Lab Assignment #04 The source-filter model and schwa

Due **W Sept 17** at 2:30pm on Canvas (Assignments) 20 points total

Lab session: Part of class on **F Sept 12** is a lab session for this assignment. You will have an opportunity to collaborate with classmates, get help with Praat, and ask questions.

Purpose

The way that the vocal tract produces sounds can be understood in terms of the **source-filter model of speech acoustics**, a model that depends heavily on the concepts of **resonance frequencies** in node/node and node/antinode systems.

This assignment provides an opportunity to:

- Review how to interpret and analyze the **spectrum** of a complex wave
- Review how to calculate **tube length**, given **resonance frequencies**
- Practice working with the key concepts behind the **source-filter model**
- Apply the source-filter model to a **uniform-vocal-tract vowel**, [ə] (schwa)
- Compare the applications of **narrow-band and wide-band spectra**

Task

A. Prepare to complete the lab assignment

- **Download** the following files from the "Lab assignments" page and save them on your computer, and then open them with Praat. You will probably need to right-click on the link and choose "Download as...", "Save as...", "Save link as...", or a similar-sounding command.

  `[lab04_schwa01.wav]`
  `[lab04_schwa02.wav]`
  `[lab04_vs-x.wav]`

B. Answer questions (1)–(10) directly in Canvas

- Go to Assignments, "Lab 04 | The source-filter model and schwa"

1. The spectrum of a uniform-tube [ə]

- Open the sound file `[lab04_schwa01.wav]` in a Sound window (`View & Edit`). This is a synthesized [ə] vowel, produced with the characteristics of a uniform-tube vocal tract. Use the `Spectrogram > Spectrogram settings` menu to change the "window length" to 0.05 sec (not 0.5 sec as in Lab #03). Click once near the (time) midpoint and view the spectrum (spectral slice). Then answer the following questions.

(1) What is the **frequency** of the **first** (lowest-frequency) **component** of this [ə]?

(2) What are the **frequencies** of the **next four components** of this [ə]?

(3) What is the **frequency** of the **first** (lowest-frequency) **formant** of this [ə]?

(4) What is the **frequency** of the **second formant** of this [ə]?

(5) Assuming that the speed of sound in air is 350 m/s, what is the **length of the vocal tract** of a speaker who could produce this [ə]?

- Now open the sound file `[lab04_schwa02.wav]` in a Sound window. This is another synthesized [ə] vowel, likewise produced with the characteristics of a uniform-tube vocal tract.

(6) This [ə] has either the same **source**, or the same **filter**, as the first [ə] you viewed. Which is it? Explain how we can tell which it is.

2. Narrow-band and wide-band spectra

- Open the file `[lab04_vs_x.wav]` in a Sound window. This is the synthesized [ə] vowel we heard and analyzed in class on Wednesday; see the class outline slides for details.

(7) Click near the (time) midpoint of the sound and view a spectrum (spectral slice). Make sure the `Window length` setting in `Spectrogram > Spectrogram settings` is still at 0.05 sec; a spectrum with a long time window like this is called a **narrow-band spectrum**. Take a **screenshot** of this **Spectrum window** and upload it on Canvas as a **PDF or doc/docx** file. (Please remember to include your **name** in the filename or in the document.)

(8) Go back to the Sound window showing `[lab04_vs_x.wav]` and use the `Spectrogram > Spectrogram settings` menu to change the `Window length` setting to 0.005 sec. Click near the (time) midpoint of the sound and view a spectrum (spectral slice). A spectrum with a short time window like this is called a **wide-band spectrum**. Take a **screenshot** of this **Spectrum window** and upload it on Canvas as a **PDF or doc/docx** file. (Please remember to include your **name** in the filename or in the document.)

(9) Which of the two spectra, the **narrow-band spectrum** from question (7) or the **wide-band spectrum** from question (8), makes it easier to see the **individual components** of the **glottal source wave**? If you like, you may expand on or explain your answer (optional but might help with partial credit).

(10) Now consider the spectrum that you did *not* choose for question (9). Is there anything about the acoustic properties of the [ə] vowel that is **easier to see** on this spectrum than on the one you chose for question (9)?

Criteria for success

This lab assignment is worth a total of 20 points, with each question worth 2 points. Points will be awarded for accuracy, and partial credit will be given where appropriate.