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Introduction

The main question that I am looking at is if vowels in bilingual speakers change from casual speech to clear speech and focus on one specific language and how the first language will affect it. We will have three speakers of different backgrounds, one who has learned French along side English (me); one who has learned French in school and has a level of C1 proficiency (Megan), and a French native who learned English (Stephan, my father). The hypotheses for the English-French bilingual with the English forward background that I will look at are:

1. Vowels in English will have less variable in clear speech than in casual speech
2. Vowels in French will have less variability in clear speech than in casual speech
3. There will be a bigger distinction between English vowels from casual to clear compared to the French comparison
4. There will be no distinction in the vowels in the casual speech of English or in French and the clear speech in French.

In the French-English bilingual, it would be reversed in terms of the languages due to the heavy French influence. So the hypotheses would be:

1. Vowels in French will have less variable in clear speech than in casual speech
2. Vowels in English will have less variability in clear speech than in casual speech
3. There will be a bigger distinction between French vowels from casual to clear compared to the English comparison
4. There will be no distinction in the vowels in the casual speech of French or in English and the clear speech in English.

Also, I would expect for the C1 level speaker to have a strong tendency towards English vowels compared to me due to the fact of learning from school but the hypotheses from above would still apply here.

Method

I will have myself, the C1 level speaker, and one French-English bilingual speaker record ourselves saying some sentences. The crucial demographic characteristics would be that the French dialect would be roughly from the same region, the south of France, and a the characteristics that would be looked at is the strong tendency to one language. I will collect sentence-level utterances for both types of speech. The speaker will be asked to say the words listed below in three different contexts

1. Once as a benchmark
2. Once in a casual setting (prompted by "say them as if you are talking to a friend")
3. Once in clear speech (prompted by "speak as clearly as possible").

Each time the speaker would be saying these words in the sentence of "The word is (word)" and the French version: "Le mot est (word)". The speakers were prompted to leave some space between the carrier sentence and the word and leave some space between sentences.

Vowel	English words	French word
[i]	see, be, he, key, pea, fee, tea, bee, sea, she	si, dit, mis, pis, vis, bis, fils, dix, six, qui
[u]	do, too, sue, zoo, boo, coo, goo, shoe, pooh, who	sous, tout, coup, doux, fou, vous, goût, boue, pou, hou
[ϵ]	bet, pet, set, get, vet, debt, tech, pep, spec, sec	sec, bec, peps, tech, def, spec, chef, sept, bête, dette, guette, tête, seche
[a] / [ɑ]	pop, cop, top, stop, hop, shop, sop, bop, pot, got	pas, bas, cas, tas, patte, pâte, chat, spa, sas, max

Table 1: table of the words that the participants will say and the related vowel for constancy

As seen in the table, all of the words have the same vowels so that it will be consistent and be more measurable across the board. Also, all of the consonants are the same across both languages to, again, be consistent on pronunciation.

Materials

I will have the recordings of myself (the English-French speaker with a English background) and the speakers (the C1 speaker of French and the English-French speaker with a French background) in Praat and will run a Praat script to extract F1 and F2 of each file. The first pass of the sentences will been discarded since there will be subconscious tendencies for speakers at the first utterance of the sentences. After extracting the formants from the Praat script, I will use python scripts to run an f-test for the casual and clear for each language, a t-test to see the vowel difference between languages, and calculate the means and standard deviation of the F1 and F2 together. Also this python script will plot the formants to have a visual on how different or lack of difference of the vowels are between clear and casual speech.

Results

We can look firstly at the Luc data and vowel by vowel. There are some values that are significant in the variability where the fromants between clear and casual are compared.

For [ɛ] in English we see some variability between F1 in casual ($M = 539.375$, $SD = 29.641$) and clear ($M = 516.858$, $SD = 32.778$), we can see that $F(18) = 1.238$ and a p-value of 0.752 so it is not fully significant. With F2 in casual ($M = 1616.194$, $SD = 36.011$) and clear ($M = 1755.304$, $SD = 82.262$) context, we can see that $F(18) = 5.284$ with a p-value of 0.022 which is $< 5\%$ so it is significant. If we look at the standard deviation, we can see that in both, the deviation increases which ties into the hypothesis that there will be less variability in casual speech than in clear.

For [a] / [ɑ] in English, we do not see any variability. For F1 in casual ($M = 729.08$, $SD = 84.588$) and clear ($M = 575.495$, $SD = 36.027$), we can see that $F(19) = 0.181$ with a p-value of 0.018 so the lack of variability is significant. With F2 in casual ($M = 1128.355$, $SD = 88.391$) and clear ($M = 1005.011$, $SD = 42.959$) context, we see little variability from the f-test; $F(19) = 0.236$ with a p-value of 0.043 so it is significant. If we look closely at the standard deviation, we see the opposite trend as for the [ɛ] which goes against my hypothesis.

For [u] in English, we see variability between clear and casual but is not statistically significant. For F1 casual ($M = 347.844$, $SD = 12.714$) and clear ($M = 283.477$, $SD = 17.836$), there is variability from the F-score, but it is not valuable to say with strong evidence; $F(19) = 1.968$ with a p-value of 0.328. For F2 casual ($M = 1399.502$, $SD = 244.766$) and clear ($M = 1148.594$, $SD = 353.324$), we see variability but statistically not significant. As a note, [u] tend to be messy to find F2 since it is close with F1 so the high standard deviation is to be expected. Even though the f-score shows a variability with the p-value, it is not valuable to say with strong evidence; $F(19) = 2.084$ with a p-value of 0.289. When we take a close look at the standard deviation, we see the same effect as [ɛ] where casual is lower than clear which goes with my hypothesis.

Finally, for [i] in English, we variability in F1 but it is not statistically significant to accept the hypothesis. For F1 casual ($M = 297.31$, $SD = 11.367$) and clear ($M = 252.955$, $SD = 16.274$), there is variability from the f-score but it is not valuable to say with strong evidence; $F[19] = 2.05$ with a p-value of 0.3. When we look at the F2, casual ($M = 2037.853$, $SD = 100.374$) and clear ($M = 2219.624$, $SD = 71.57$), there is no variability but it is not valuable to say with strong evidence; $F[19] = 0.508$ with a p-value of 0.328. If we look at the standard deviation, we see less variation in F1 for casual compared to clear, but more variation in F2 for casual compared to clear.

For [ɛ] in French, we see variability in F1, in casual ($M = 501.46$, $SD = 51.454$) and clear ($M = 528.194$, $SD = 32.317$), but it is not statistically significant to accept the hypothesis; $F[25] = 2.535$ with a p-value of 0.121. For F2, casual ($M = 1778.044$, $SD = 73.534$) and clear ($M = 1764.671$, $SD = 54.366$), there is variability from the f-score but it is not valuable to say with strong evidence; $F[25] = 1.829$ with a p-value of 0.309. We see in the standard deviation that the clear speech has less deviation than the casual which ties with the hypothesis of French clear being less variable than casual.

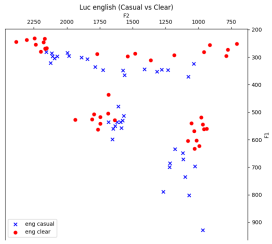
For [a] / [ɑ] in French, we see some variability only in F1 but it is not statistically backed up. For F1 casual ($M = 626.192$, $SD = 49.757$) and clear ($M = 644.64$, $SD = 45.492$), there is variability but it is not valuable to say with strong evidence; $F[19] = 1.196$

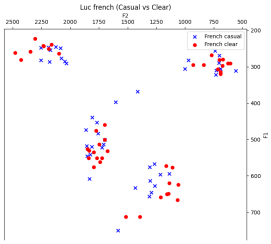
with a p-value of 0.794. For F2, casual($M = 1311.812$, $SD = 115.567$) and clear($M = 1196.688$, $SD = 138.829$), we do not see variability but it is not valuable to say with strong evidence; $F[19] = 0.693$ with a p-value of 0.594. When we look at the standard deviation, the same effect applies for F1 but it is the opposite effect for F2.

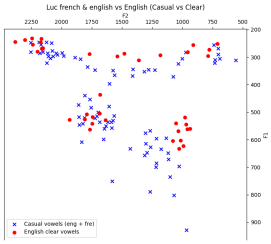
For [u] in French, we variability in both formants with strong backing. For F1, casual ($M = 301.811$, $SD = 29.507$) and clear ($M = 297.038$, $SD = 12.446$), there is variability with the statistical backing; $F[19] = 5.621$ with a p-value of 0.017. For F2, casual ($M = 824.851$, $SD = 232.816$) and clear ($M = 714.486$, $SD = 92.333$), we see strong variability; $F[19] = 6.358$ with a p-value of 0.011. When we look at the standard deviation, we see the same effect for both formants which goes with the hypothesis.

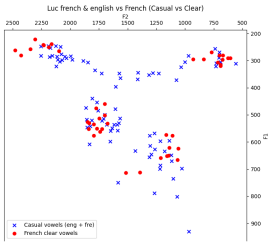
Finally, for [i] in French, there is some variability, especially in F1, but it is not statistics to back it up. For F1, casual ($M = 266.181$, $SD = 18.181$) and clear ($M = 253.002$, $SD = 16.087$), we see variability but is not valuable to say with strong evidence; $F[19] = 1.277$ with a p-value of 0.721. For F2, casual ($M = 2141.512$, $SD = 76.459$) and clear ($M = 2123.958$, $SD = 465.354$), we do not see variability; $F[19] = 0.027$ with a p-value of 0.0. As a note, the 0 in the p-value could have been resulted of a python rounding error and the same note as the English [u] applies here as well. When we look at the standard deviation, we see the trend for F1 but not in F2.

We can now look at the casual vowel chart compared to the clear vowel chart. When we take the difference between the clear and casual formant values and run an un-paired t-test, we do not see a difference between the group; $t[163] = 0.709$ with a p-value of 0.48.









We can look at the Stephan data and vowel by vowel. There are some values that are significant in the variability where the fromants between clear and casual are compared.

For [ϵ] in English we see no variability between F1 in casual ($M = 536.952$, $SD = 119.055$) and clear ($M = 554.333$, $SD = 25.478$), we can see that $F(19) = 0.602$ and a p-value of 0.462 so it is not fully significant. With F2 in casual ($M = 1730.183$, $SD = 125.443$)

and clear ($M = 1718.513$, $SD = 51.974$) context, we can see that there is some variability; $F(19) = 1.763$ with a p-value of 0.411 but it is not valuable to say with strong evidence. If we look at the standard deviation, we can see that in both, the deviation increases in F1 which ties into the hypothesis that there will be less variability in clear speech than in casual but not with F2.

For [a] / [ɑ] in English, we do see variability. For F1 in casual ($M = 581.923$, $SD = 40.108$) and clear ($M = 652.599$, $SD = 38.331$), we can see that $F(19) = 1.095$ with a p-value of 0.895 so the lack of variability is significant. With F2 in casual ($M = 1097.532$, $SD = 146.74$) and clear ($M = 1056.384$, $SD = 78.499$) context, we see variability from the f-test; $F(19) = 3.494$ with a p-value of 0.076 so it is significant but it is close. If we look closely at the standard deviation, we see the same trend as for the [ϵ] which goes with the hypothesis.

For [u] in English, we see variability between clear and casual but is not statistically significant. For F1 casual ($M = 304.501$, $SD = 29.558$) and clear ($M = 329.207$, $SD = 30.722$), there is little variability from the F-score, but it is not valuable to say with strong evidence; $F(19) = 0.926$ with a p-value of 0.91. For F2 casual ($M = 992.737$, $SD = 267.522$) and clear ($M = 1053.611$, $SD = 140.163$), we see variability but statistically not significant. As a note, [u] tend to be messy to find F2 since it is close with F1 so the high standard deviation is to be expected. Even though the f-score shows a variability with the p-value, it is not valuable to say with strong evidence; $F(19) = 3.643$ with a p-value of 0.068. When we take a close look at the standard deviation, we see the same effect as [ϵ] where clear is lower than casual which goes with my hypothesis.

Finally, for [i] in English, we see variability in F1 but it is not statistically significant to accept the hypothesis. For F1 casual ($M = 299.17$, $SD = 23.597$) and clear ($M = 280.851$, $SD = 30.407$), there is little to no variability from the f-score but it is not valuable to say with strong evidence; $F[19] = 0.602$ with a p-value of 0.462. When we look at the F2, casual ($M = 1984.292$, $SD = 32.847$) and clear ($M = 2115.078$, $SD = 24.736$), there is variability but it is not valuable to say with strong evidence; $F[19] = 1.763$ with a p-value of 0.411. If we look at the standard deviation, we see more variation in F1 for casual compared to clear, but more variation in F2 for casual compared to clear which is against my hypothesis.

For [ϵ] in French, we do not see variability in F1, in casual ($M = 462.987$, $SD = 33.366$) and clear ($M = 546.463$, $SD = 16.573$), and it is statistically significant to reject the hypothesis; $F[24] = 0.248$ with a p-value of 0.024. For F2, casual ($M = 1620.735$, $SD = 66.483$) and clear ($M = 1742.778$, $SD = 58.842$), there is little variability from the f-score but it is not valuable to say with strong evidence; $F[24] = 0.789$ with a p-value of 0.688. We see in the standard deviation that the casual speech has less deviation than the clear which ties with the hypothesis of French casual being less variable than clear.

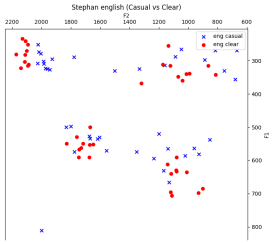
For [a] / [ɑ] in French, we see some variability in both formants but it is not statistically backed up. For F1 casual ($M = 558.449$, $SD = 43.0184$) and clear ($M = 713.192$, $SD = 43.513$), there is variability but it is not valuable to say with strong evidence; $F[20] = 1.033$ with a p-value of 0.97. For F2, casual($M = 1298.599$, $SD = 88.393$) and clear($M = 1371.086$, $SD = 108.264$), we do see variability but it is not valuable to say

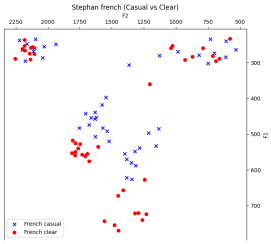
with strong evidence; $F[20] = 1.515$ with a p-value of 0.544. When we look at the standard deviation, the same effect applies for F1 but it is the opposite effect for F2.

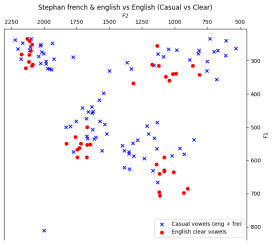
For [u] in French, we variability in both formants with strong backing. For F1, casual ($M =$, $SD =$) and clear ($M =$, $SD =$), there is variability with the statistical backing; $F[] =$ with a p-value of . For F2, casual ($M =$, $SD =$) and clear ($M =$, $SD =$), we see strong variability; $F[] =$ with a p-value of . When we look at the standard deviation, we see the same effect for both formants which goes with the hypothesis.

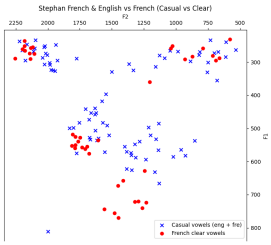
Finally, for [i] in French, there is little to no variability, but it is not statistics to back it up. For F1, casual ($M = 259.32$, $SD = 18.877$) and clear ($M = 265.798$, $SD = 16.105$), we do not much see variability but is not valuable to say with strong evidence; $F[19] = 0.728$ with a p-value of 0.644. For F2, casual ($M = 2107.872$, $SD = 82.869$) and clear ($M = 265.798$, $SD = 16.105$), we do not see variability; $F[19] = 0.259$ with a p-value of 0.057 which is so close to be significant. When we look at the standard deviation, We see the effect for F1 but not with F2 in casual vs clear, this goes with my hypothesis.

We can now look at the casual vowel chart compared to the clear vowel chart. When we take the difference between the clear and casual formant values and run an un-paired t-test, we do see a difference between the group but is not significant to say much but it is close; $t[163] = 1.941$ with a p-value of 0.054.









We can lastly look at the Megan data and vowel by vowel. There is one valus that are significant in the variability where the fromants between clear and casual are compared.

For [ϵ] in English we see some variability between F1 in casual ($M = 769.573$, $SD = 58.200$) and clear ($M = 802.669$, $SD = 102.480$), we cans see that $F(16) = 2.727$ and a p-value of 0.235 so it is not fully significant even thought there is variation from the F-test. With F2 in casual ($M = 1964.309$, $SD = 129.717$) and clear ($M = 2045.594$, $SD = 119.143$) context, we can see that $F(16) = 0.739$ with a p-value of 0.655 which is $< \%$ so it is not significant that we see a lack of variation. If we look at the standard deviation, we can see

that in F1, the deviation increases, while F2 does the opposite, which partially ties into the hypothesis that there will be less variability in casual speech than in clear.

For [a] / [ɑ] in English, we do not see any variability. For F1 in casual ($M = 871.334$, $SD = 37.467$) and clear ($M = 871.359$, $SD = 60.582$), we can see that $F(22) = 2.681$ with a p-value of 0.114 so the variability cannot be confirmed statistically. With F2 in casual ($M = 1460.274$, $SD = 266.123$) and clear ($M = 1191.889$, $SD = 54.073$) context, we see little to no variability from the f-test; $F(22) = 0.042$ with a p-value of 0.0 so it is significant. As a note, the p-value being 0, could be the result of python's rounding error when calculating the p-value. If we look closely at the standard deviation, we see the opposite trend as for the [ɛ], only for F1, which goes against my hypothesis.

For [u] in English, we see variability between clear and casual but is not statistically significant. For F1 casual ($M = 362.672$, $SD = 31.533$) and clear ($M = 336.141$, $SD = 20.956$), there is variability from the F-score, but it is not valuable to say with strong evidence; $F(19) = 0.442$ with a p-value of 0.239. For F2 casual ($M = 1239.196$, $SD = 320.719$) and clear ($M = 336.141$, $SD = 20.956$), we see variability but statistically not significant. As a note, [u] tend to be messy to find F2 since it is close with F1 so the high standard deviation is to be expected. Even though the f-score shows a variability with the p-value, it is not valuable to say with strong evidence; $F(19) = 1.218$ with a p-value of 0.773. When we take a close look at the standard deviation, we see the deviation less in clear than in casual for both formants.

Finally, for [i] in English, we variability in F1 but it is not statistically significant to accept the hypothesis. For F1 casual ($M = 297.357$, $SD = 12.898$) and clear ($M = 302.387$, $SD = 15.902$), there is variability from the f-score but it is not valuable to say with strong evidence; $F[19] = 1.52$ with a p-value of 0.543. When we look at the F2, casual ($M = 2912.26$, $SD = 48.74$) and clear ($M = 2970.259$, $SD = 50.251$), there is variability but it is not valuable to say with strong evidence; $F[19] = 1.063$ with a p-value of 0.929. If we look at the standard deviation, we see less variation in both formants for casual compared to clear.

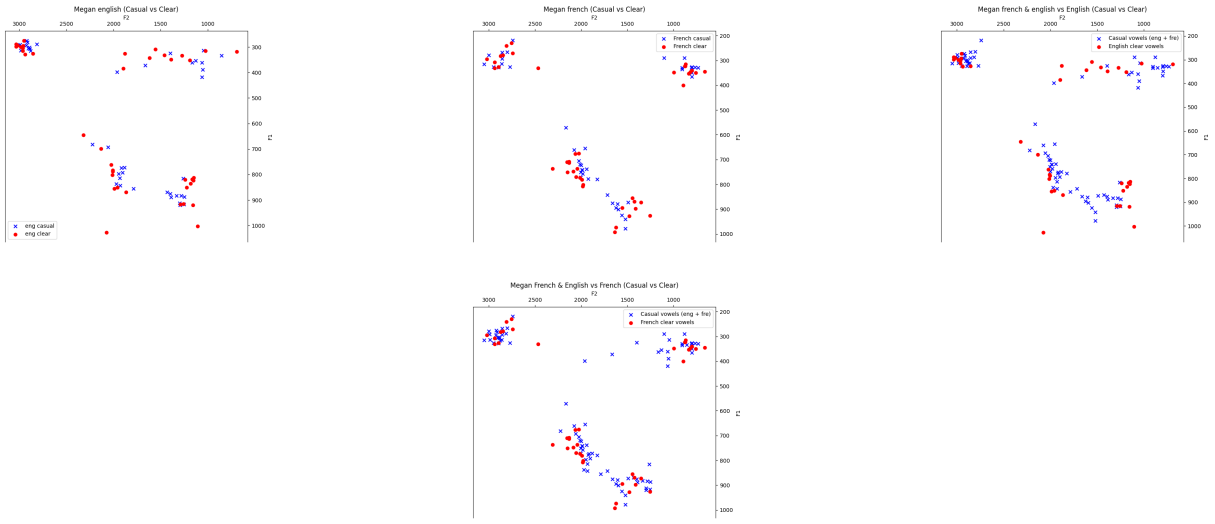
For [ɛ] in French, we see variability in F1, in casual ($M = 716.341$, $SD = 55.261$) and clear ($M = 742.114$, $SD = 40.654$), but it is not statistically significant to accept the hypothesis; $F[26] = 1.859$ with a p-value of 0.281. For F2, casual ($M = 2005.152$, $SD = 59.524$) and clear ($M = 2079.567$, $SD = 86.408$), there is little to no variability from the f-score but it is not valuable to say with strong evidence; $F[26] = 0.477$ with a p-value of 0.21. We see in the standard deviation that the clear speech has less deviation than the casual, only in F1, which ties with the hypothesis of French clear being less variable than casual.

For [a] / [ɑ] in French, we see some variability only in F1 but it is not statistically backed up. For F1 casual ($M = 889.226$, $SD = 51.946$) and clear ($M = 912.342$, $SD = 44.7981$), there is variability but it is not valuable to say with strong evidence; $F[18] = 1.328$ with a p-value of 0.7. For F2, casual($M = 1611.595$, $SD = 97.561$) and clear($M = 912.342$, $SD = 44.798$), we do not see variability but it is not valuable to say with strong evidence; $F[18] = 0.679$ with a p-value of 0.575. When we look at the standard deviation, the same effect applies for F1 but it is the opposite effect for F2.

For [u] in French, we do not see much variability in F1 but not in F2 both. For F1, casual ($M = 326.826$, $SD = 22.182$) and clear ($M = 344.183$, $SD = 22.252$), there is variability with the statistical backing; $F[19] = 0.994$ with a p-value of 0.993. For F2, casual ($M = 848.512$, $SD = 100.594$) and clear ($M = 836.267$, $SD = 84.273$), we see variability, but it is not valuable with strong evidence; $F[19] = 1.425$ with a p-value of 0.606. When we look at the standard deviation, we see the opposite effect for both formants which goes with the hypothesis.

Finally, for [i] in French, there is little to no variability, but it is not statistics to back it up. For F1, casual ($M = 293.0$, $SD = 33.533$) and clear ($M = 288.639$, $SD = 33.985$), we see variability but is not valuable to say with strong evidence; $F[19] = 0.974$ with a p-value of 0.969. For F2, casual ($M = 2879.143$, $SD = 93.29$) and clear ($M = 2829.018$, $SD = 145.760$), we do not see variability; $F[19] = 0.41$ with a p-value of 0.2.The same note as the English [u] applies here as well. When we look at the standard deviation, we see the trend for F1 but not in F2.

We can now look at the casual vowel chart compared to the clear vowel chart. When we take the difference between the clear and casual formant values and run an un-paired t-test, we do not see a difference between the group; $t[165] = 0.764$ with a p-value of 0.446.



All of these figures show the relationship between casual and clear versions of the vowels. In some of the figures, we see clear differences between speech patterns while in other contexts we see little to no variance.

Discussion

When we take a look at the hypotheses:

1. Vowels in English will have less variable in clear speech than in casual speech

2. Vowels in French will have less variability in clear speech than in casual speech
3. There will be a bigger distinction between English vowels from casual to clear compared to the French comparison
4. There will be no distinction in the vowels in the casual speech of English or in French and the clear speech in French.

and:

1. Vowels in French will have less variable in clear speech than in casual speech
2. Vowels in English will have less variability in clear speech than in casual speech
3. There will be a bigger distinction between French vowels from casual to clear compared to the English comparison
4. There will be no distinction in the vowels in the casual speech of French or in English and the clear speech in English.

we can see that for some of the vowels in every speaker has some variability and certain ones can be backed with the p-value. We can see in the vowel charts of each speaker that there is variability but each vowel changes from clear to casual slightly different. Some vowels will centralize like in [ϵ] or decrease/increase one of the formants to make the distinction. Unfortunately we cannot fully say that every vowel show any much variability in either casual or clear just statistically.

For the vowels in the language specific data of each speaker, the first learned language in the English dominant English-French bilingual shows more variability in the f-score than the first language in the French dominant English-French bilinguals.

The place that we can see variability but is a good first step is with the standard deviation which was discussed in the results section. Even though standard deviation is not a good measure, we do see the trend between casual and clear which relates to the hypotheses.

I mentioned that there has been some p-values of 0, at a certain range, for small values, python's rounding error. I also mentioned that measuring [u] has resulted in some wide standard deviation. This is due to the closeness of F1 and F2 and Praat having a difficult time finding so to combat this issue, in the Praat script, I increased the amount of formants and decreased the pitch ceiling so that Praat was giving more information to find F2.

An overall generalization that can be made is that there is variability in the vowels in both languages, separately, but there is no one language that any of the speaker gravitate towards.