Lab Assignment #03 — Tube resonances

Due **M Sept 8** at 2:30pm on Canvas (Assignments)
20 points total

Lab session: Part of class on **F Sept 5** is a lab session for this assignment. You will have an opportunity to collaborate with classmates, get help with Praat, and ask questions.

Purpose

This assignment provides an opportunity to:

- Review **period** and $\boldsymbol{f_0}$ and how to determine them using the **waveform** of a sound file in Praat
- Use the Praat **spectral slice** (=**power spectrum** in *AAP*) function to find the **components** of a complex wave and **determine resonance frequencies**
- Relate the **resonance frequencies** of a tube to the **boundary conditions** and **length** of the tube

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 something similar.

  `[lab03_tube01.wav]` `[lab03_tube03.wav]`
  `[lab03_tube02.wav]`

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

- Go to Assignments, "Lab 03 | Resonance frequencies"
- Reminders: Use Praat handouts #2–4 to help you navigate in Praat, open sound files, and play sounds. Use my feedback on your previous labs to check your understanding of concepts from earlier in the course.

Part 1: Review—Calculating f_0 from a waveform

Open each of the three sound files `[lab03_tube01.wav]`, `[lab03_tube02.wav]`, and `[lab03_tube03.wav]` in its own Sound window in Praat. (Refer to the Praat handouts and previous lab assignments if you need reminders for how to do this.)

(1) For the sound file **Tube01**, use the Praat waveform display to measure the **period** of the wave near the midpoint of the sound. Then use your measurement to calculate $\boldsymbol{f_0}$. Show your work. Do the same for **Tube02** and for **Tube03**.

Warning: Even simple sounds like these sometimes fool a pitch tracker, depending on your settings! Trust your measurements, and use your ears to compare the three sounds. You can even use information coming from other questions in this lab to cross-check your answers.

Part II: Resonance frequencies

In class, we have discussed how the length of a tube and its boundary conditions determine its resonance frequencies. In this lab, we will **examine the sound waves** produced by a column of air vibrating in three different tubes, using information about the **component frequencies** to determine the **boundary conditions** and calculate the **length** of each of the tubes.

Before we being looking at spectra to find components of the sound waves, we will need to fine-tune the spectrogram/spectrum settings.

- Close all your Sound windows in Praat except for the one for Tube01.
- In the top menu of the `Sound lab03_tube01` window, click on `Spectrogram > Spectrogram settings`. A box with various values should appear. In the field labeled `Window length (s)`, set the value to **0.5** and click `OK`. (Note: not 0.05 as for Lab #02!)

(2) In the `Sound lab03_tube01` window, click approximately at the (time) midpoint of the Tube01 sound wave. Use `Spectrogram > View spectral slice` to see a **spectrum** of this wave. Find the frequencies of the **first three resonances** of the tube—that is, the resonances with the *three lowest frequencies* (which is the low end of the frequency axis?). State the **frequencies** of these three resonances, from lowest to highest. (Remember units of measurement.)

Warning: We need to distinguish the components visible on the spectrum that are actually resonances of the vibrating tube from other components that happen to appear in the recorded sound (caused by things like the turbulence of my breath blowing into the tube). So **look for** the regular pattern of relatively high-amplitude resonances, and ignore the messier lower-amplitude components. For Tube 01, disregard anything lower than 200 Hz.

(3) Determine the **boundary conditions** for Tube01. Is this tube open at both ends, or open at one end and closed at the other? **Explain** how you determined this.

(4) How **long** is Tube01? Show your work.

(5) Now do the same for Tube02. Open this sound file in a Sound window, click at the (time) midpoint of the sound wave, view a spectrum (spectral slice), and **give the frequencies of the first three resonances** (again, this will be three relatively high-amplitude components at the low end of the frequency axis.)

(6) Determine the **boundary conditions** for Tube02 and **explain** how you determined this.

(7) How **long** is Tube 02? Show your work.

(8) Finally, do the same for Tube03. Open the sound, view a spectrum, and **give the frequencies of the first three resonances**.

(9) Determine the **boundary conditions** for Tube03 and **explain** how you determined this.

(10) How **long** is Tube 03? Show your work.

Criteria for success

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