Lab Assignment #05 Vowel formants and wide-band spectrograms

Due M Sept 19 at 11:15am on Sakai
25 points total

Purpose

This assignment provides an opportunity to:

- Create a TextGrid in Praat and use it to label intervals on a sound file
- View vowel characteristics on a narrow-band spectrum and a wide-band spectrogram
- Use the Praat formant tracker
- Plot vowels in a F1 × F2 formant chart
- Relate vowel articulations to formant frequencies (in a 5-vowel system)

Task

A. Prepare to complete the lab assignment

- **Download** the following file from the "Lab assignments" page and save it on your computer, and then open it with Praat: `[lab05_swahili.wav]` (from the *V&C* web site; see here or Table 3.1 in *V&C* for information about the Swahili words in the recording)

B. Answer questions (1)–(8) directly in Sakai

- Go to Tests & Quizzes, "Lab 05 | Vowel formants and wideband spectrograms" (work in progress may be saved; no time limit)

1. Creating a TextGrid and labeling intervals in a sound file

In the Praat Objects window, highlight the Sound object `lab05_swahili` and click `Annotate > To TextGrid`. This opens a dialogue box for creating a TextGrid object. Refer to Praat handout #4, "TextGrids", for instructions that will tell you how to do the following:

- Use the dialogue box to create a TextGrid with one interval tier whose tier name is "word". (No point tiers.)
- Open the Sound `lab05_swahili` and your new TextGrid `lab05_swahili` together in a TextGrid window.

This sound file contains five words of Swahili, one demonstrating each of the five vowels in the language in the frame [p__ta].

- Create an interval on the "word" text tier for each of the five Swahili words in the recording.
- Listen to the sound file and identify the vowels. On the text tier, label the interval for each word with the IPA symbol for the vowel that you hear in the first syllable of that word, choosing from these IPA symbols: [i e a o u].

- If the box of IPA symbols is showing on the right side of the TextGrid window, use the "X" button to **hide** it. If the trackers for pitch (light blue), pulses (gray), formants (red), or intensity (yellow) are turned on, use the menus at the top of the TextGrid window to turn them **off**.

(1) Click the `all` button at the bottom of the TextGrid window to make sure all five Swahili words, and their vowel labels on the TextGrid, are showing. Then take a **screenshot** of this TextGrid window and **upload it** to the Lab #05 T&Q on Sakai. (Please remember to include your name in the filename of the screenshot.) *PDF files as well as image files in .jpg, .png, or .gif formats are **all** acceptable.* [5 points total; 3 points for creating TextGrid as specified and uploading screenshot, and 2 points for labeling vowels accurately]

2. The narrow-band spectrum of [i]

- Use `Spectrogram > Spectrogram settings` at the top of the TextGrid window to set the value for `Window length` at **0.05** s, for a narrow-band spectrum.
- Place the cursor approximately at the midpoint of the [i] vowel in the word [pita] and create a spectral slice. View the spectral slice. (Select and zoom in on the frequency scale for better resolution as needed.)

(2) Give the **frequencies** of:

(a) The **lowest-frequency component** of this [i] (Note: Not everything you can see at the low end of the frequency range is a component, but you should be able to figure out what is relevant based on what you know about vowel spectra.)

(b) The **highest-amplitude component** of this [i]

(3) The spectrum of the **glottal-source wave** typically has components with amplitudes that decrease as the frequency increases. Given that context, briefly **explain why** the highest-amplitude component in this [i] spectrum is **not** the first (lowest-frequency) component.

3. Wide-band spectra/spectrograms and the Praat formant tracker

- Go back to the TextGrid window with the Swahili words. Click `Spectrogram > Spectrogram settings` at the top of the TextGrid window and reset your spectrogram settings by clicking the button labeled `Standards`. This should return the value for `Window length` to **0.005** s (for a wide-band spectrogram) and set the top end of the view range at 5000 Hz. After you click `OK`, the spectrogram in your Sound window should look very different.

Once again, place the cursor at about the midpoint of the [i] vowel and create a spectral slice. This should look very different from the spectral slice you created from this [i] for question (2)!

(4) As we discussed in class, the amplitude peaks that are visible in a wide-band spectrum taken from a vowel are the **formants** of the vowel. What **frequencies** for **F1** and **F2** can you measure for this [i], using your wide-band spectrum?

(5) Compare the formant values you have just measured for Swahili [i] with the [i] formant values we calculated or estimated in class using either the multiple-tube model or pertubation theory (you may choose which model to discuss). Are the measured Swahili values similar to the predicted values? Why do you think that {is/is not} the case?

Wide-band spectrograms, and the corresponding spectral slices, are useful for viewing and analyzing formants. We can now use the wideband spectrogram in the TextGrid window to compare the first two formants of the vowels [i e a o u] in Swahili.

Go back to the TextGrid window with the Swahili words. In each word, where the vowels are, you should be able to see the vowel's formants as thick dark horizontal bars.

- Turn on the formant tracker: in the top menu in the TextGrid window, click on `Formants` and select `Show formants`. Red dots should appear in the spectrogram, and they should (mostly) line up with the formants you can see. (The formant tracker uses a different mathematical computation than is used in the spectrogram, and they don't always match perfectly.)

Look more closely at each of the five Swahili words in this sound file by doing the following:

- Click the `all` button so that the whole sound file is showing in the TextGrid window. Then click on the vowel label you made for each word (in the text tier), one at a time, to select the whole word. After selecting a word, click the `sel` button so that the selected word fills the whole TextGrid window.
- Each time you select and zoom in to view a word, click on the spectrogram at approximately the midpoint of the vowel in the first syllable (one of [i e a o u], not including the [a] vowels at the ends of all the words). If the formant tracker is doing something funny in one spot (compared to the visible formants in the spectrogram), try clicking in another spot.
- In the top menu bar of the TextGrid window, click on `Formants > Get first formant` and `Get second formant` in order to find the first and second formant frequencies (F1 and F2).

(6) List the frequencies of F1 and F2 for all five of the Swahili vowels (using the first syllable of each word). [5 points]

4. Plotting vowel formants

Make a **vowel plot (F1 × F2) graphic** like those you have seen in the reading. You may do this with software (such as Excel), or you may do it by hand and scan your paper, or you may modify the formant chart PDF (see below) with graphics software and submit that.

- You may use the **blank formant chart** provided with the Lab #5 materials on the course web site, but this is not required.
- Remember to plot **F1** on the **vertical** axis and **F2** on the **horizontal** axis. If you are using the blank formant chart provided with the lab, note that the (0,0) point is in the *upper right* corner of the graph and both axes are "reversed" as compared to a typical graph. If you are plotting with software and your software permits, it would be nice if you could put the (0, 0) point in the upper right in this way, but don't worry if you can't make it do that.

(7) Upload your vowel plot to Sakai. *PDF files as well as image files in .jpg, .png, or .gif formats are **all** acceptable.* [5 points]

(8) Analyze your results: What traditional **property** of vowels does **F1** correlate with? (That is, what class of vowels has high F1, and what class has low F1?) Likewise, what does **F2** correlate with? You may wish to compare your results with course readings and slides.

Criteria for success

This lab assignment is worth a total of 25 points, with each question worth 2 points except where noted above. Points will be awarded for accuracy, and partial credit will be given where appropriate. Some of the parts may be automatically graded on Sakai, but I will double-check by hand in case of Sakai errors.