

Lab: Measuring Vowel Formants

When phoneticians (and other linguists) study a language or dialect, they often begin by describing its sounds. One step in illustrating a sound system is to measure and place its vowels on an F1-by-F2 (F1xF2) plot. Vowel plots can then be compared between speakers or groups. Vowels may be in different locations between dialects or other speech groups (e.g., American vs. British English), some vowels may be monophthongs for one group but diphthongs for another (e.g., [æ] vs. [iə]), or one system may have one phoneme where another has two (e.g., the Low Back Vowel Merger).

In this lab, you will use Praat to measure vowel duration and formants, then plot your formant measures to map the vowel space for a speaker of Hoosier English, a dialect of American English centered around Southern Indiana. You will then examine the plot and compare its vowel configuration to that of the Standard American English plot in your text book (ch. 4, Fig. 4.2, p. 90). All questions will be answered on Moodle.

Materials

The sound files for this lab are ten monosyllabic English words spoken by an American from Southern Indiana. Each word begins with /h/ or /ʔ/ and ends with /d/ or /t/. The files are numbered, so you won't know from the filenames what the words are.

You will need Praat and the Charis SIL font installed on your computer, as well as internet access to Moodle. If you wish, you may use the Excel spreadsheet provided on the class webpage to enter your measurements and create your plot automatically. Or, if you prefer to do your calculations and plotting by hand, print the Self-Calculations Table and the Blank Vowel Plot from the class webpage.

Tasks (13 steps)

1. **Set up.** Open your sound files in Praat. Open the Excel data table, or have your paper copy handy.
2. **Praat settings.** Click "Edit" (or "View & Edit") for the first sound file. Before you get started, make sure that "Spectrum > Show Spectrogram" and "Formant > Show Formants" are checked. Go to "Spectrum > Spectrogram Settings" and click "Standards." Go to "Formant > Formant Settings" and click "Standards." If the "Maximum Formant" is set to 5500 Hz, change it to 5000 Hz before clicking "OK." These settings will remain for all subsequent sound files (or until you change them).

- 3. Transcriptions.** Listen to the word and enter a broad transcription in your data table (either the whole word or just the vowel). To enter IPA symbols in Excel, use an IPA keyboard layout (see links on Catalyst), an online character picker (links on Catalyst), or within Excel, “Insert > Symbol.” In the first set of questions on Moodle, select the vowel transcription for each sound file. (You may answer the questions later, but doing so now may help you decide which IPA symbols to use.)

Measurements – All Vowels at Midpoint. For each sound file (repeat for all sound files):

4. Look at the waveform and spectrogram in Praat, and identify the vowel onset and offset. For this lab, accuracy within 5 milliseconds (0.005 s) is reasonable. In your Vowel Midpoints data table, enter the timestamps for the onset and offset (shown in red above the waveform). The Excel sheet will calculate the vowel duration and the timestamp for its midpoint. (Or, follow the instructions with the PDF data table to calculate these yourself.)
5. In Praat, place your cursor the midpoint. Go to “Select > Move cursor to...” and enter the time stamp from your data table.
6. Check that the formant tracker is lined up well. Are the lowest two red dots nearest your cursor located in the middle of the lowest two dark formant bands? If not, check your formant settings: “Formant > Formant settings...” (see #2 above). You can also try changing the number of formants by one or two (up or down).
7. Get the measurements for the first two formants. Go to “Formant > Get first formant” or hit F1 on your keyboard. Enter the output in your data table. You can type manually or copy and paste into the Excel sheet (it should round to the nearest Hz). Do the same for F2: “Formant > Get second formant” or hit F2.
8. The vowel plot in the Excel sheet will fill in automatically to match the data you enter. Examine the chart and see if the location of each vowel seems plausible. Go back and listen to each vowel while looking at the chart to see if its location and label make sense. If something seems off, double-check your measurements. (If you are plotting by hand, also double-check your duration and midpoint calculations and that you have plotted F1 vertically and F2 horizontally.)
9. The second set of questions on Moodle has a vowel plot with numbered dots representing possible vowel locations. For each sound file, find the dot that corresponds to that vowel on your plot. If a vowel doesn’t line up clearly with just one dot, double-check your measurements. You may wish to keep track of your answers by entering each dot number in your data table.

Note: Monophthongs vs. Diphthongs

On a spectrogram, monophthongs generally have little change in F1 and F2 over their durations, except for transitions into or out of a consonant at the very edges of the vowel. In contrast, diphthongs show more change in F1, F2, or both. For example, in the diphthong [ai], the quality begins at [a], with a high F1 and a medium F2, but it ends near [i], with a low F1 and high F2. However, other diphthongs do not move as far across the vowel space, and some change more in one direction than another (F1 vs. F2). When comparing only monophthongs, it may be sufficient to take only one measurement at the vowel midpoints. However, when measuring or plotting diphthongs, at least two measurements are needed to show how the vowels change over their durations. These are usually taken at designated points between 20% and 33% from the beginning and end of each vowel duration. For this lab, you will take measurements at 1/3 and 2/3 of the vowel durations (33% and 67%). Several of the vowels in this data set change over their durations, but we will examine only the two that we expect to be diphthongs, [eɪ] and [oʊ].

Measurements - Diphthongs.

10. For the Diphthongs data table, find the rows in your Vowel Midpoints table for the indicated diphthongs. Copy their file numbers, onsets and offsets (and duration if you're calculating by hand) into your Diphthongs table. The Excel sheet will calculate the time stamps for 1/3 and 2/3 of the vowel durations. (Or, follow the instructions with the PDF data table to calculate these yourself.)
11. Repeat steps 5-7 for the 1/3 and 2/3 time points of these diphthongs. Enter your measurements in the third set of questions on Moodle.
12. The vowel plot in the Excel sheet will automatically add each diphthong for you. It will place a dot at the 1/3 point with an arrow pointing to the 2/3 point. (Do this yourself if plotting by hand.) Examine the diphthong locations and the directions of their arrows. Listen to the diphthongs again while looking at the chart to see if their locations and trajectories make sense. If something seems off, double-check your measurements. (If plotting by hand, also double-check your time point calculations and that your arrows flow from your 1/3 to 2/3 measures, with F1 on the vertical axis and F2 on the horizontal.)
13. To answer the last set of questions on Moodle, you will compare the configurations of the vowels in your Hoosier plot to those in the Standard American plot in the Ladefoged & Johnson text book (chapter 4, Figure 4.2, p. 90).

When you're finished with all the questions on Moodle, submit your answers. Do not turn in your data table or plot.