Lab 3: Vowel Space

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Introduction

In this lab, we will investigate a person's acoustic vowel space. We try to find answers for the following questions:

How is the speaker's vowel space similar to the traditional IPA vowel quadrilateral? How are they different?

(No Hypothesis)

Can we see evidence for Canadian Raising in the speaker's speech?

Hypothesis: No. Since the speaker is not a native speaker of Canadian English, there isn't likely to be evidence for Canadian Raising.

Can we find evidence for two distinct vowel phonemes [ɑ, ɔ] in the speaker's speech?

Hypothesis: No. Because the speaker does not quite distinguish the vowels [ɑ, ɔ], so it is expected that they will have very similar distribution patterns in speech.

Is /u/ always pronounced as a high back vowel? If not, what is the different realization and when do you use it?

Hypothesis: No. /u/ can sometimes be realized as more front, and it is used when it does not precede a syllable final /l/. Because in the syllable final position, /l/ becomes /ɬ/, which raises the back of the tongue and its position is more /u/-like. Therefore with the influence of velarized /ɬ/, /u/ is more back than those without the influence of /ɬ/.

Method

Speaker Information

Age	Sex	From	Native Language	Age Started Learning English
19	M	Nanchang, China	Mandarin	9

Data Information

The data is a sound file of the speaker pronouncing 96 English words. It was recorded using a built-in microphone on a laptop. The words contain vowels before and after consonants in various place of articulations. They are analyzed using Praat.

Results

The shape of the vowel space is a bit squished due to the F1, F2 axis range generated by Praat script provided in the assignment. Were the axis range to be smaller, the shape would be identical to a quadrilateral. However, the region of the low-back vowel is rather blank. The distributions overall match the IPA chart very well, despite a few outliers. In the articulatory perspective, the data in the vowel plot correctly correspond to the fact that F1 is correlated to vowel height and F2 is correlated to vowel roundness.

How is the speaker's vowel space similar to the traditional IPA vowel quadrilateral? How are they different?

The vowels' positions in the vowel chart relatively match the positions in the IPA chart, except for /ʌ/ which shows presence at different places in the vowel space.

Can we see evidence for Canadian Raising in the speaker's speech?

Our hypothesis is that there is no evidence for Canadian Raising in the speaker's speech. Since the speaker is not a native speaker of Canadian English, there isn't likely to be evidence for Canadian Raising. Evidence for Canadian raising did not show in the speaker's audio data.

Can we find evidence for two distinct vowel phonemes [ɑ, ɔ] in the speech?

Our hypothesis is no evidence for two distinct vowel phonemes [ɑ, ɔ]. Because the speaker does not quite distinguish the vowels [ɑ, ɔ], so it is expected that they will have very similar distribution patterns in speech. According to the vowel plot generated, the area distributions of [ɑ] and [ɔ] are greatly overlapped. It indicates that the speaker merged these two vowels.

Is /u/ always pronounced as a high back vowel? If not, what is the different realization and when do you use it?

No. /u/ can sometimes be realized as more front, and it is used when it does not precede a syllable final /l/. The vowel plot illustrates this point, as it shows that for all the words with /u/ vowel, those who end with a syllable final /l/ ("tool", "school", "pool") are distributed farther back than those who don't ("shoot", "cooped", "renewed").

Discussion

How is the speaker's vowel space similar to the traditional IPA vowel quadrilateral? How are they different?

The distributions of vowels in speaker's vowel space is mainly similar to the traditional IPA vowel quadrilateral, despite a few outliers. For example, the close-front vowel /i/ appears at the F1 200 ~ 300Hz and F2 2100 ~ 2500 Hz, which is the upper-left corner of the vowel plot. This matches the IPA quadrilateral perfectly. We notice the low-back region of the vowel plot is rather blank. The reason may be that the IPA is only an ideal alignment of vowels. In a real vowel space, the vowels don't exactly align nicely on the grid. One strange finding is the vowel /ʌ/, which was supposed to be at lower-back space according to the IPA vowel quadrilateral, instead has a very sparse distribution of F1 400 ~ 700 Hz and F2 1200 ~ 2400Hz. We think the reason is also due to the speaker being a non-native English speaker, maybe pronouncing some of the words with an accent. That is, when the speaker pronounces some words with the vowel /ʌ/, he was actually pronouncing another vowel rather than /ʌ/.

Can we see evidence for Canadian Raising in the speaker's speech?

We hypothesized that there is no Canadian Raising in the speaker's speech. As shown in the words plot, /a/ in words is not shifted to /ʌ/ or /ə/. For example, in words such as "wife" and "sight", the data we obtained does not demonstrate the shift from /aɪ/ to /ʌɪ/, and the reason behind this that the speaker is not a native speaker of American or Canadian English. Thus, we can conclude that we didn't find evidence for Canadian Raising in the speaker's speech. The hypothesis is correct.

Can we find evidence for two distinct vowel phonemes [ɑ, ɔ] in the speaker's speech?

We hypothesized that there are no two distinct vowel phonemes [ɑ, ɔ] in the speaker's speech. We did not find evidence for two distinct vowel phonemes [ɑ, ɔ] in the vowel plot(e.g: hogs and hot). The reason is these two vowels were merged by the speaker since the speaker's mother tongue (Mandarin) does not distinguish these two vowel phonemes. Our hypothesis is correct.

Is /u/ always pronounced as a high back vowel? If not, what is the different realization and when do you use it?

We hypothesized that /u/ is not always pronounced as a high back vowel. In the Acoustic space plot, while the F1 of /u/ stays steadily at 300Hz, the F2 of /u/ ranges from 800Hz to 1600 Hz. Sometimes /u/ is pronounced as a high central vowel and sometimes /u/ could be a high near-back vowel. According to the plot, the word 'renewed' has a high central /u/ (F1:300 Hz F2:1800Hz) instead of high back /u/ and the word "pool" was found at a near-back

position(F1:300Hz, F2:1000Hz). The reason is when /u/ is not velarized by a following /l/, is less back than those that are velarized. Thus, the hypothesis is correct according to the data.

Conclusion

In this lab, we investigated an English-as-second-language speaker's vowel space by analyzing the speech of words. We found that the speaker shows no sign of Canadian Raising, merges the vowels [ɑ, ɔ] when speaking, and does not always pronounce /u/ as a high back vowel.

Appendix

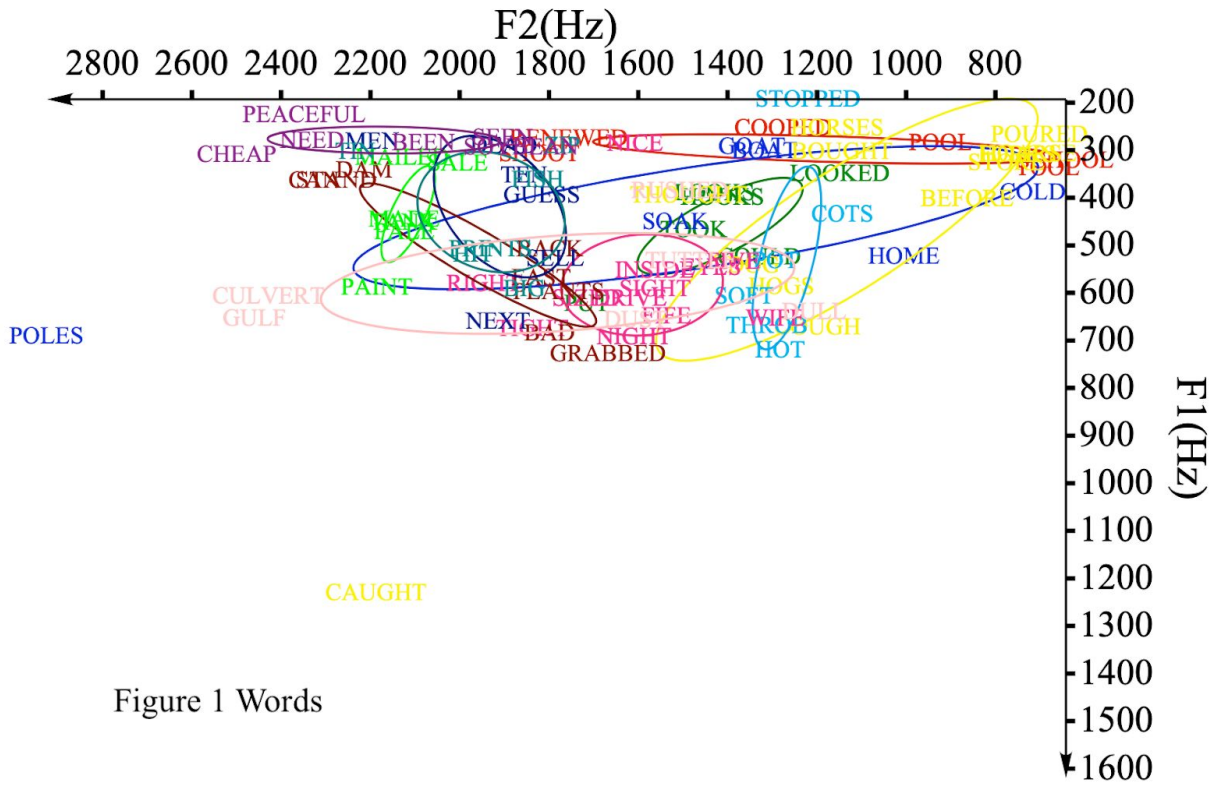

Figure 1 Words

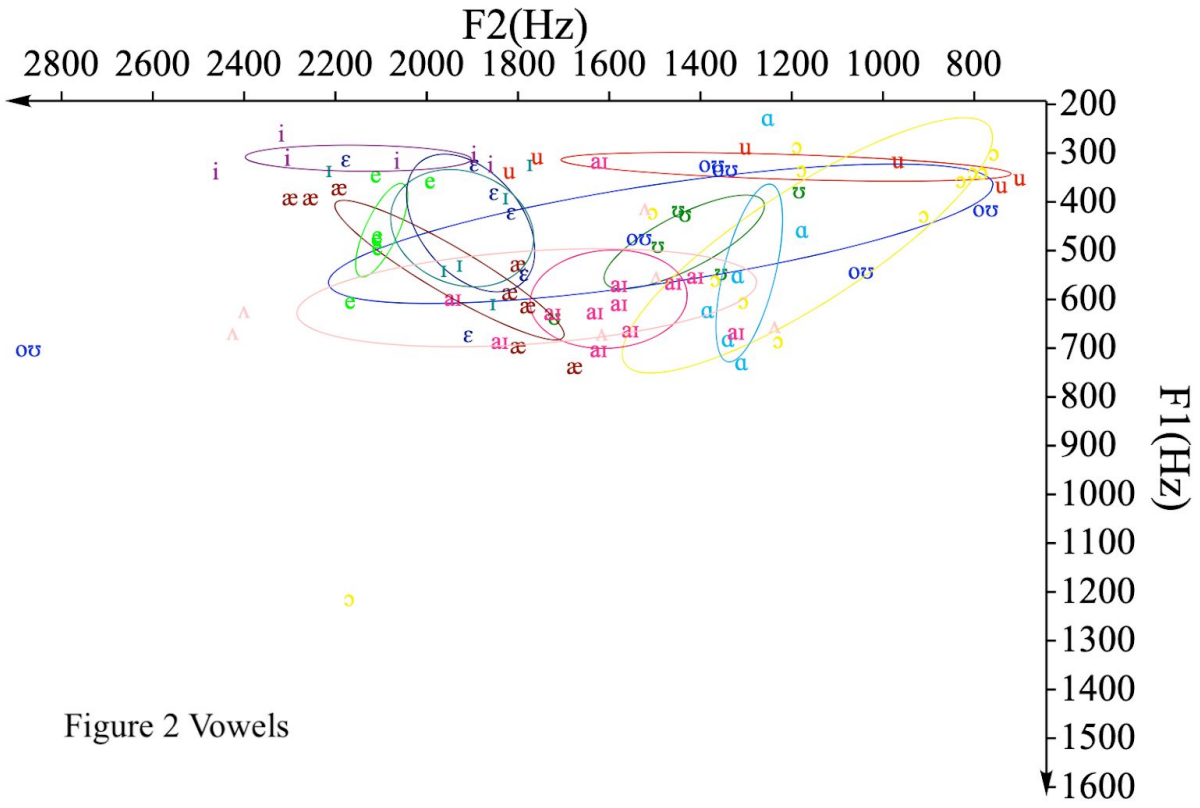

Figure 2 Vowels

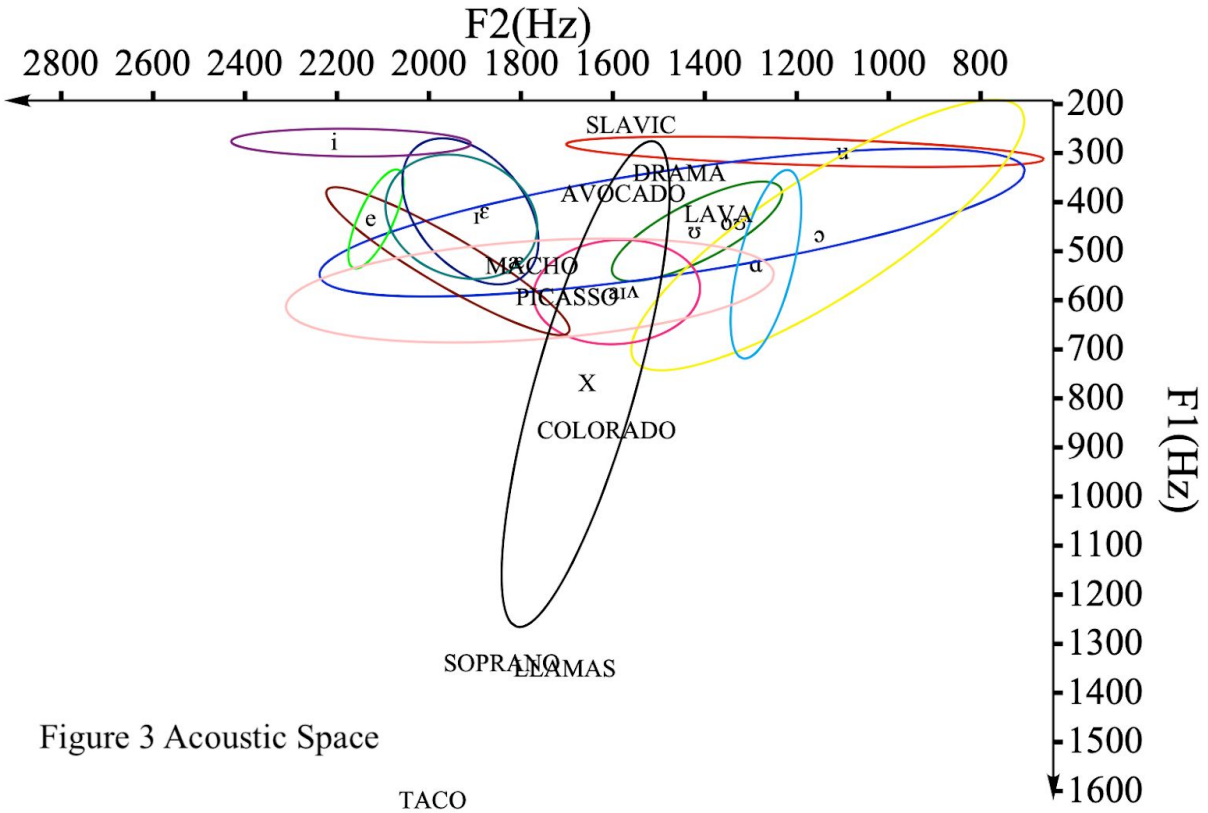

Figure 3 Acoustic Space