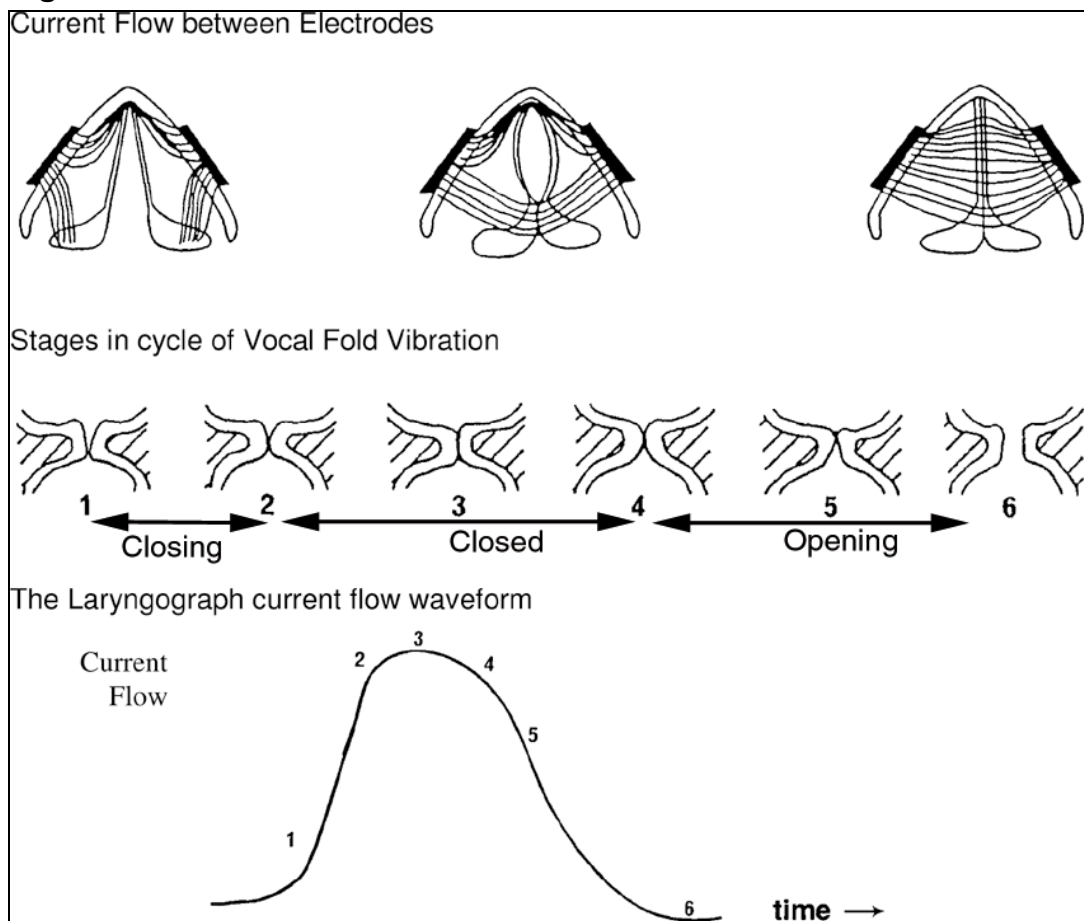


Introduction to Speech Science: Laboratory 2: Laryngographic analysis of voice

Direct observation of vocal fold vibration is difficult and intrusive. As an alternative, we use an electrical means to get information about vocal fold movement that be collected during normal speech. This uses a Laryngograph (sometimes called an Electroglottograph) to measure the changes in the vocal fold contact area through the voicing cycle. Two electrodes are placed on either side of the thyroid cartilage, and a small electrical current is passed from one electrode to the other. When the vocal folds are closed, the electrical current path through the neck becomes more conductive so that a higher current flows between the two electrodes, As the vocal folds open, and the contact area reduces, the conductivity falls and the current flow is reduced.

Figure 1



The Laryngograph produces a waveform known as Lx. This shows how the current flow (and hence the vocal fold contact area) changes with time. From the Lx waveform individual phonation cycles can be seen, and the individual phases (closing – closed – opening – open) of that cycle can be inferred, see figure 1.

In this lab you will use the Lx waveform to give information about voice fundamental frequency. Once an Lx waveform has been recorded, the software will analyse the waveform to locate each individual cycle of the Lx waveform and measure the period (the duration) of each cycle. This period is called Tx. Then, for each cycle, the repetition frequency of each cycle is calculated according to the following equation:

$$F_x (\text{Hz}) = 1/T_x (\text{s})$$

The repetition frequency is more commonly called the **fundamental frequency**. The software we are using labels fundamental frequency as F_x (elsewhere you will find fundamental frequency abbreviated as F_0).

We now have a sequence of measures of F_x . These can be plotted over time to give an F_x contour, showing the way that the voice changes in pitch over time. This is especially useful when we study intonation. We can also use this set of F_x values to characterise the pitch range of a talker. For this purpose, we look at the distribution of fundamental frequency in the form of a histogram. This distribution is called D_x for short. From D_x , we can take measurements of central tendency (median or mode). The analysis you will use calculates two distributions. One includes all the detected T_x periods. The measures that you will use are taken from a distribution that excludes periods that are very different to the immediately adjacent periods. This eliminates noise and some of the effects of irregular voice quality.

Object of this laboratory

- To collect laryngographic data illustrating the linguistic use of voice pitch variation
- To become familiar with the laryngograph and associated methods for the investigation of voice pitch range and intonational variation.

For each talker, you will record two samples of speech along with laryngograph waveforms. The first sample is a passage that is long enough to represent the typical range of speaking pitches used by the talker. The second sample is a short sentence, spoken with contrasting prosodic forms. From the second sample you will compare the pitches used for accented and unaccented syllables in the sentences. Because talkers vary widely in the range of pitches used in speaking, the exact pitch values used in the sentences need to be interpreted with respect to the talkers' pitch range as measured from the longer passage.

You will use the program SFS. This works similarly to WASP, but can record two signals at once, and can analyse the L_x waveform.

Step 1. Fit the electrodes to the talker.

The electrodes should be placed either side of the thyroid cartilage. You can often locate the ideal placement by touch – find the spots at which larynx vibration can be felt with the fingers while the talker makes a low pitched sound. The electrodes need to be held tightly enough that they do not move around during neck movements; secure firmly with the Velcro band.

Step 2. Make a test recording to verify placement of electrodes

Record - Select Speech& L_x - Press "Test levels" and say a few words

Make sure that there is a deflection of both level indicators, and that neither bar is going all the way across the scale. If all is OK, click "stop". Then click "record", produce a sequence of three isolated vowels, click "stop" and finally click "done".

You will see a new window listing a speech and an L_x item. Take a look at the display to check that you have a good L_x waveform. To do this, click on the button with two blue lines. The top pane shows the speech waveform and the lower one shows L_x . There should be a clear L_x signal throughout each vowel. Select and zoom into one of the vowels to check the shape of the L_x waveform. It should look similar to the one in the figure above. If so, proceed to the next step. If not, ask for help.

Step 3. Record the passage

At the main SFS menu, select File and New.

Then click the record button and record the whole of the passage. Click "stop" and then "done". You need to save this recording away for later. Do this with File and Save As – give the file a name that will be unique, including your name and ending with P.sfs

Step 4. Record the sentences

You will say the sentence “They saw twenty snowmen” once as a statement in which you stress the word “twenty”, and once as a question. Select File ----New, and record as before. Save this file too, ending the file name with S.sfs.

Step 5. Analyse the recordings.

You have saved your files on the computer network and can open them on any of the PCs, including the ones without the Laryngograph setup.

Start with the passage. In SFS, use the File – Open command – find your passage file and open it.

The analysis requires several commands.

1/ To have SFS measure the Tx periods from the Lx waveform:

Tools – Lx – Pitch period (Tx) estimation. This produces a new Tx item.

2/ For the passage, you need to make an analysis that gives the distribution of pitches -

Tools – Tx – Display Tx analysis (to see this on the screen)

AND also do

Tools – Tx – Print Tx analysis - for a printed record: enter a title to identify your printout.

For the sentences, open the appropriate file, and

1/ measure Tx from Lx as above

2/ Calculate Fx from Tx using

Tools – Tx – Fundamental frequency conversion.

Step 6. Examine the data

Now you can study the Fx contour for the sentences with the command -

Tools – Speech – Display – Wide spectrogram

The resulting display shows the speech waveform, a spectrogram, the Lx waveform, the Tx markers for each period of Lx, and the Fx contour.

Zoom into each individual sentence and print this display.

Annotate the printout with the words in the sentences, aligning these to the contour. Listen to the recording to check your alignment.

Observations

A/ What are the major changes in contour between the two versions? What differences do you observe between accented and unaccented syllables?

B/ Compare the fundamental frequencies used in the sentences with the distribution of fundamental frequency plotted for your reading of the passage (you can also use the percentile measures and the median). Why might it be more useful to consider the Fx values in relation to the distribution rather than as absolute frequencies?

If you have time:

C/ A recording of a pathological speaker has been stored on the computer in the file POLYPS; display this file, listen to the recording and look at the speech and Lx waveforms and the spectrogram.

Click the “display all” icon to see these displayed (the button with two blue wavy lines)

How would you describe the voice quality? What parameters of the laryngograph waveform appear normal? Which appear abnormal?

Abbreviations

Lx: Larynx excitation

Tx: Period of Larynx cycle

Fx: Fundamental frequency of Laryngeal excitation

Dx: Distribution of fundamental frequency of excitation

Cx: Scatter (Cross) plot of fundamental frequency of excitation Lx

Readings on the laryngograph:

Baken, Clinical Measurement of Speech and Voice (1st edition), Chapter 6: Laryngeal function. Also covers other measurement techniques.

Abberton & Fourcin (1997) Electrolaryngography. In Ball & Code, Instrumental Clinical Phonetics. Describes use of laryngograph, available from listening centre.