 of the second harmonic. This measure should be made on nonhigh vowels (i.e., vowels with a high F1) so that the F1 prominence does not influence significantly the amplitudes H1 and H2. The quantity H1-H2 is a measure of the open quotient, i.e., the percent of the cycle in which the glottis is open.

H1-A1: The difference between the amplitude H1 of the first harmonic and the amplitude A1 of the strongest harmonic in the first-formant range. This quantity is an approximate measure of the first-formant bandwidth. A larger value of the H1-A1 is indicative of a wider F1 bandwidth, and hence greater acoustic losses at the glottis. This measure should be made for a nonhigh vowel.

H1-A3: The difference between the amplitude H1 of the first harmonic and the amplitude A3 of the third formant prominence. This quantity is a measure of the spectral “tilt.” A larger spectral tilt usually means a glottal configuration with a glottal “chink” that never closes during a cycle of vibration.

A. Stored in the Unix computer (in `~labc/6.542/glottal/partA/`) are several utterances of “say bat again” and “say pat again” spoken by several speakers. The speakers are identified as AH, K, M, C, and H. Look at spectra sampled in the middle of the vowel /æ/ in **bat** and /æ/ in **pat**. Use a 40-ms window. Measure H1-H2, H1-A1, H1-A3, and F0 for each vowel. It is best to make 3-4 measures on each vowel, say at 20-ms intervals, and then obtain an average for each. Note that there should be no pre-emphasis for these measurements. (This is the default condition in xkl.) Make scatterplots of H1-H2 versus H1-A1, and H1-A3 versus H1-A1. Comment on the correlations between these measures. Which speakers are the most breathy and the least breathy? For the most breathy speaker (largest H1-A3), do you observe any other attributes of the spectra, such as high-frequency noise, and evidence of tracheal resonances? Note differences between the male and female speakers.

B. In `~labc/6.542/glottal/partB/` are recordings of the utterances “say pat again” and “say bad again” by two speakers (H and K). Pick one speaker, and measure H1-H2 and H1-A3 as a function of time through each of the two vowels /æ/. Note any changes in the parameters, and interpret the data in terms of the changing glottal configurations through the two vowels. Does the voicing, or lack of voicing, of the consonants have any effect?

C. In `~labc/6.542/glottal/partC/` are recordings of the utterance “say pad again” by two speakers (K and H) at three levels (soft, normal, loud). Pick one speaker, and measure the parameters H1-H2, H1-A1, and H1-A3 in the middle of each vowel /æ/. Comment on the differences in terms of the glottal waveform for the three conditions.