VOWEL SPACE IN THE ATHABASKAN LANGUAGE OF TSUUT'INA: VOWEL SHIFT IN LANGUAGE ATTRITION

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The Athabaskan language of Tsuut'ina has historically been thought to have four distinct vowel spaces: /a/, /i/, /o/, and /u/. In order to look at the vowel space of the language as it is today, an acoustic analysis was performed on recorded field sessions with three female native speakers of Tsuut'ina. This paper looks to determine the vowel phonemic inventory of the language and how word position, phonetic environment, vowel duration, and vowel pitch alter the vowel space. In doing so, it is found that the vowel space of the language today appears to be less distinct than the four separate spaces previously thought to reside in the language, suggesting that Tsuut'ina has three vowel phonemes instead of the four traditionally used. Overall, the language is shifting towards general vowel centralization. This shift could possibly be due to Tsuut'ina's deemphasizing vowels and subsequent focus on consonants, as well as its current state in language attrition.

1. INTRODUCTION**.** The Tsuut'ina language, while very diverse in its consonant inventory, seems to lack distinction between its vowels. This paper explores ways of dividing up the Tsuut'ina vowel space in terms of linguistic parameters via exploratory formant plotting. In previous work on the language, Cook (1971 & 1984) and Li (1930) found there to be four vowel spaces: /a/, /i/, /o/, and /u/. After a couple of sessions with speakers of the language, traditional methods of eliciting words and finding minimal pairs were not enough to mark four distinct phonemic vowels. Acoustical measurements such as formants, vowel duration, and pitch, along with lexical measurements of phonetic environment and syllable structure will then be used to chart out these four vowel spaces.

2. METHODOLOGY. Three adult female speakers, Speaker A, Speaker B, and Speaker J, were recorded during two field sessions, with each session lasting roughly an hour and a half. Each vowel(s) was marked in every Tsuut'ina utterance, yielding a total of 786 useable tokens. Several vowels had to be discarded due to either recording quality, more than one person speaking at one time, or indistinguishable speech. Each token was then measured for its duration, and F0, F1, F2, and F3 values were taken at the middle of the durations using Praat's automatic formant extractor (Boersma & Weenink, 2009). The F0 values for each speaker were divided into thirds and grouped into high, middle, and low pitch categories. Likewise, the vowel durations for each speaker were dichotomized into long and short lengths. Lexical measurements of phonetic environment and syllable structure were transcribed and recorded by hand. The log transformed

F1, or G1, was plotted against the log transformed F2, or G2, [henceforth, a (G1, G2) plot], and analyzed according to the aforementioned acoustic and lexical parameters.

3. RESULTS.

3.1 Overall Vowel Space. In looking at the plot of all the vowels for all the speakers, three general vowel spaces are evident: front high, back high, and low. The notion of only three vowel areas runs contra to the findings of Cook and Li. However, this sideways "v" shape is only more evident when plotted by speakers.

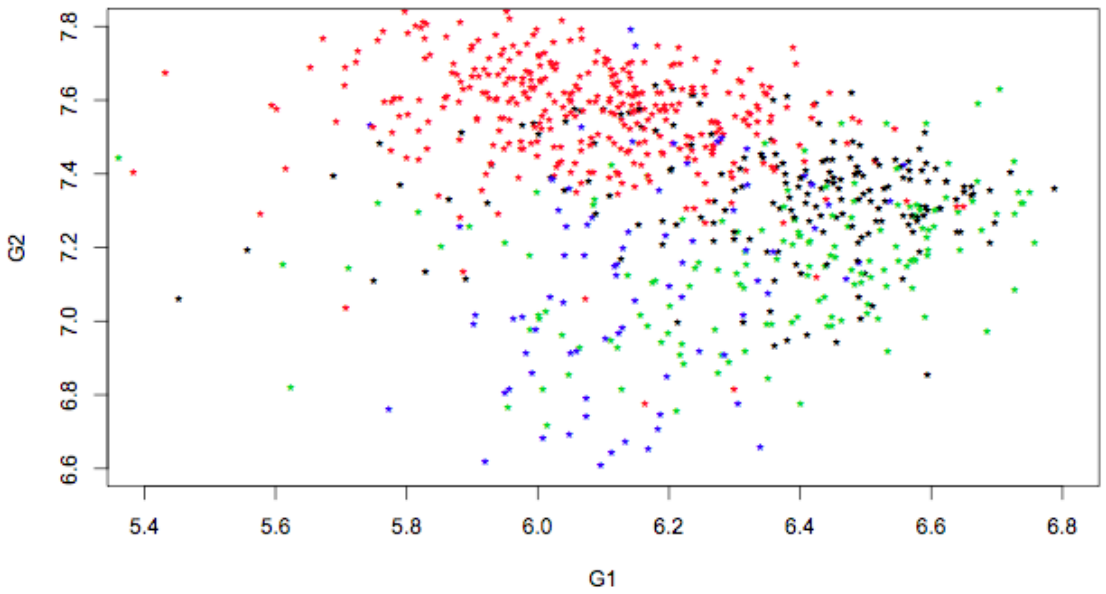

FIGURE 1 – (G1, G2) for every vowel, color-coded by vowel:
red is /i/, black is /a/, green is /o/ and blue is /u/

Here (Figure 2), Speaker B's vowels seem well defined. Speaker A's vowel space resembles that of Speaker's B, but contains more vowel scattering, hinting towards an effect of centralization. The vowel space of Speaker J, on the other hand, does not seem to have any regularity. Any sort of vowel distinction on this plot might only be made between high and low. The similarities between Speaker A and Speaker B and their dissimilarity with Speaker J are better seen when plotted together.

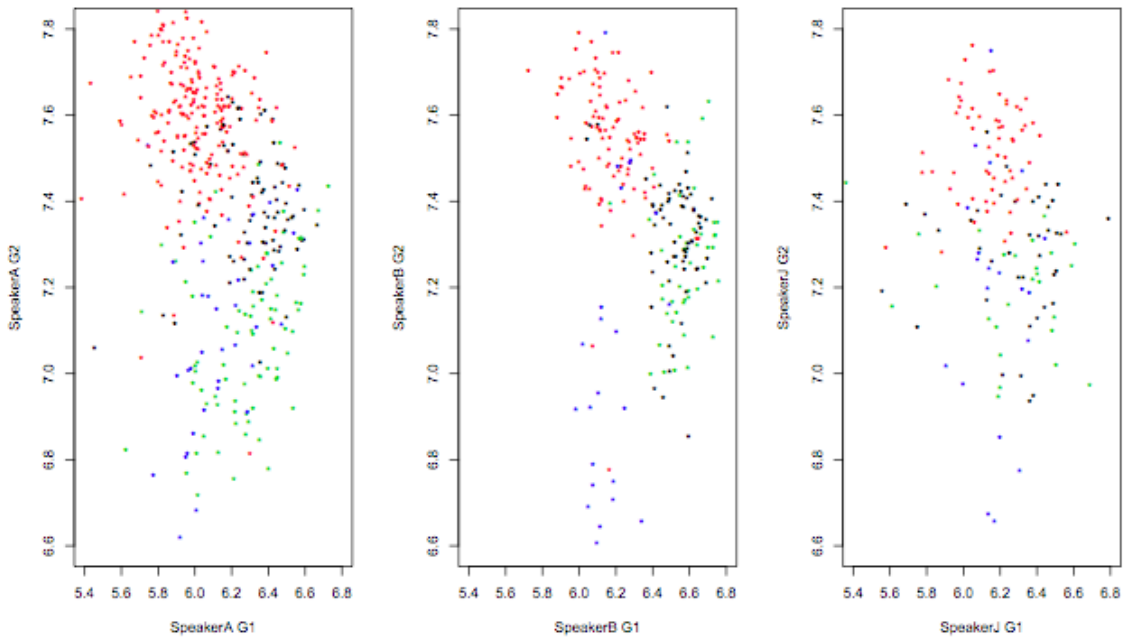

FIGURE 2 – (G1, G2) for every vowel, grouped by speaker, and color-coded by vowel: red is /i/, black is /a/, green is /o/ and blue is /u/

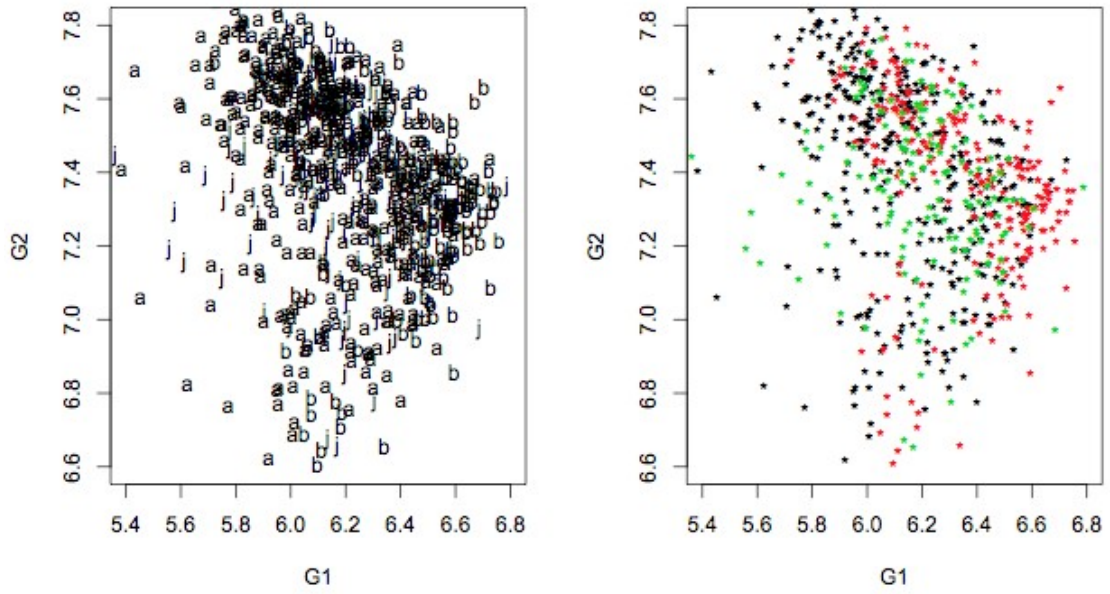

FIGURE 3 – (G1, G2) for every vowel, color-coded by speaker: red is Speaker A (denoted as "a" on the left-hand plot), black is Speaker B (denoted as "b"), and green is Speaker J (denoted as "j")

Though the overall plots of each speaker's vowels show three distinct vowel spaces, the remaining results will consider all parameters under the assumption of four vowel spaces. This is to see if there are in fact four vowel spaces, as it may be the case that the lower two vowels (/a/ and /o/) mesh together, with their spaces distinguishable only by looking at certain parameters. After considering all the parameters, the issue of defining the overall vowel space will be discussed in the final section.

3.2 Word Position. Word position as it is used here is defined as the syllable position (or number) in which a vowel resides out of the total number of syllables in a word. For instance, if the vowel resides in the second syllable of a word that has a total of three syllables, its word position would be .67, or 2/3. This measurement provides a convenient way of looking at both word length and any relation to a vowel's space and its situation in the word (as opposed to its situation in the immediate surrounding context, to be looked at under Phonemic Environment). The numerical values of word position roughly stand for word initial (i.e. $x < .5$), word medial (i.e. $.25 < x < .75$), and word final (i.e. $x=1$). The plots for each vowel by syllable position, grouped by speaker, are below in figures 4-7.

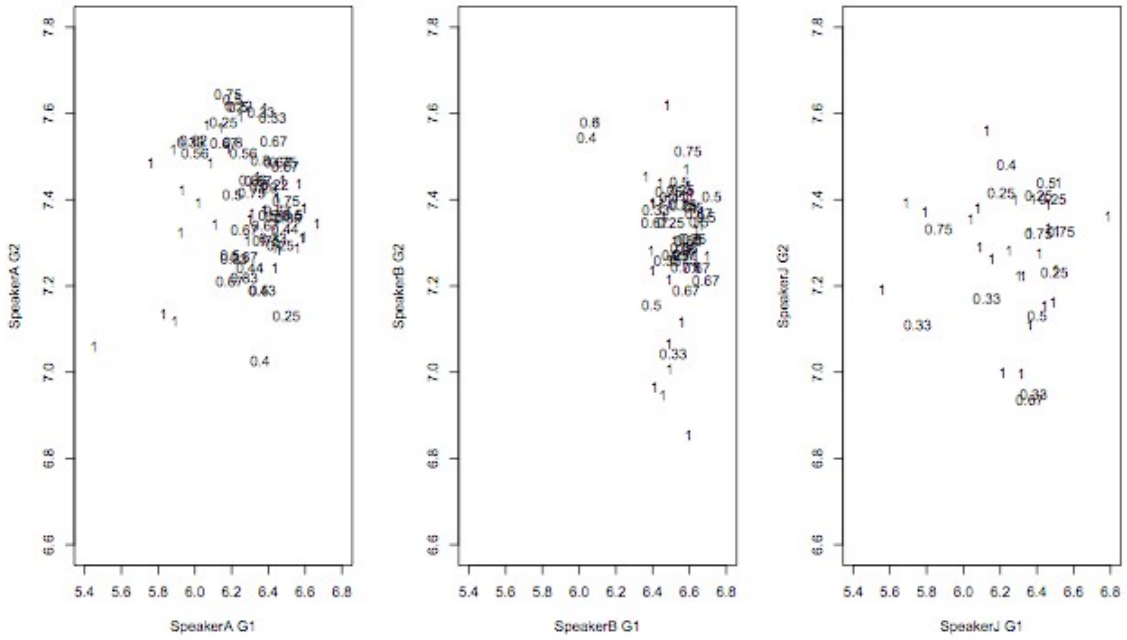

FIGURE 4 – (G1, G2) for /a/, labeled by word position, grouped by speaker

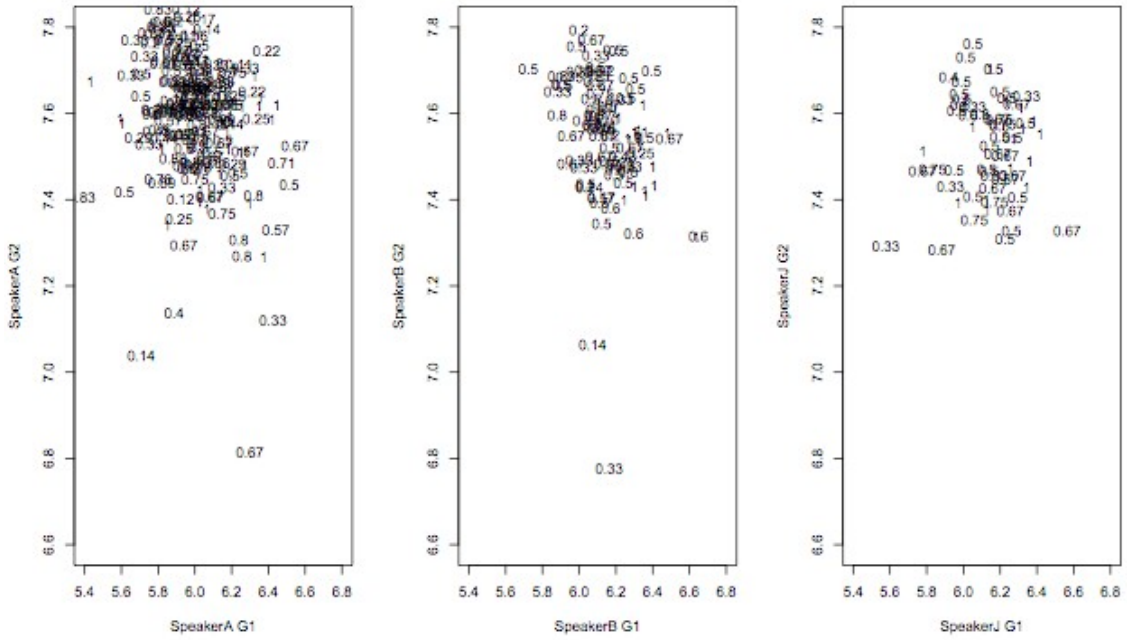

FIGURE 5 – (G1, G2) for /i/, labeled by word position, grouped by speaker

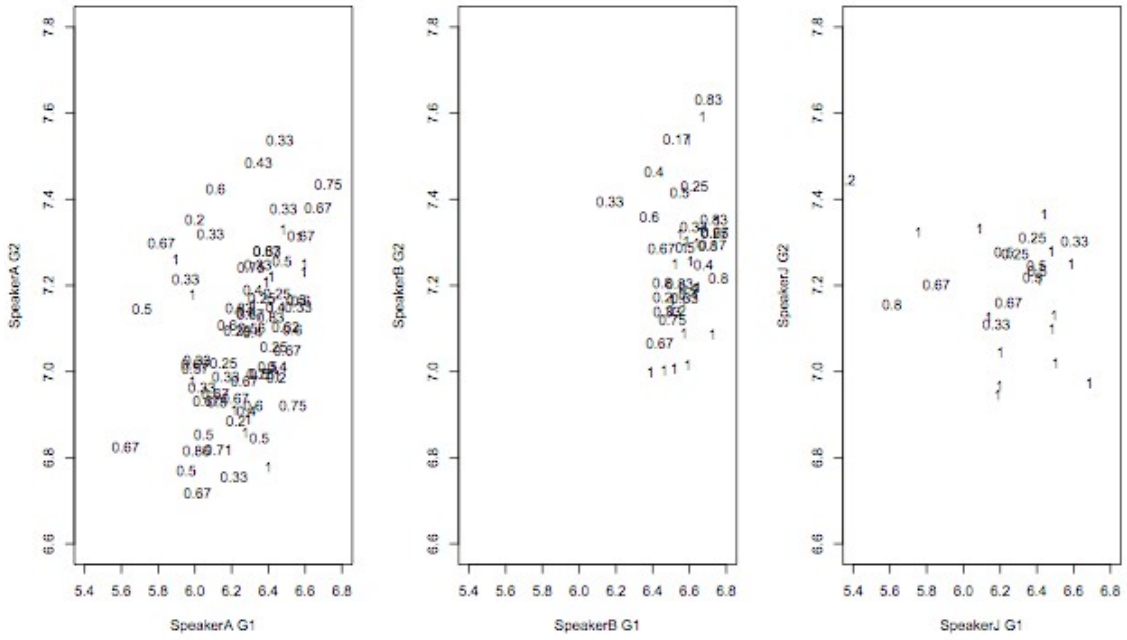

FIGURE 6 – (G1, G2) for /o/, labeled by word position, grouped by speaker

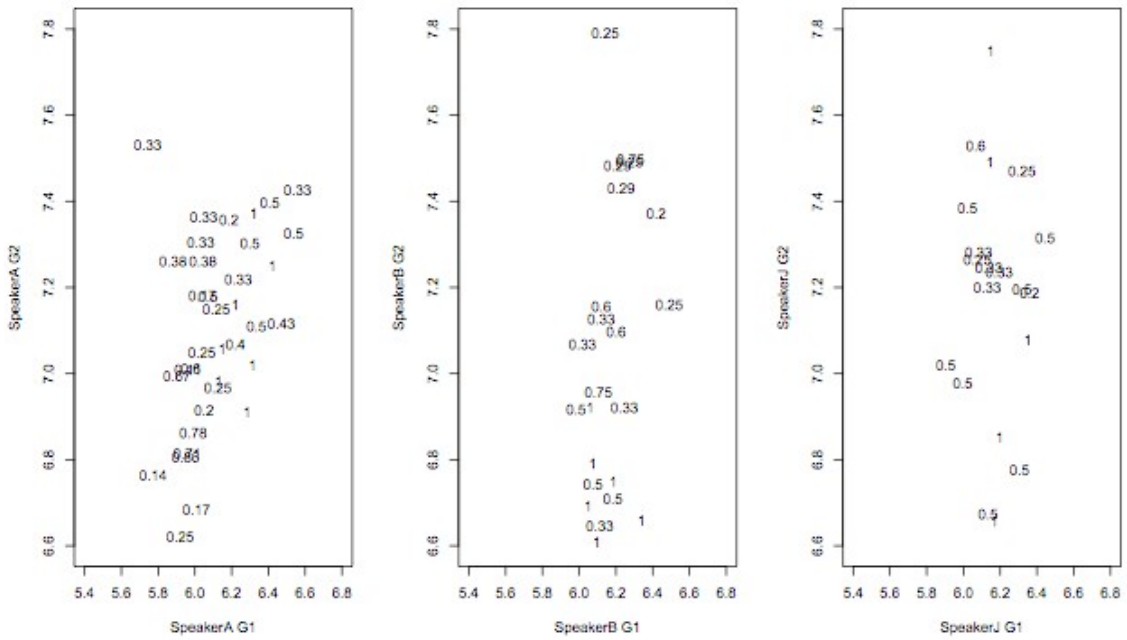

FIGURE 7 – (G1, G2) for /u/, labeled by word position, grouped by speaker

The correlates interpreted from the plots are as follows: For /a/, /i/, and /o/, word final position is in correlation to the vowel being centrally articulated. Additionally, word medial position correlates to high articulation for /i/. And as a special case, word final position is found with lower /u/ vowels, possibly centralizing the vowel. The general findings from (G1, G2) by word position show that vowels undergo a change in a word final position. The final pronunciation of a vowel may then be seen as a centralization effect, accounting for some of the scatter seen in figures 1 and 2.

3.3 Phonetic Environment. To further tease out the vowel space in Tsuut'ina, possible effects of coarticulation are looked at in (G1, G2) plots. It is hard to image that the surrounding phonetic environment does not influence the articulation of the vowels, so the preceding and following consonants are to be analyzed for each vowel token. Similar to word position, the phonetic environment looks at each vowel token in a lexical context that may have colored the vowel's articulation. In figures 8-11, the consonant preceding each vowel is looked at in correlation to vowel space.

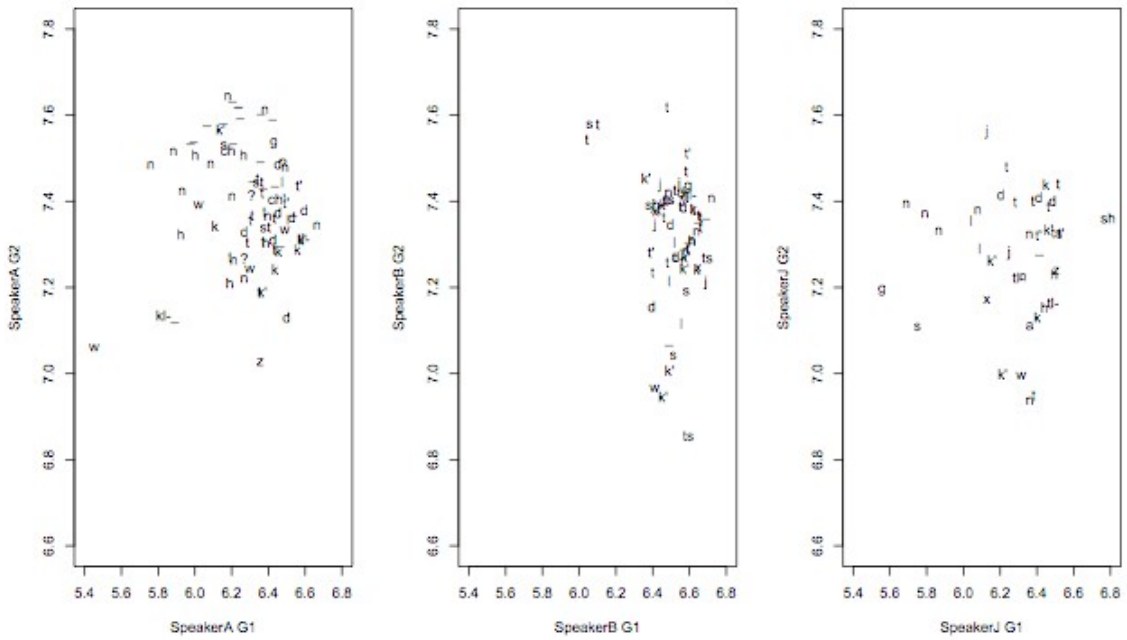

FIGURE 8 – (G1, G2) for /a/, labeled by preceding consonant, grouped by speaker

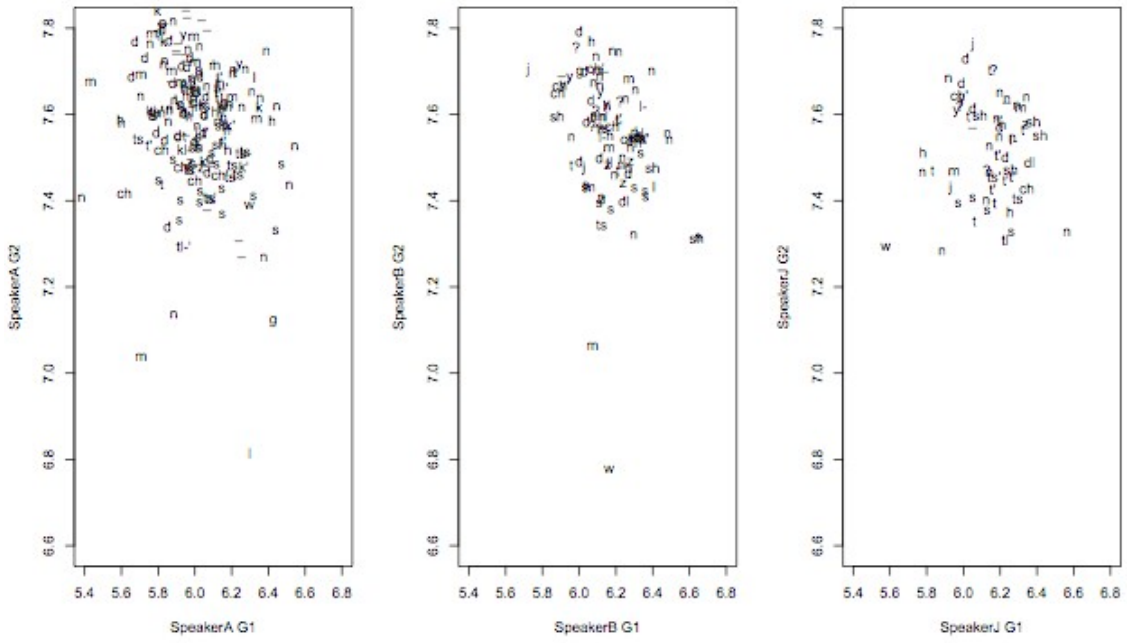

FIGURE 9 – (G1, G2) for /i/, labeled by preceding consonant, grouped by speaker

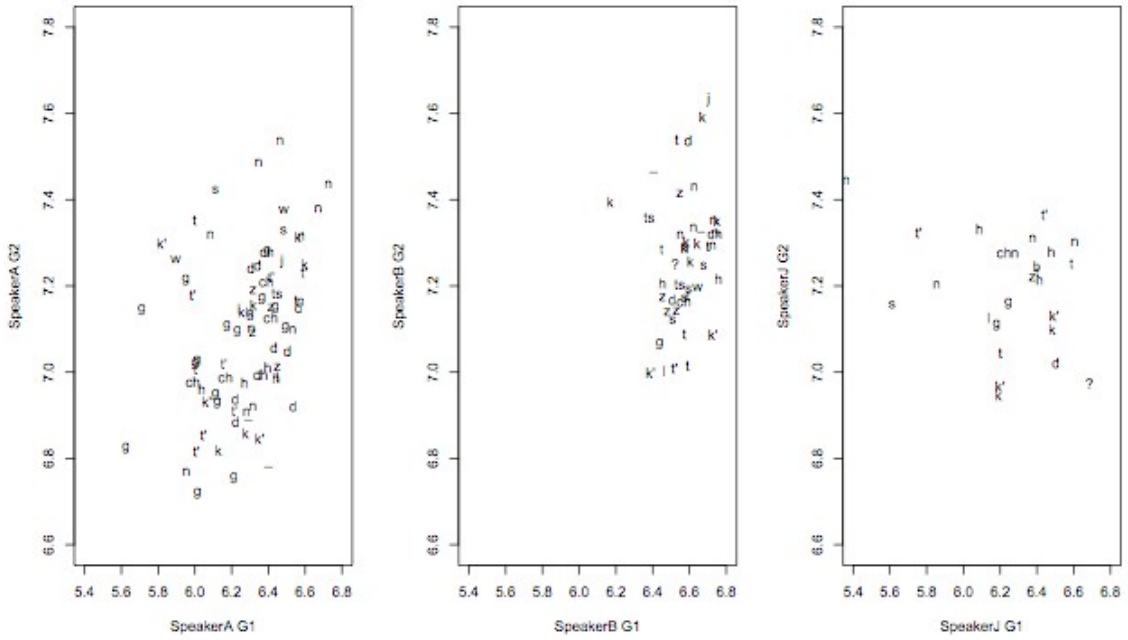

FIGURE 10 – (G1, G2) for /o/, labeled by preceding consonant, grouped by speaker

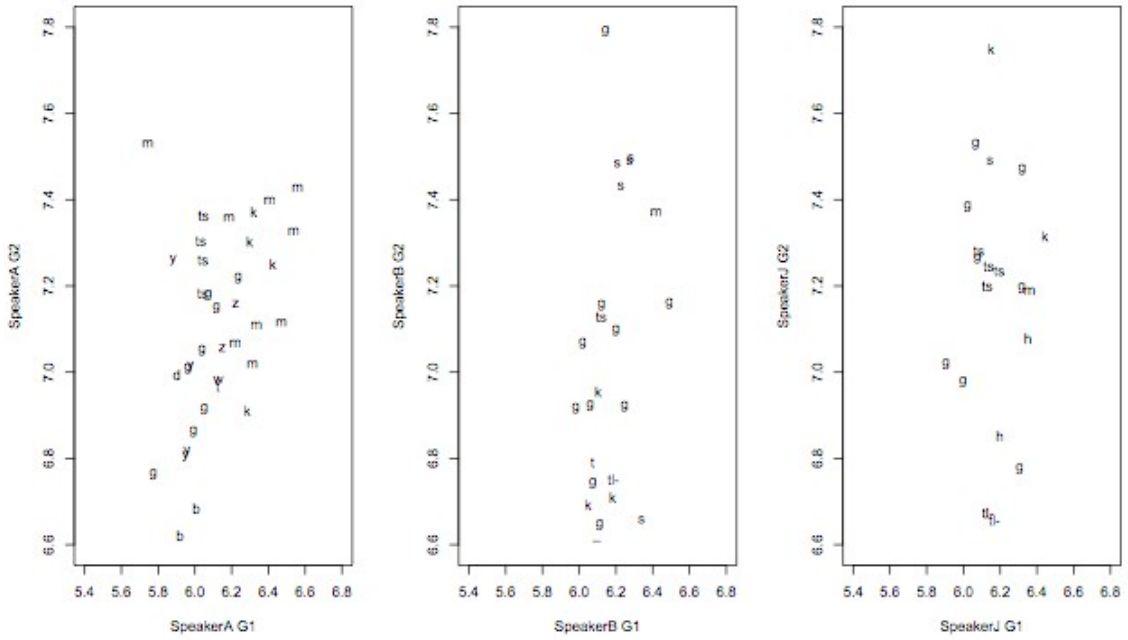

FIGURE 11 – (G1, G2) for /u/, labeled by preceding consonant, grouped by speaker

For /a/, the alveolar consonants /n/, /s/, and /t/ as well as the lack of a preceding consonant (denoted on the plots as "_") seem to group in the frontal areas of the plot. However, the affricates /ts/ and /ch/ as well as back consonants /k/, /g/, and /w/ correlate with more back areas of the vowel space. This is also found in the case of /i/ and /u/ where /_/, /m/, /n/, /d/, and /t/ correlate with frontness and /ts/, /ch/, /tɬ/, /kɬ/ and /w/ correlate with backness. The only vowel to not follow this front/back distinction is /o/, where no correlation could be found. Generally, though, it can be said that more frontal consonants appear with a fronting of the vowels, while more back consonants appear with the more back spaces of the vowels. To further analyze the phonetic environment surrounding the vowel tokens, figures 12-15 look at the consonant following each vowel.

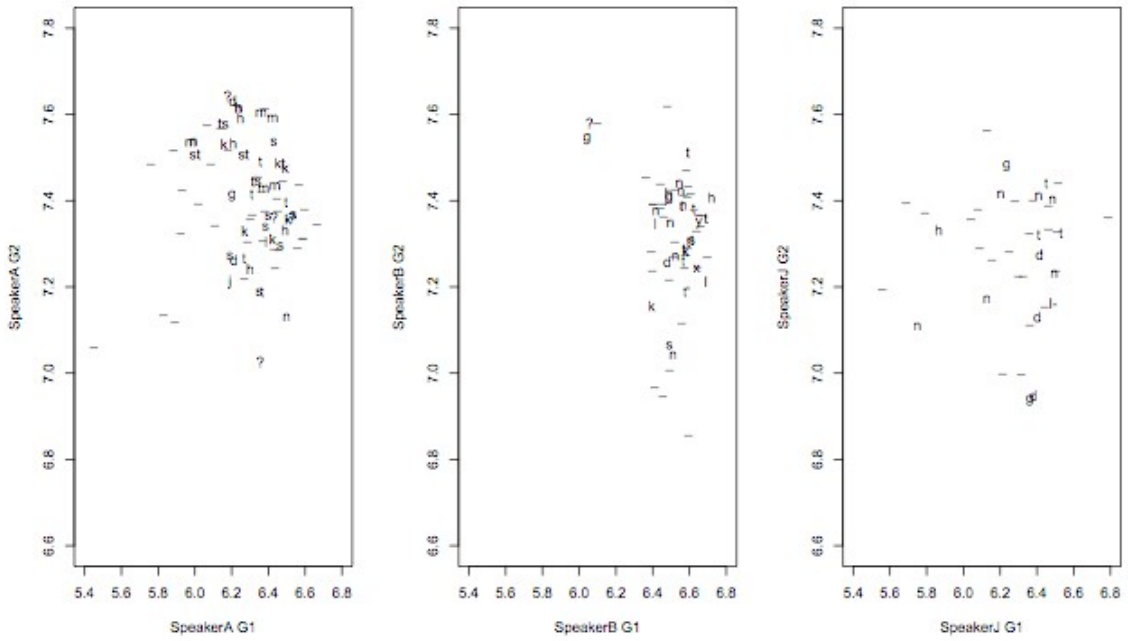

FIGURE 12 – (G1, G2) for /a/, labeled by following consonant, grouped by speaker

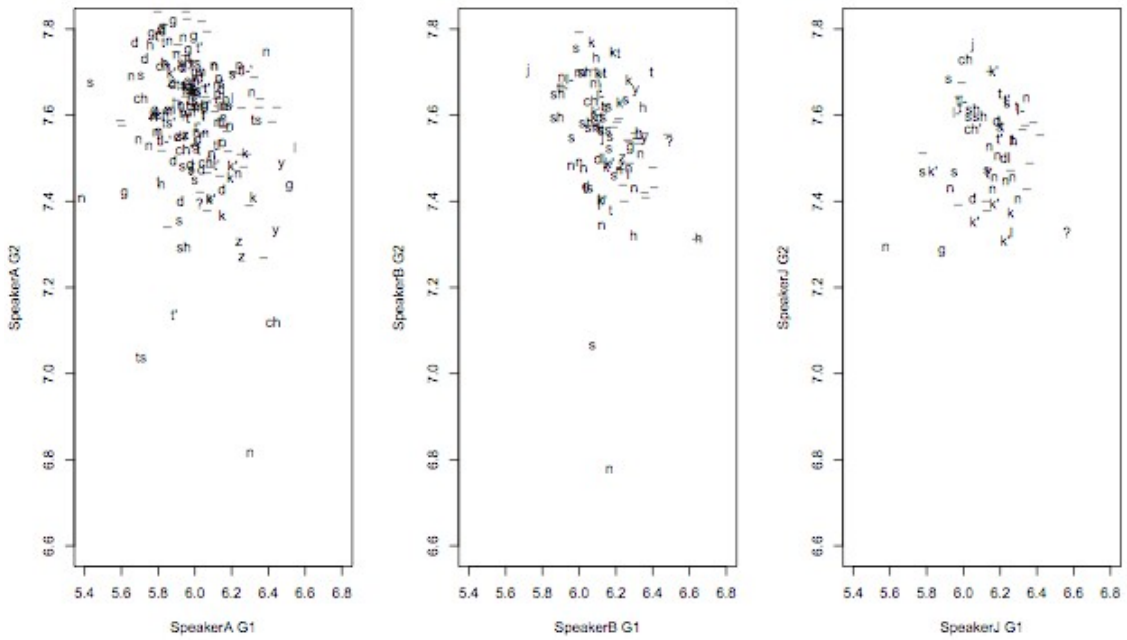

FIGURE 13 – (G1, G2) for /i/, labeled by following consonant, grouped by speaker

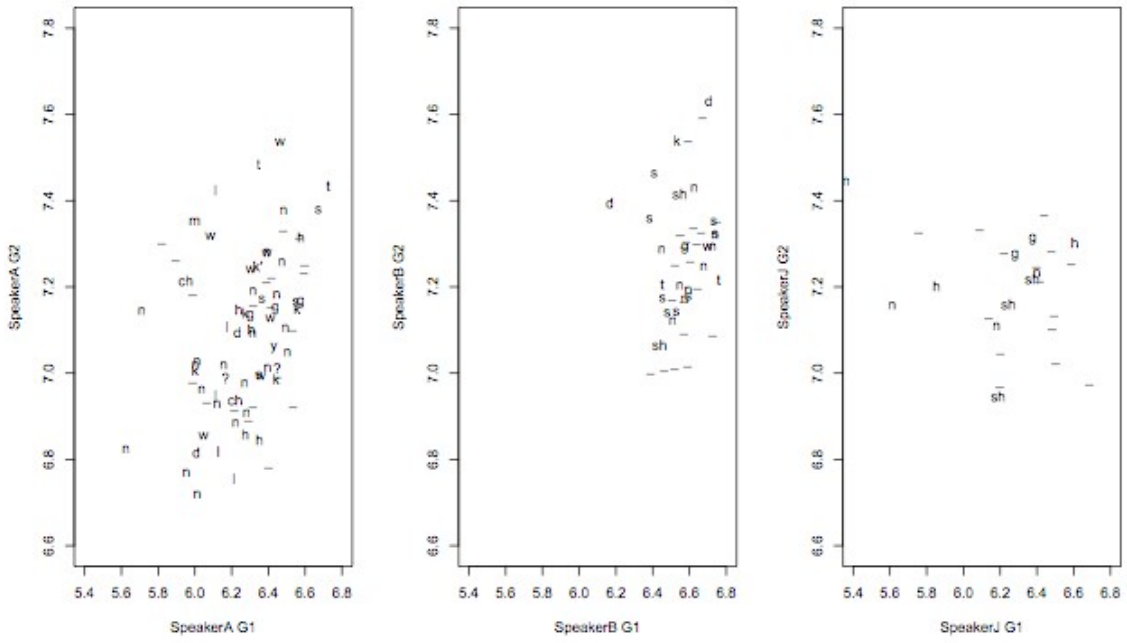

FIGURE 14 – (G1, G2) for /o/, labeled by following consonant, grouped by speaker

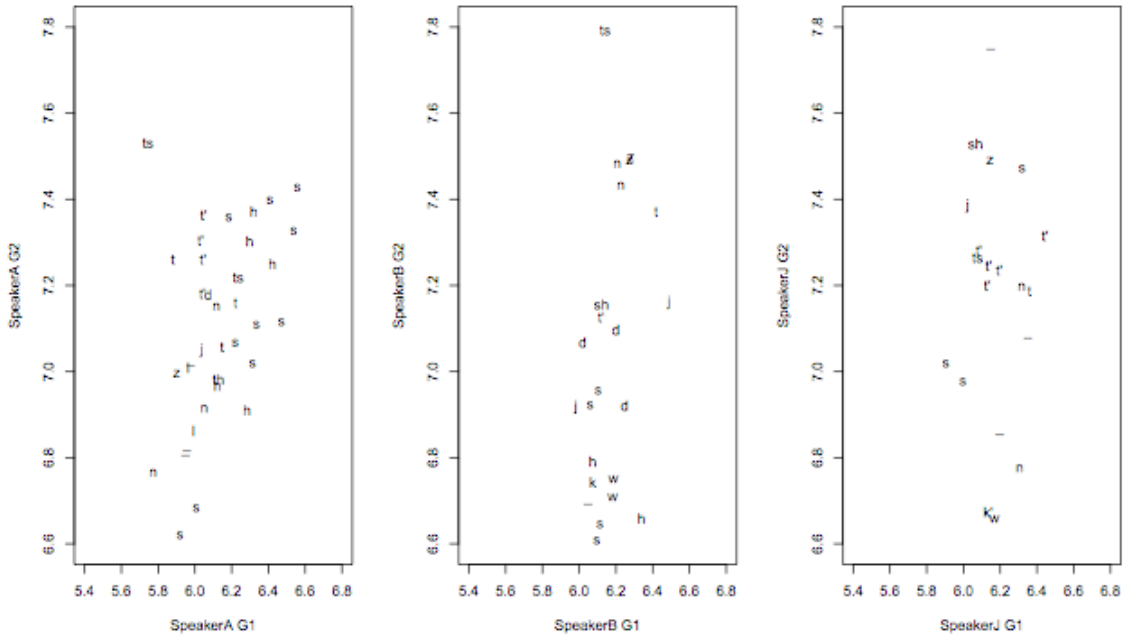

FIGURE 15 – (G1, G2) for /u/, labeled by following consonant, grouped by speaker

Just by looking at the plots, there does not seem to be any correlation with the following consonant for every vowel. Vowels, then, seem to be more coarticulated with the preceding consonant, rather than the following one. These findings are perhaps not surprising since the syllable structure of Tsuut'ina tends to be more CV, and rarely CVC (e.g. CV: /go.na.hi/ "talk" versus CVC: /buus/ "cat") as found by Rice (2000). That is to say that the super-segmental structure of the language itself is arranged so that vowels are to coarticulate with their preceding consonant. This phenomenon, then, can be viewed as more than just a correlation, but as a direct relationship to vowel space.

3.4 Duration. As discussed by Cook (1971 & 1984) and Li (1930), duration is a phonemic characteristic of the Tsuut'ina vowels. The language makes use of two lengths of each vowel: a short length and a long length. While length is used to phonemically distinguish vowels, it may also phonetically alter the vowel space. The vowel tokens are then to be analyzed according to either short length (denoted as "S" on the plots) or long length (denoted as "L"), according to figures 16-19.

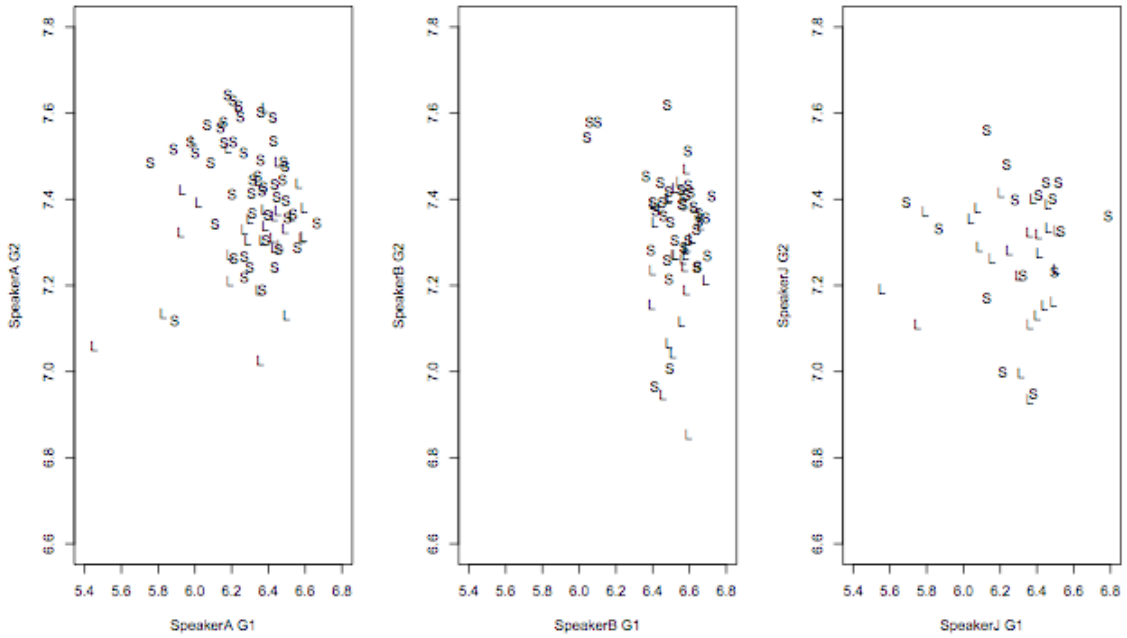

FIGURE 16 – (G1, G2) for /a/, labeled by length, grouped by speaker

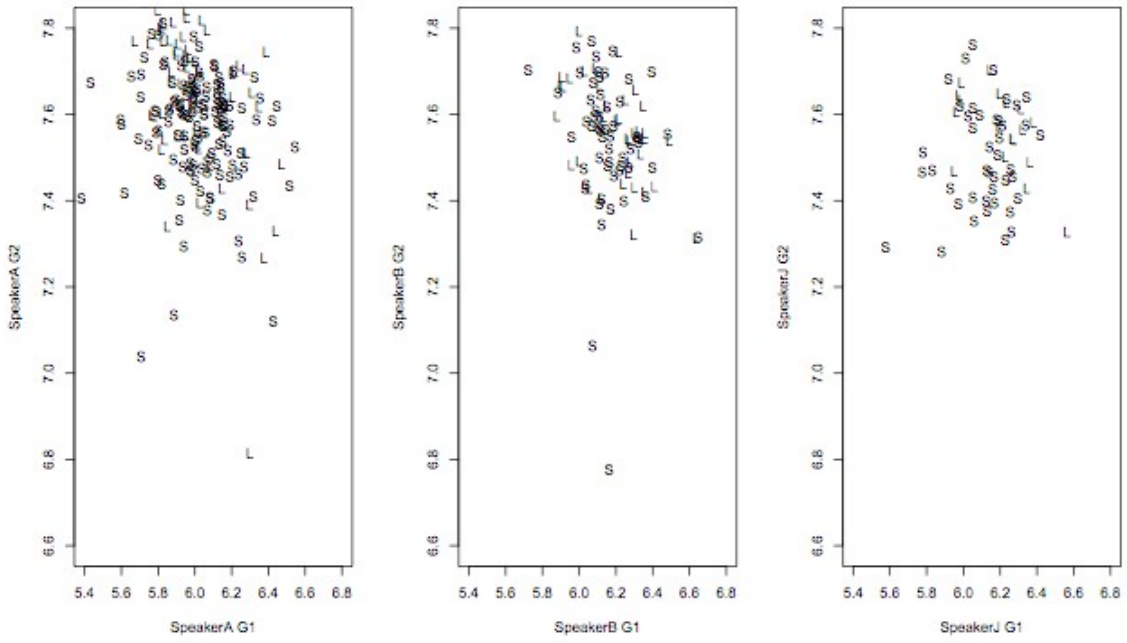

FIGURE 17 – (G1, G2) for /i/, labeled by length, grouped by speaker

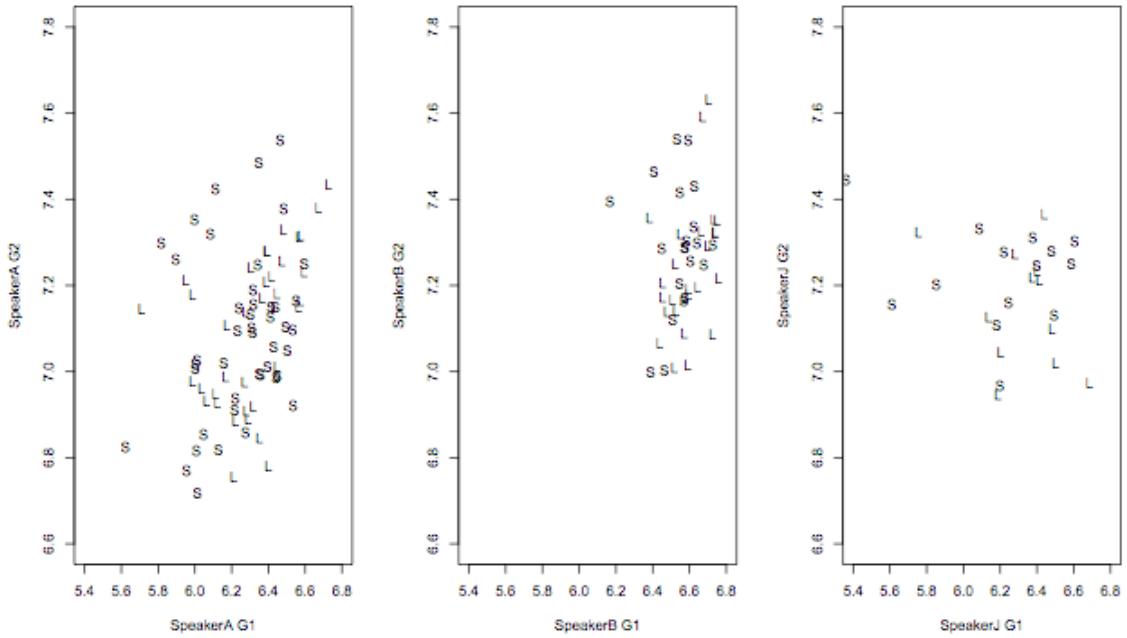

FIGURE 18 – (G1, G2) for /o/, labeled by length, grouped by speaker

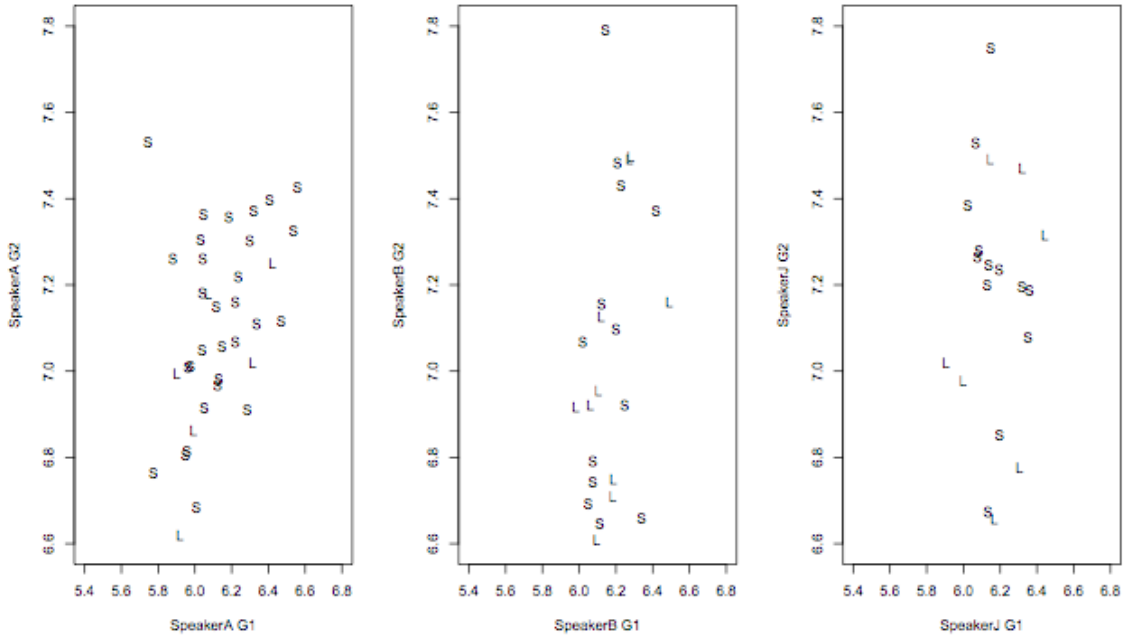

FIGURE 19 – (G1, G2) for /u/, labeled by length, grouped by speaker

It appears from the (G1, G2) plots that the only strong correlations to be made between length and vowel space are with vowels /a/ and /u/. Both vowels exhibit higher vowel spaces with short lengths, and lower vowel spaces with long lengths. The vowel /o/ also shows correlates with long vowel lengths and low vowel space, but it is not the case that short vowel lengths correlate with high vowel spaces. There are no correlations to be found with /i/ in terms of length.

3.5 Pitch. As first observed by Sapir (1925) and later expanded upon by Li (1930), Cook (1971 & 1984) and Rice (2000), the pitch of a vowel also carries phonemic meaning, making Tsuut'ina a tonal language. The number of tones that Tsuut'ina uses is debated, with distinctions placed from three (Rice 2000) to six (Cook 1971). Speakers of the language generally concur that there are three tones, or at least three tones. For the pruposes of plotting, the speakers' consensus of three tones is used and defined as high (denoted as "H"), mid (denoted as "M"), and low (denoted as "L"). The plots in figures 20-23 were then made under this assumption of the language having three tones.

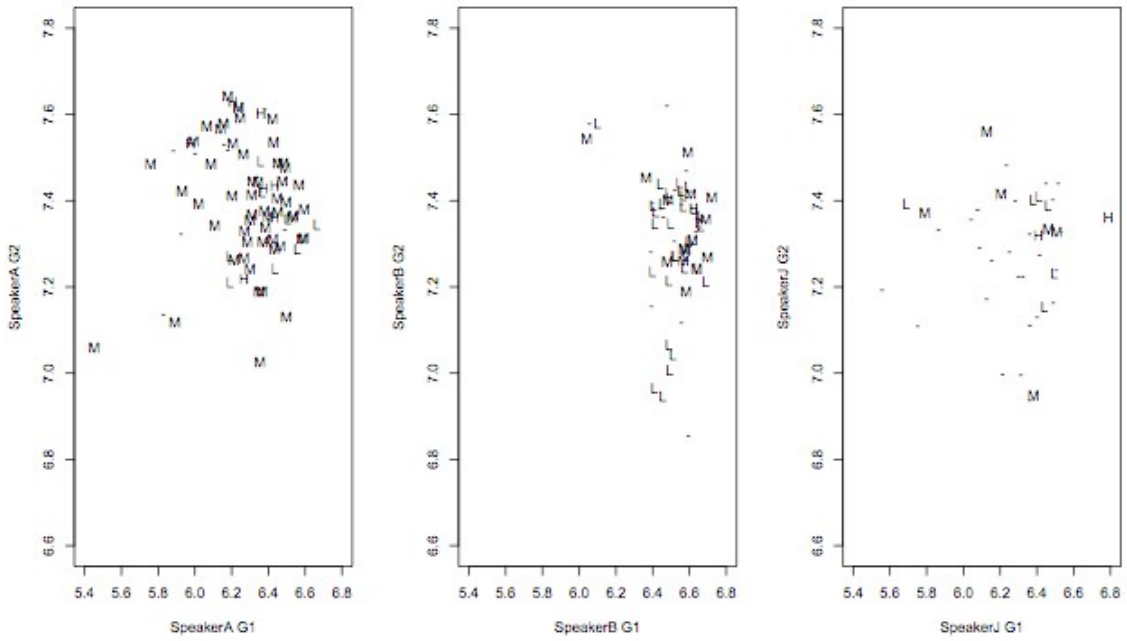

FIGURE 20 – (G1, G2) for /a/, labeled by length, grouped by speaker

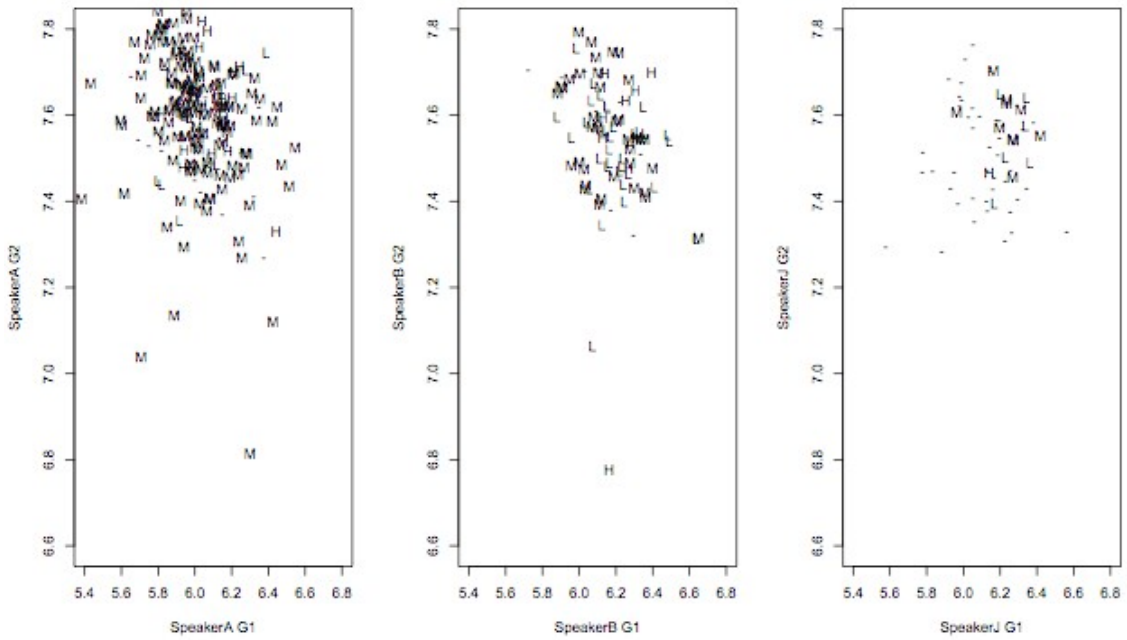

FIGURE 21 – (G1, G2) for /i/, labeled by length, grouped by speaker

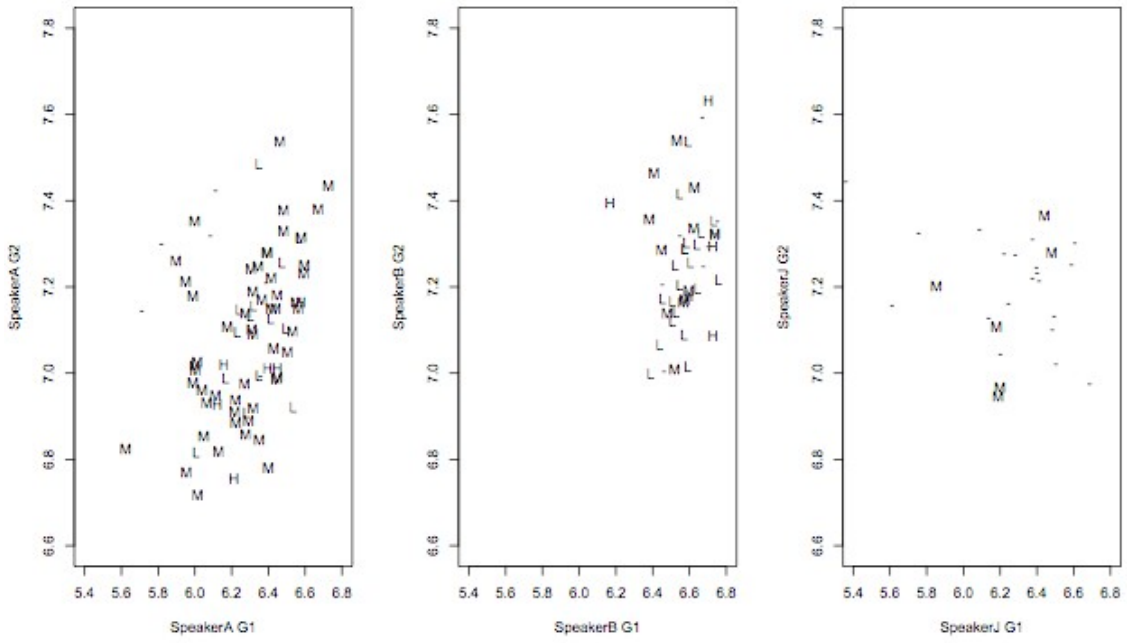

FIGURE 22 – (G1, G2) for /o/, labeled by length, grouped by speaker

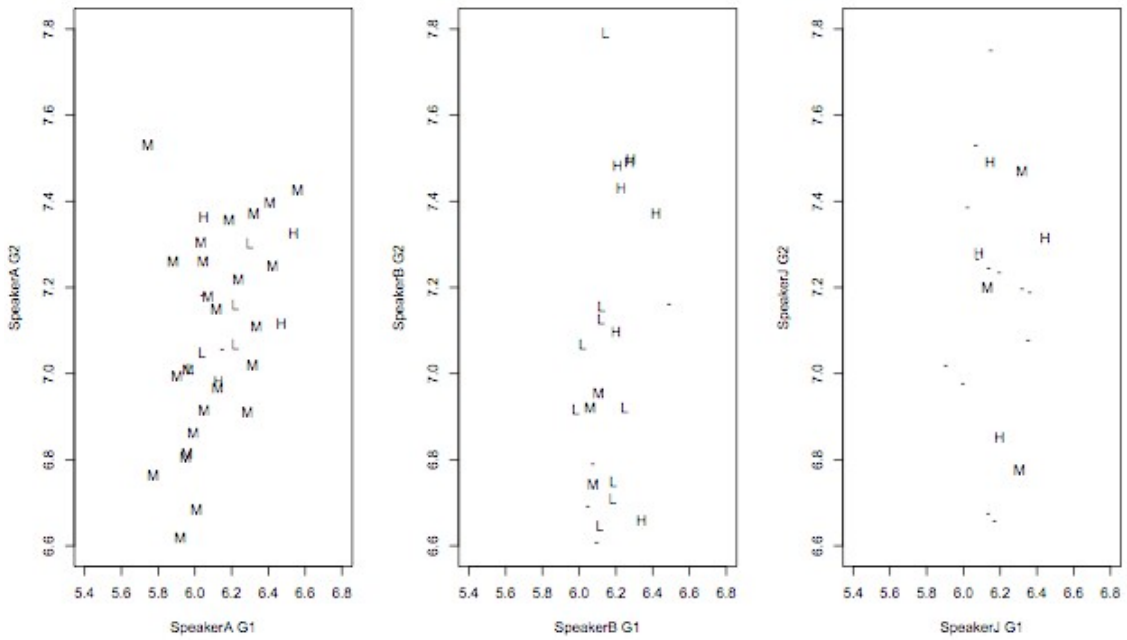

FIGURE 23 – (G1, G2) for /u/, labeled by length, grouped by speaker

Gathering from the data, it seems that Speaker A is the only speaker to exhibit any correlation with tone. For the vowels /a/ and /o/, the mid tone of Speaker A shows a more scattering of the vowels. This scattering could be interpreted as a centralization effect of pitch for Speaker A. However, no other correlations between pitch, vowels, and speakers are to be seen.

4. DISCUSSION. It is evident from (G1, G2) plotting that certain linguistic parameters play a role in defining the vowel space for the Tsuut'ina language. First, an overall vowel centralization effect is correlated with a vowel being in the final position of a word. Moreover, pitch and tone may account for the scattering effect seen in figures 1 and 2, and, perhaps, for a centralization of the low back vowels as seen in Speaker A's vowel space. It does not appear that vowel length has any correlation with vowel space, except in the isolated cases of the /u/ and /a/ vowels, where a short length correlates with frontness and a long length correlates with backness. However, it seems that the greatest contributor to where a vowel is articulated is the coloring of the preceding consonant. Vowel space can then be said to be heavily influenced by the coarticulation of with its phonetic environment. The language's over all prosody seen in the syllabic structure of words supports this notion as importance is placed on the onset with few words having a rhyme.

Returning to the issue of wholly defining the Tsuut'ina vowel space, there is not enough evidence to support the notion of the language having four distinct vowels. All of the vowel tokens can be accounted for with the hypothesis that three vowels undergo phonetic alterations along the parameters discussed above. The three vowels can be phonemically distinguished as high front /i/, high back /u/, and low /a/. This is especially evident when taking into account coarticulation with the previous consonant. It is hypothesized that the low vowel is produced as [o] when it occurs after back consonants, and produced as [a] otherwise. Vowel length, too, is

also hypothesized to play a role in what is produced as a low front vowel. Here it can be said that the low vowel is produced as [o] with it is of long length, and as [a] otherwise. What was previously thought of as separate phonemes /a/ and /o/, is now proposed to instead be allophones of a single low vowel phoneme, /a/.

As Tsuut'ina currently has roughly 40 speakers, all of whom are over the age of 60, the language is well primed to follow the path of extinction, giving into to the dominate language, English. It is perhaps the case, then, that Tsuut'ina at one time had four distinct vowels and, as the language began to die out and attrition set in, the lower two vowels combined into one single vowel. Each speaker's plot as seen in figure 2 contains evidence of such a shift. While remnants of four vowels can be seen in Speaker B's plots, Speaker A shows signs of separate vowel spaces combining into larger spaces. Speaker J's vowel space plot is perhaps an extreme case of this sort of vowel shifting, where not only have /o/ and /a/ combined, they have progressed to combining with /i/ and /u/ so that the only vowel distinction left is between front and back. It could be that speakers of Tsuut'ina are in the process of shifting towards not placing as much importance on vowel distinctions. Other phonemic characteristics such as length, pitch, and consonants may make up the bulk of Tsuut'ina and be enough for the language.

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