Acoustics Assignment 2: Due 10/15

The goal of this assignment is to investigate alternative models of the acoustic effects of lip rounding by trying to account for the observed formant frequencies of rounded and unrounded vowels.

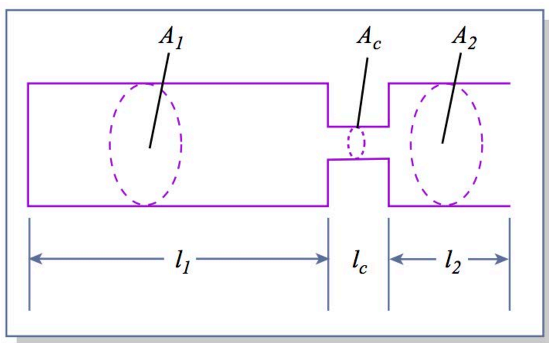
A. Generating the data:
Try the following:

1. Produce an [i] vowel, then round the lips while keeping the position of your tongue unchanged, producing [y], then unround the lips again (hopefully returning to the original [i] quality).
2. Produce an [u] vowel, then unround the lips while keeping the position of your tongue unchanged, producing [ɯ], then round the lips again.

I recorded myself following these directions – the sound file is in the Assignment section for this course.
Measure F1, F2 and F3 during [i], [y], [u] and [ɯ].

B. Model the formant data.

Model F2 and F3 of the unrounded vowels using the two-tube model for non-low vowels:



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- F2 and F3 should the be the first resonances of the front and back cavities (F1 should be the helmholtz resonance of the back cavity plus constriction – you don't need to model that).
- Estimate the lengths of the front and back cavities on this basis. For [i], F3 is supposed to be a front cavity resonance, but you should check. For back unrounded [ɯ], F2 is a front cavity resonance.
- Try to derive the effects of lip-rounding on F2 and F3. I.e. try to derive the measured F2 and F3 values of [y] and [u] by modifying the vocal tract models you estimated for their unrounded counterparts [i] and [ɯ]. Try two modelling strategies:
    - Increasing the effective length of the front cavity – models the effects of a modest lip constriction and/or lip protrusion.
    - Adding a narrow constriction to the front cavity. Treat the front cavity as a tube closed at both ends, and the front cavity plus lip constriction as a

Helmholtz resonator. In calculating the helmholtz resonance of the front cavity you have quite a few variables to play with. Reasonable values: length of the lip constriction: about 1cm, area of the lip constriction are around 0.3 - 0.6 cm^2, cross-sectional area of the front cavity about 2-3 cm^2.

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- Both models predict that back cavity resonances should be unaffected by lip-rounding, except via acoustic coupling. I.e. if a front cavity resonance gets close to the frequency of a back cavity resonance, they will be pushed apart.
- Report the results of both modeling strategies, and discuss how well they account for the observed formant frequencies. Which model provides the best account?
- NOTE: lip-rounding may change the cavity affiliation of F2 and F3 – whichever resonance is lower is F2. For example, if, in an unrounded vowel, the first resonance of the front cavity is higher than first (non-Helmholtz) resonance of the back cavity, then the front cavity resonance is F3. If lip-rounding lowers the first resonance of the front cavity below the first resonance of the back cavity, then the front cavity resonance becomes F2.