Data Visdualization 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.

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" (see Ashby &

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

The vowel productions are different in NS and NNS groups (Table 1). In terms of F1, the height of the tongue placement, NNS typically produce a higher F1 than NS, i.e. [a], [e], [u], with the exception of [ə], where NNS's F1 is lower. This suggests that NNS have a tendency to place the tongue at a higher position during the vowel production than NS. Variations in the F2 production, the backness of the tongue, are also evident between NS and NNS. In general, NNS exhibit a higher F2 in [e], [o], [u] than NS except for [y]. The differences indicate that NNS, when producing vowels, exhibit a more backward lingual placement than NS. It is clear that second language learners of Manradin present with a English-colored vowel production when compared to the native speakers.

Conclusion

The present study examined vowel distributions of native speakers of Mandarin as well as non-native speakers of Mandarin. We were interested to understand vowel distributions among NS as well as between NS and NNS. From the current dataset, we conclude that there are individual NS variations in the vowel production. The differences are also evident between NS and NNS speakers. This project is significant for clinical applications. Learners of Mandarin can use F1 and F2 values as biofeedback for their accent modifications. Future work can include a larger sample size in the analysis for better generalization of results.

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.

Table 1

Formant by volwels among non-native and native groups

Mean	group	a		e	ə		i	o	u	y
F1	NNS	913.33	901.50	520.67	651.33	640.33	335.67	551.50	416.00	321.50
F1	NS	910.33	848.00	556.83	717.67	596.83	308.33	554.50	335.00	309.17
F2	NNS	1513.83	1377.00	2320.00	1980.00	1702.33	2646.50	1043.67	1122.83	1806.83
F2	NS	1655.50	1305.17	2486.50	1850.50	1289.67	2916.17	908.67	840.00	2420.83

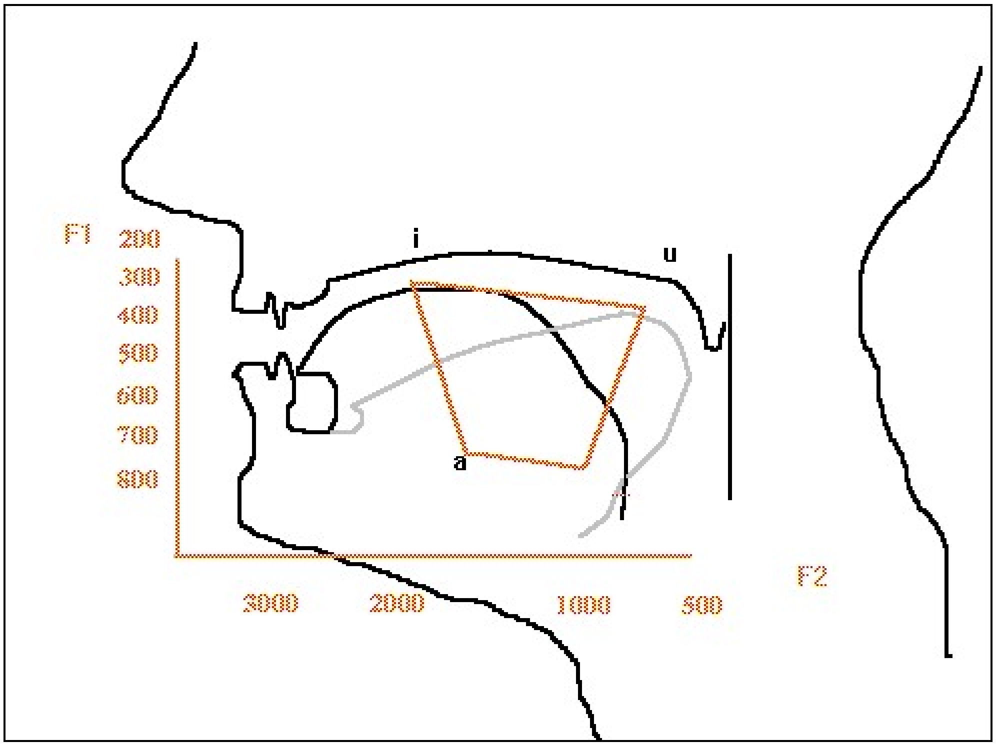

Figure 1. vocal tract

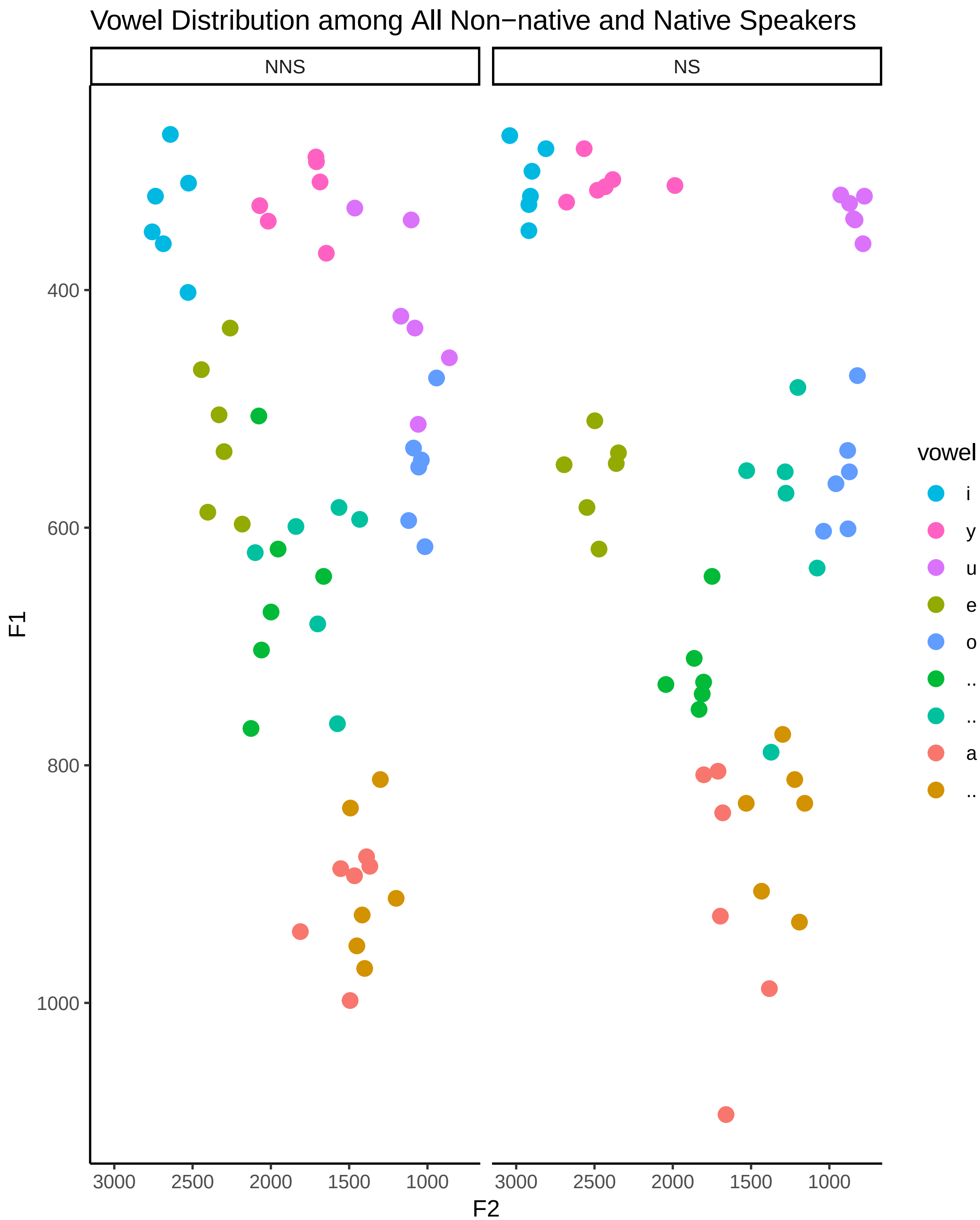
Vowel Distribution among All Non−native and Native Speakers
NNS
NS
F1
400
600
800
1000
F2
3000
2500
2000
1500
1000
vowel
i
y
u
e
o
..
..
a
..

Figure 2

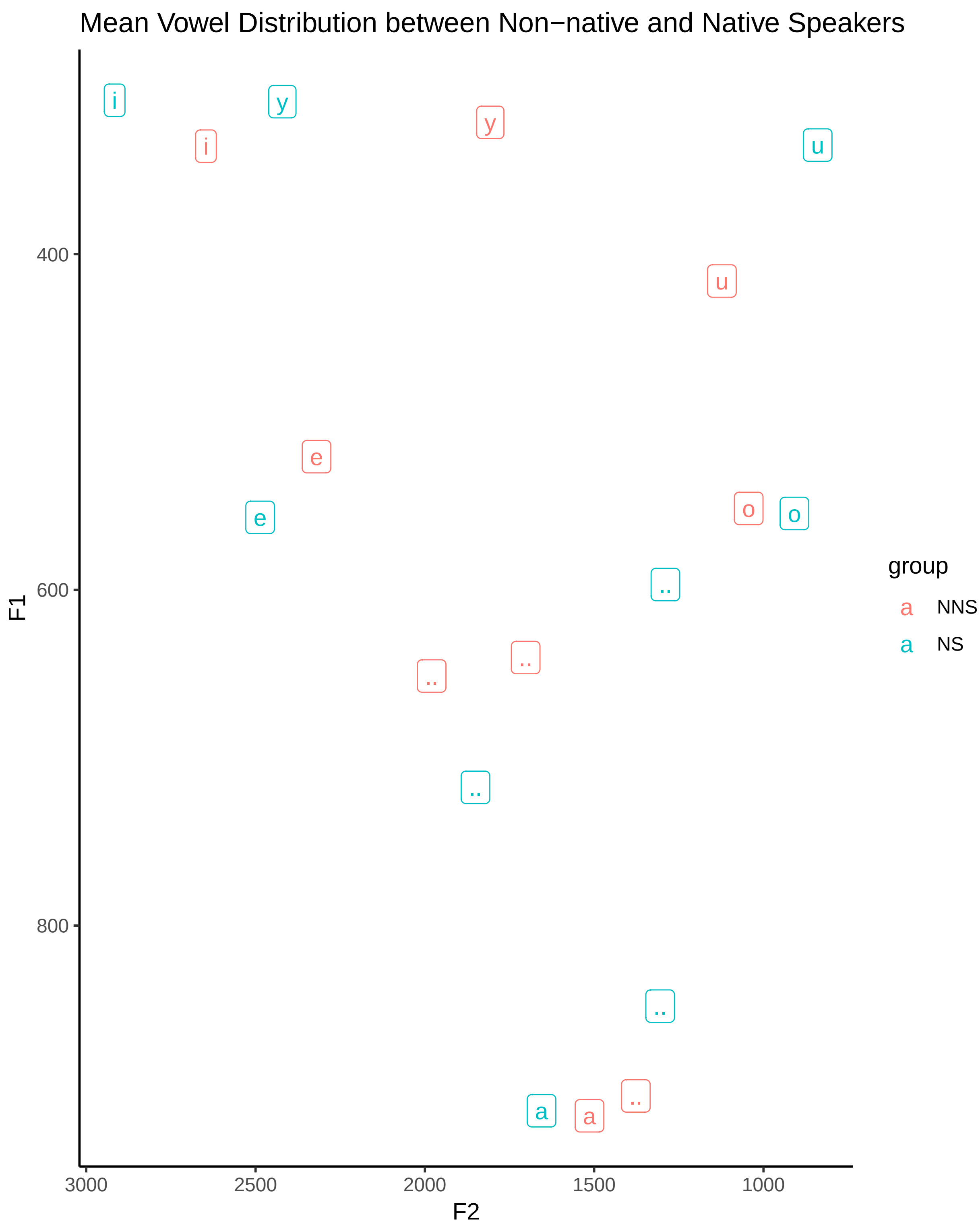
Mean Vowel Distribution between Non−native and Native Speakers
F1
F2
400
600
800
3000
2500
2000
1500
1000
group
a NNS
a NS
i
y
u
e
o
a
..

Figure 3

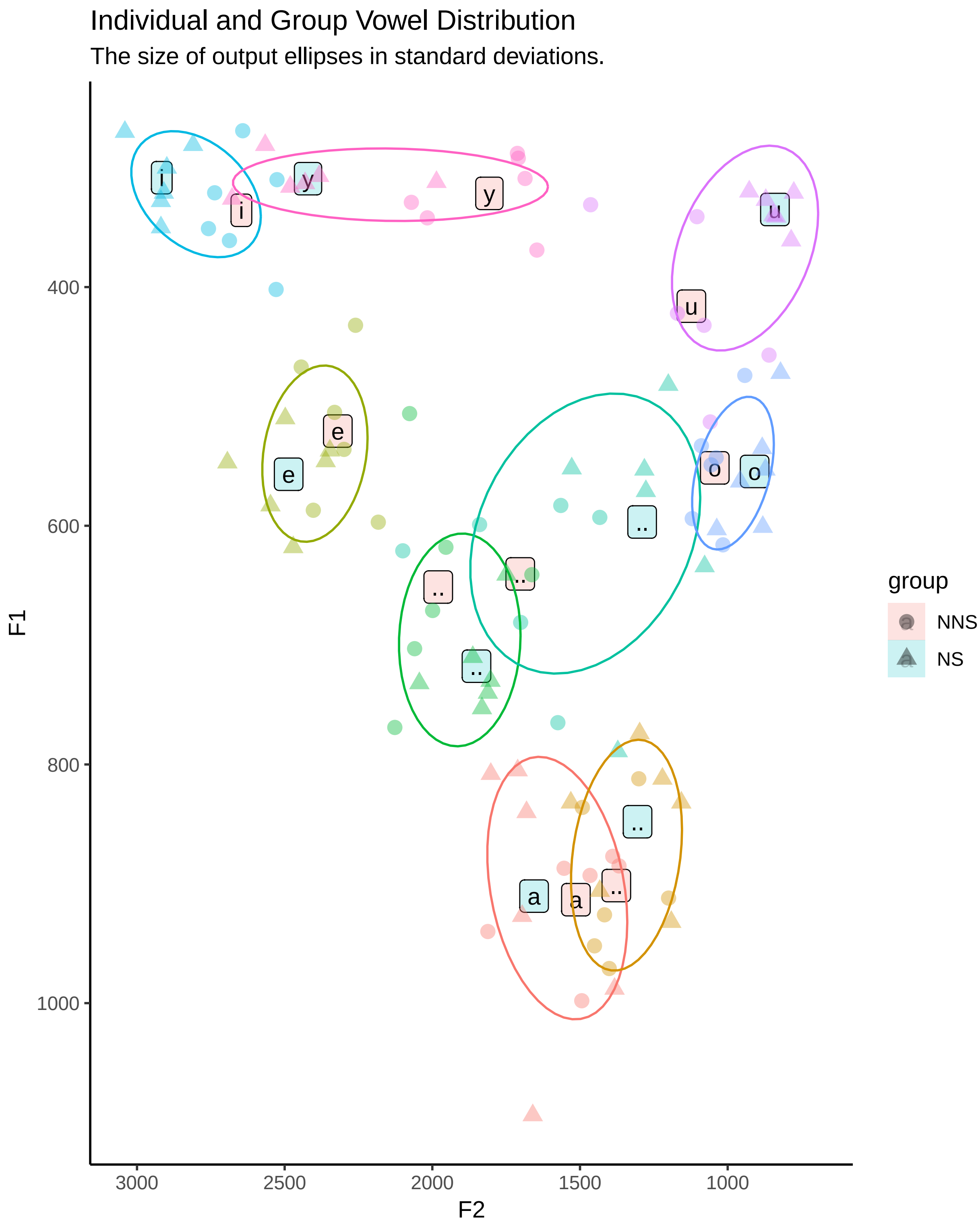
Individual and Group Vowel Distribution
The size of output ellipses in standard deviations.
F1
F2
400
600
800
1000
3000
2500
2000
1500
1000
group
NNS
NS
i
i
y
y
u
u
e
e
o
o
a
a

Figure 4

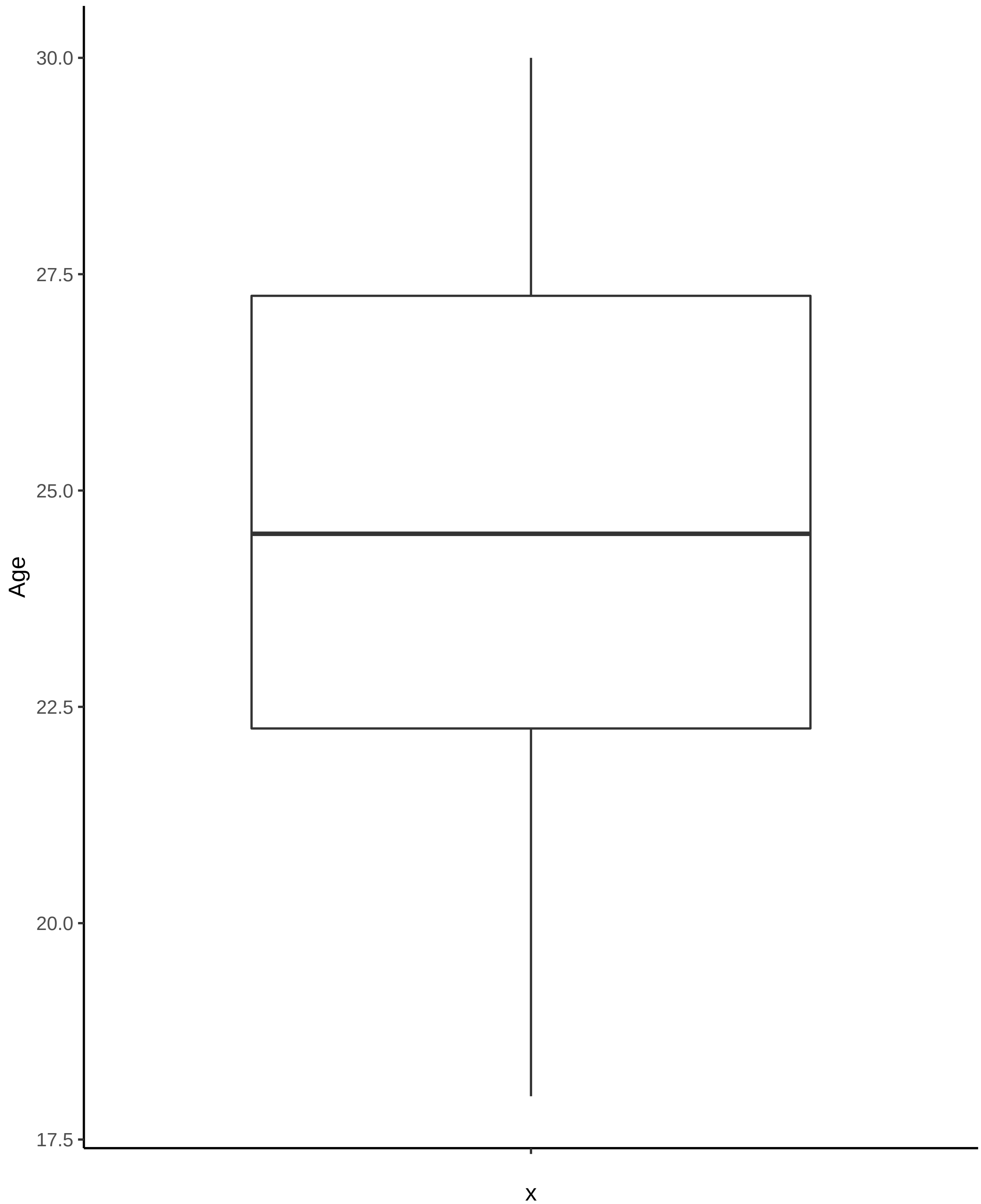

Figure 5

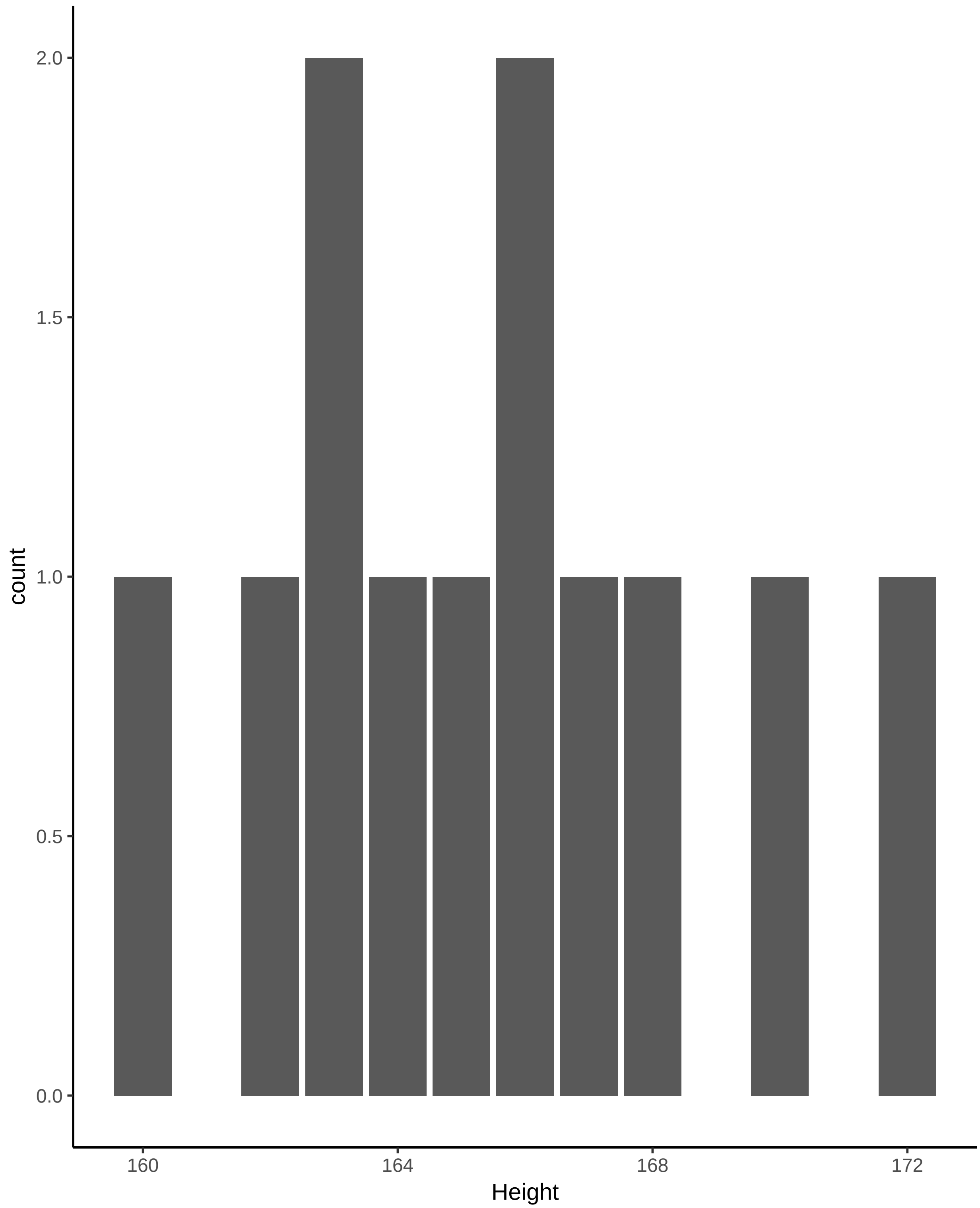

Figure 6