

Data Visualization on Madarin Vowels

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Author Note

Steffi and Jun are the owner of the dataset. They have the correct permissions to make the dataset public.

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Abstract

Several studies have examined consonant-vowel boundaries in sentences and concluded that vowels contribute more than consonants to sentence intelligibility. Since Mandarin has a greater proportion of vowels than consonants, 35 vowels and 21 consonants, vowels indeed play an important role for phonemic contrasts. This study examines six female native speakers and six female non-native speakers' vowel production in Mandarin. The native speakers' vowel space is compared with each other and the Standard Chinese vowel chart to explore similar patterns. Also, the non-native speakers' vowel space is compared with the native speakers' vowel space and the Standard Chinese vowel chart to examine native-like or non-native-like patterns.

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Introduction

It is generally agreed that Mandarin Chinese has a five-vowel system (see Hinton, Nichols, & Ohala, 2006). These five vowels are [i], [y], [u], [ə] and [a]. Among these vowels, the mid vowel has four allophones: [e], [o], [ə] and [ɤ]; and the low vowel has two allophones: [a] and [ɑ]. However, little attention has been paid to the individual variances when producing these nine vowels. Few researchers did empirical studies to examine Ashby and Maidment (2005) vowel space of Chinese. In order to fill these gaps, this study investigates the vowel distribution of native Chinese speakers, aiming to determine whether native Chinese speakers show similar patterns when producing Chinese vowels and whether their patterns look similar to Roach's (2004) proposal of Chinese vowel chart. In addition, this current work examines the vowel distribution of American English learners of Chinese, with the purpose of finding out whether non-native speakers perform similarly to native speakers in the vowel production.

Methods

Participants

Six female native (L1) Mandarin speakers and six female non-native (L2) Mandarin speakers participated in the study. The mean age of the L1 Mandarin speakers is 22.33 (range: 23-30) and that of the L2 Mandarin speakers is 26.33 (range: 18-28). Among L1 Mandarin speakers, two speakers are from northern Mainland China (Beijing and Tianjin), three speakers were from southern Mainland China (Nanjing, Chengdu and Chongqing), and one speaker was from Taiwan. The Taiwanese participant identified Mandarin as her most fluent language. All the six L2 Mandarin speakers' native language was American English. They were all novice-low learners who enrolled in first-year accelerated Chinese language course at the same university. They had learned Mandarin for six months and none of them had any study-abroad experience.

Speech materials

We prepared nine Chinese sentences for speech materials. Each sentence includes one of the following nine vowels: [i], [y], [u], [e], [o], [ə], [ɤ], [a], [ɑ]. Each vowel appears after the aspirated bilabial stop [p] with a high tone (55).

Procedure

Productions were elicited in a sentence-repetition oral task. Non-native speakers (NNS) and native Chinese speakers (NS) were asked to read the sentences twice. All participants read the speech materials for practice once before recording. Recordings were made in a quiet study room in the library using Praat Sound Recorder with 44,100 Hz sampling frequency, and then these recordings were saved as wav files on a laptop. Formant 1 (F1) and Formant 2 (F2) were measured in the vowel mid-point for each vowel shown in the spectrogram. All measurement was conducted using Praat program on the same laptop. After the measurement, the mean F1 and F2 values were plotted in charts using the program R to generate vowel distribution for each speaker.

Results and discussion

Native speaker patterns

Table 1 shows the mean F1 and F2 values of nine Chinese vowels for native speakers. Regarding F2 values, data shows that [i] had the highest F2 values for all native speakers, and [u] had the lowest F2 values for NS2 and NS3, but not for NS1. As for F1 values, three NS also had different lowest and highest values. While [i] had the lowest F1 value and [ɑ] had the highest F1 value for NS1 and NS3, NS2's [y] had the lowest F1 value and her [a] had the highest F1 value.

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Clearer vowel distribution for each native speaker can be seen in the formant plots

(Figure 1-3). According to the “vowel dispersion principle”, the vowel quadrilateral can be viewed as “a perceptual space in which vowels are located in the oral cavity” (Ashby and Maidment, 2005). In this study, the vowel quadrilateral is shown as formant plots where the Y-axis is F1 (Hz) that corresponds to the height of the tongue position; while the X-axis is F2 (Hz) that indicates the backness of the tongue position for each vowel (Figure 1-3).

Second language examination

Conclusion

References

- Ashby, M., & Maidment, J. (2005). *Introducing phonetic science*. Cambridge University Press.
- Hinton, L., Nichols, J., & Ohala, J. J. (2006). *Sound symbolism*. Cambridge University Press.
- Roach, P. (2004). British english: Received pronunciation. *Journal of the International Phonetic Association*, 34(2), 239–245.

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Table 1

Formant by vowels among non-native and native groups

group	vowel	F1_mean	F2_mean	F1_sd	F2_sd
NNS	a	913.33	1513.83	47.14	161.28
NNS		901.50	1377.00	63.86	107.69
NNS	e	520.67	2320.00	65.50	95.07
NNS	ə	651.33	1980.00	88.59	166.70
NNS		640.33	1702.33	70.43	238.62
NNS	i	335.67	2646.50	46.03	100.61
NNS	o	551.50	1043.67	49.79	61.90
NNS	u	416.00	1122.83	69.62	196.96
NNS	y	321.50	1806.83	31.25	186.00
NS	a	910.33	1655.50	115.38	142.20
NS		848.00	1305.17	59.50	147.96
NS	e	556.83	2486.50	38.02	128.39
NS	ə	717.67	1850.50	40.10	101.96
NS		596.83	1289.67	105.92	152.62
NS	i	308.33	2916.17	30.23	73.78
NS	o	554.50	908.67	48.53	76.63
NS	u	335.00	840.00	15.63	56.02
NS	y	309.17	2420.83	15.17	237.25

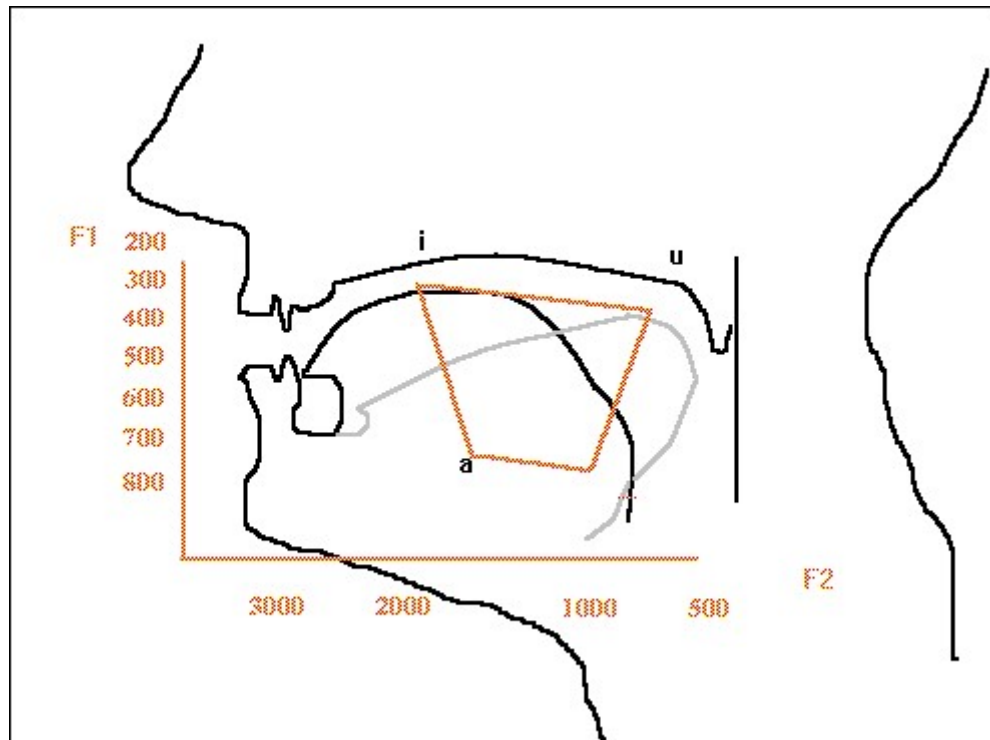


Figure 1. vocal tract

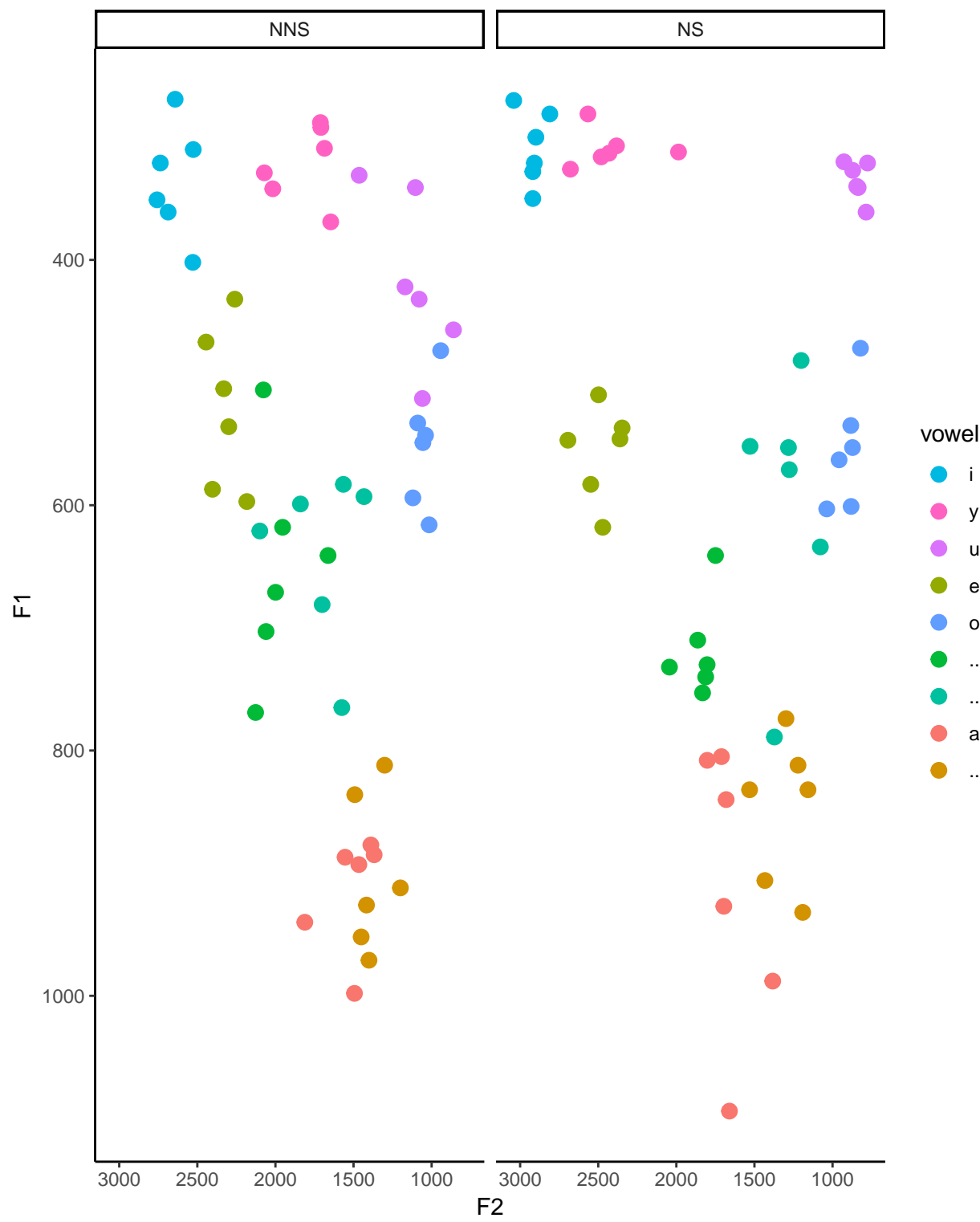
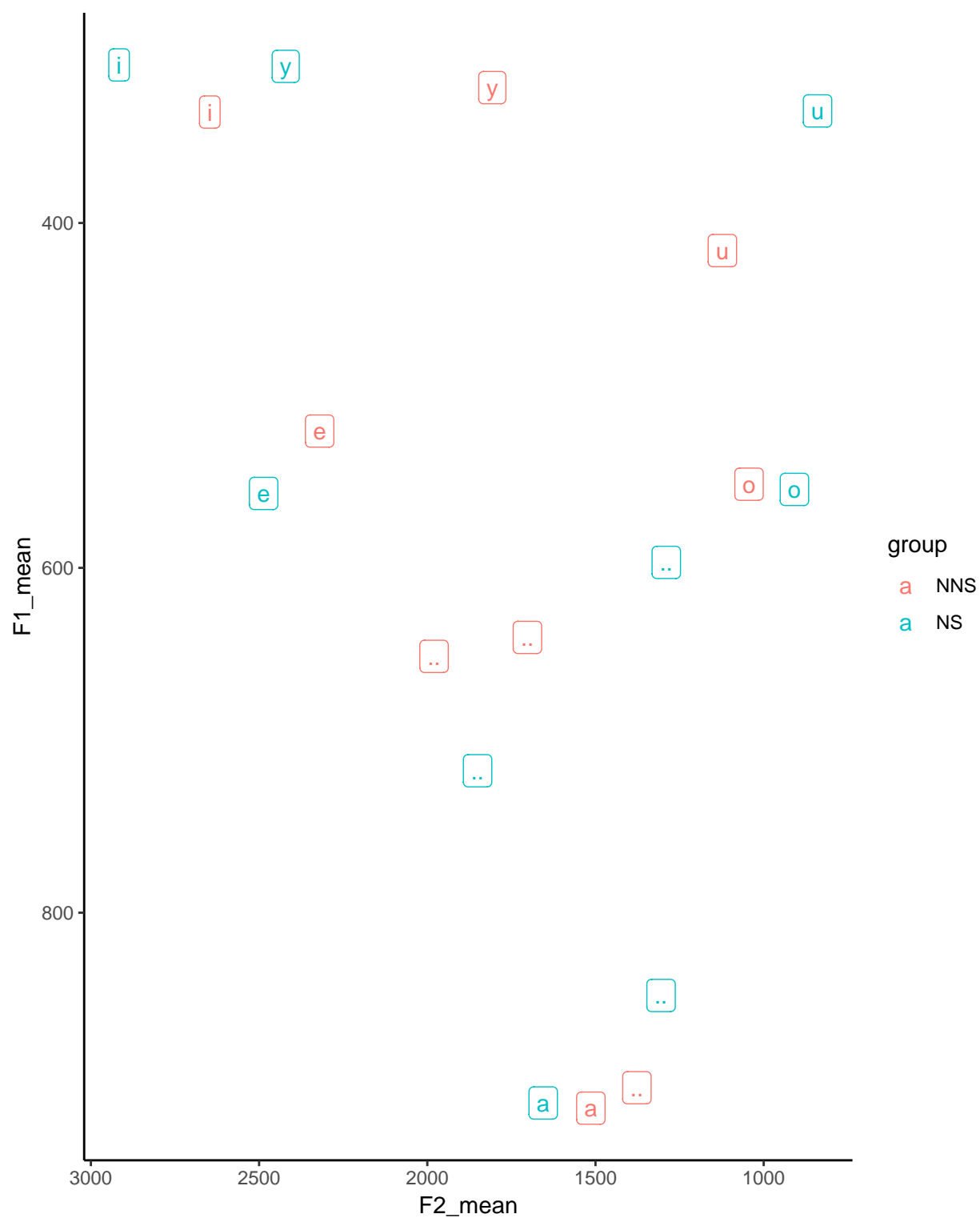


Figure 2

*Figure 3*

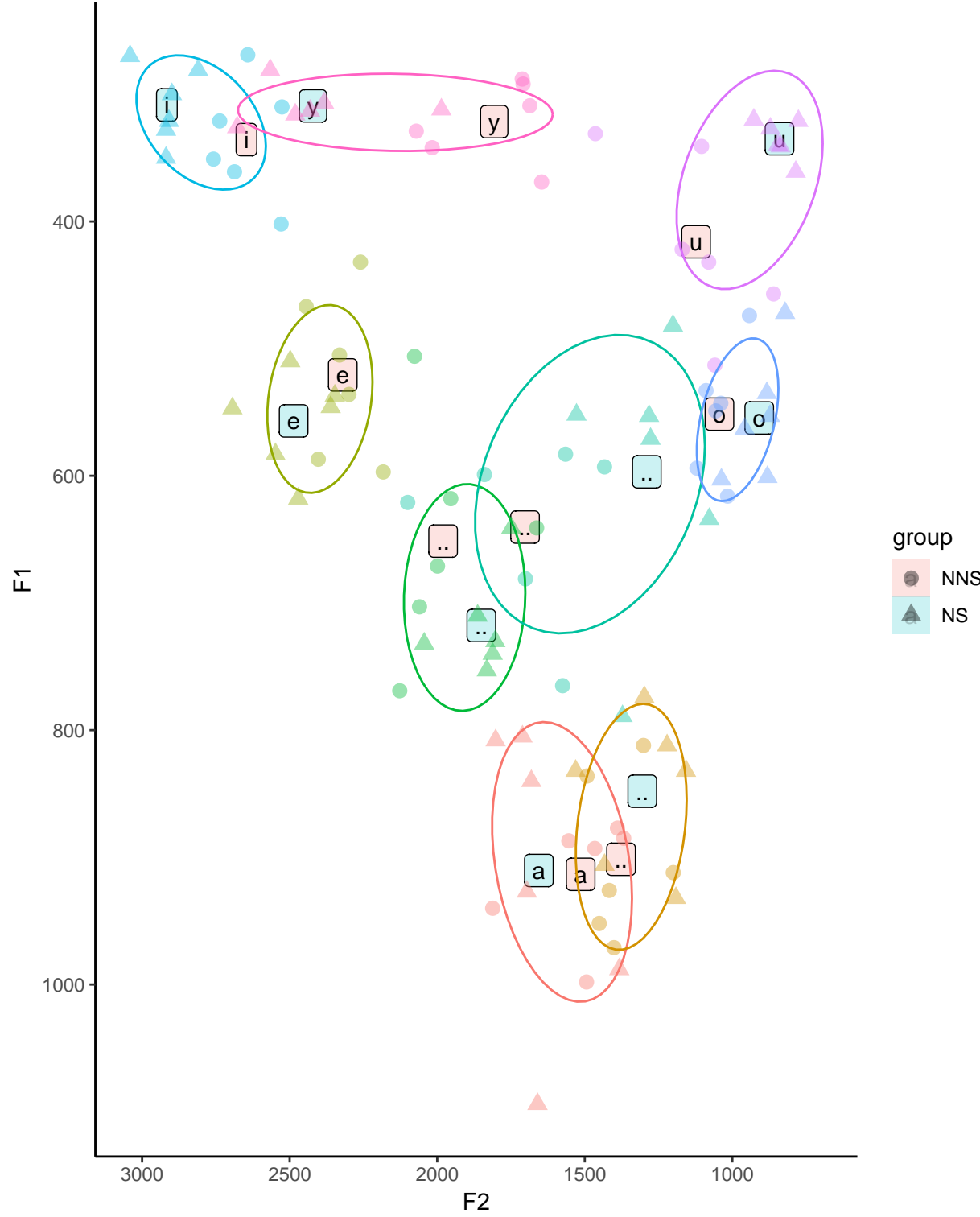


Figure 4