

AN ACOUSTIC ANALYSIS OF THE VOWELS IN FUZHOU CHINESE

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ABSTRACT

This study is an acoustic description of the vowels in Fuzhou Chinese produced by 10 speakers (5 males and 5 females) in their thirties. The vowels include 8 monophthongs /i y e ø a ɔ o u/, 14 diphthongs /iu ui ei eu ai au ou øy ɔy ie ia yo uo ua/, and 1 triphthong /uai/ in open syllable. Compared with existing studies, this study finds (i) that sometimes /e/ is diphthongized; (ii) that diphthong /yo/ may undergo change to become [ɣ]; (iii) that diphthong /ɔy/ seems to have merged with /uai/ and /øy/ in open syllable, and /eu/ also shows a tendency to merge with /iu/; (iv) that the acoustic realization of diphthong /ou/ can be [əu], [ɒu] and [ɔu] but not [ou], and diphthong /ie/ is [iɪ]. Further studies are required to corroborate the potential sound changes.

Keywords: Fuzhou Chinese, vowels, acoustic realization

1. INTRODUCTION

Fuzhou, located in the southeast of China, is the capital of Fujian province. This study investigates the Chinese variety spoken in the urban area of Fuzhou.

Fuzhou Chinese is known for its tone-dependent vowel alternation. For example, /i/ always occurs with tones /44/, /51/, /32/ or /4/¹ (Type 1 tones), while /ei/ is always with tones /21/, /131/, or /13/ (Type 2 tones), such as in a compound ‘字簿’ (‘exercise book’) pronounced as /tsi⁵³ βuo¹³¹/. But when the word ‘字’ (‘word’) is produced without tone sandhi (e.g. in isolation), it is pronounced as /tsei¹³¹/. Other vowel alternations include /y/ - /øy/, /u/ - /ou/, /o/ - /ɔ/, /øy/ - /ɔy/ and so on. The latter (diphthongal or lower) will become the former (monophthongal or higher) during tone sandhi.

In Fuzhou Chinese, there are 8 monophthongs /i y e ø a ɔ o u/, 14 diphthongs /iu ui ei eu ai au ou øy ɔy ie ia yo uo ua/, and 1 triphthong /uai/ in open syllable ((C)V syllable) and one more diphthong /ɔu/ only in the syllable ended with glottal stop /ʔ/ and nasal /ŋ/ ((C)VS and (C)VN syllable). Most descriptions of the vowels in Fuzhou Chinese is impressionistic (e.g. [4], [5], [7]) and [6] contains an

acoustic analysis based on speech samples from speakers (20 speakers for monophthongs and 10 for diphthongs and triphthong) in their fifties in 2011. At present, no published article is found for the vowels of the younger generation, but some vowel changes are expected.

This study aims at reinvestigating the vowels in Fuzhou Chinese of speakers aged 30-39, younger than those in [6].

2. METHODOLOGY

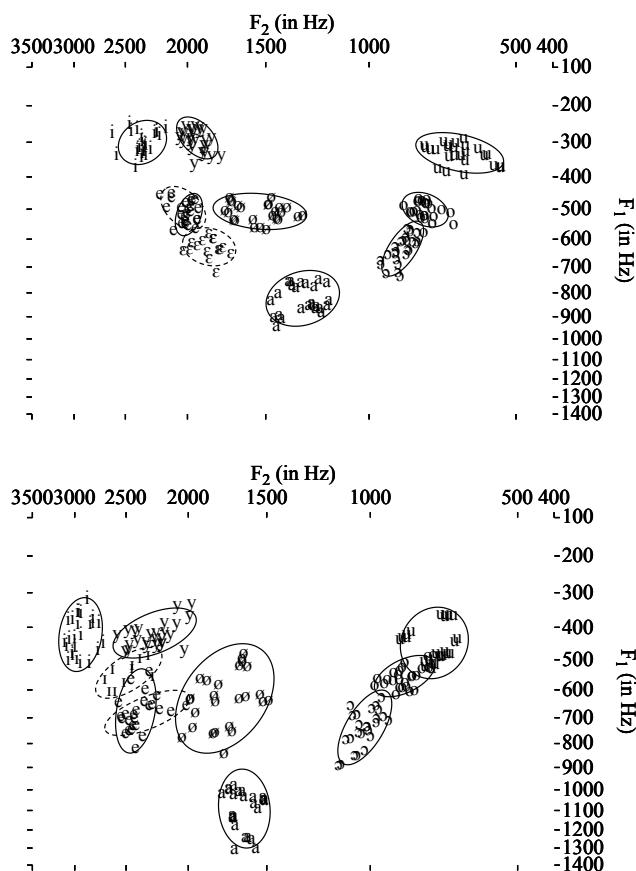
All test words are (C)V and (C)VS syllables, frequently used in daily life². For each diphthong and triphthong, two syllables associated with two types of tones are used in order to investigate possible vowel alternation. But due to space limit, only results of the vowels in open syllables and /iu ui ai au uai/ associated with two types of tones are presented. 10 native speakers of Fuzhou Chinese (5 males and 5 females in their thirties) without reported speech and hearing difficulties participated in the recordings. They were instructed to read the word list at normal speech rate for 5 repetitions. The words were randomized and produced in isolation. Praat [1] was used to obtain measurements of first three formant frequencies (F₁, F₂ and F₃) which were sampled at one point of the steady formant trajectories of the monophthongs as well as the elements of the diphthongs and triphthong. Thus, each vowel is characterized by one set of formant frequency data, but the F₃ values are not presented here. Some samples are excluded, due to unnatural speech, mispronunciation, or no reliable measurement obtained.

3. RESULTS AND DISCUSSION

Vowel ellipses are plotted in Bark-scaled F₁/F₂ planes with F₁ on the ordinate, F₂ on the abscissa and the origin at the right top corner. Data points are represented by small IPA symbols. For elements in diphthongs and triphthong, such as in /iu/, the first is symbolized as /i^u/ and the second /i^u/u/. Ellipses of the diphthongs and triphthong (in thick lines) are superimposed on the planes of the monophthongs (in thin lines).

3.1. Monophthongs

Figure 1: Ellipses of the 8 monophthongs /i y e ø a ɔ o u/ of males and females.



Most vowel ellipses occupy distinct positions, except that there are slight overlaps between /o/ and /ɔ/ of two groups of speakers as well as /o/ and /u/ of females. Generally speaking, four vowel heights can be identified, namely high /i y u/, mid-high /e ø o/, mid-low /ɔ/ and low /a/. Regarding backness, /i y e ø/ are front vowels, /a/ is a central vowel and /ɔ o u/ are back vowels. And /ø/ can also be a central vowel. Lip rounding contrasts in front vowels but not in the central vowel and back vowels. Some speakers produced a diphthongized /e/ (in test word 鞋 ‘shoe’ /e⁵¹/) as indicated by dashed lines. This may result from speakers’ attempt to produce the high falling tone and needs further investigation. According to their relative positions, they are transcribed as [ɛɛ] for males and [eɪ] for females, but it does not indicate a general gender difference.

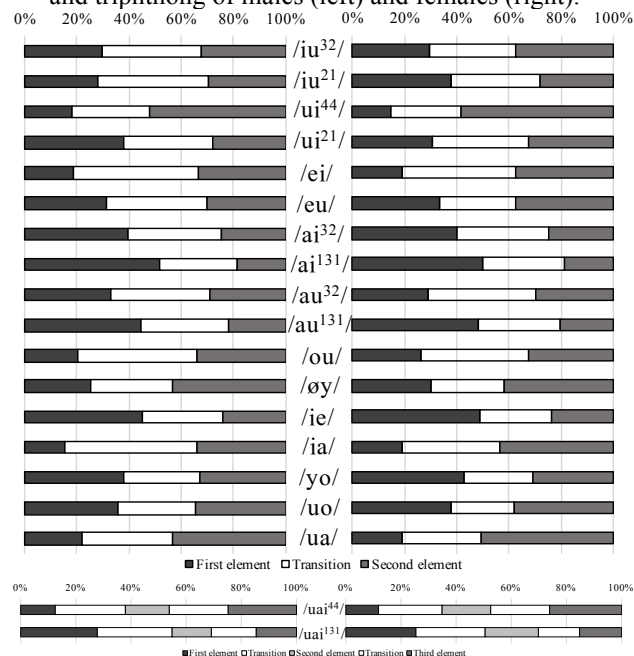
3.2. Diphthongs and Triphthong

3.2.1. Temporal structures

In [6], /iu/ is associated with tones /44/ and /131/, and /i^u/ accounts for around 20% and 40% respectively. But this contrast is less noticeable in current study.

This may result from different tones or a change in terms of temporal structure. Tonal effects on durations are conspicuous in /ui ai au uai/. For /uai/, the duration of /^uaⁱ/ is rather steady but the first and last elements are lengthened or shortened as the tone changes, same to the elements in /ai au/.

Figure 2: Temporal structures of the diphthongs and triphthong of males (left) and females (right).



3.2.2. Formant patterns

For diphthongs /iu/ and /ui/ (Figure 3-5), generally there is only slight or no overlap between the elements and vowels /i/ and /u/, except female /uⁱ/.

Figure 3: Ellipses of /iu³²/ (top) and /iu²¹/ (bottom) of males (left) and females (right).

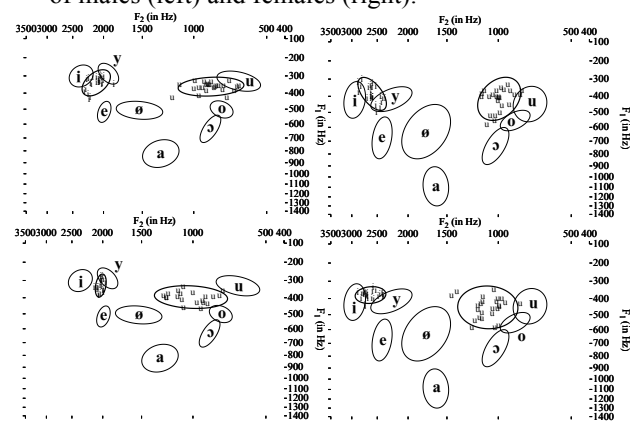


Figure 4: Ellipses of /ui⁴⁴/ of males (left) and females (right).

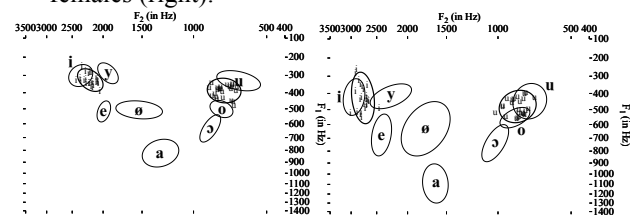
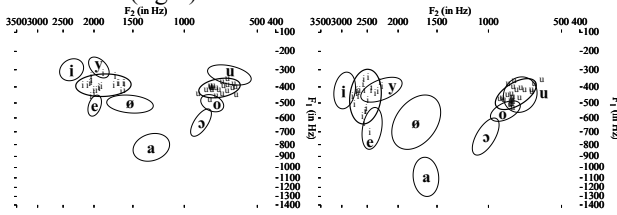
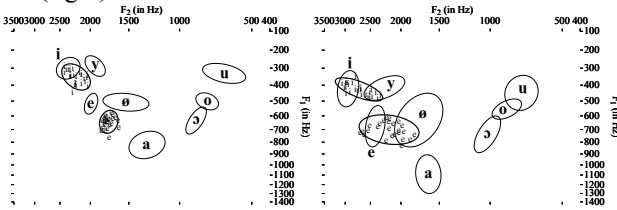


Figure 5: Ellipses of /ui²¹/ of males (left) and females (right).



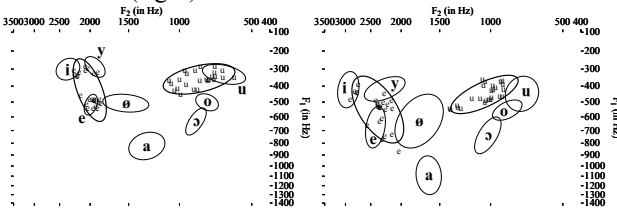
As shown in Figure 6, male /e⁻ⁱ/ is lower than the vowel /e/ without overlap. But for females, many data points of /e⁻ⁱ/ are at the same level of /e/ and centralized.

Figure 6: Ellipses of /ei/ of males (left) and females (right).



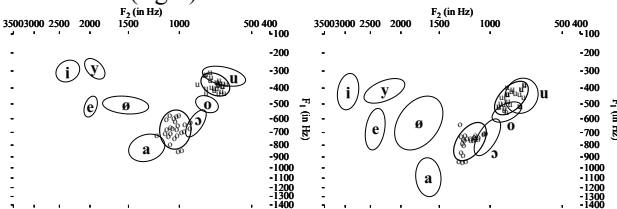
Some speakers produced /eu/ as [iu] (Figure 7). This may imply a tendency to merge these two diphthongs.

Figure 7: Ellipses of /eu/ of males (left) and females (right).



Although it is transcribed as /ou/ in impressionistic studies (e.g. [4], [5], [7]), the first element (in Figure 8) is centralized and lower than /o/. The acoustic realization of this diphthong can be [eu], [pu] and [ou], but not [ou].

Figure 8: Ellipses of /ou/ of males (left) and females (right).



As shown in Figure 9-11, when /ai/, /au/ and /uai/ are produced with tone /131/, the last elements show large variation. But when these vowels are produced with tone /32/ or /44/, the last elements are generally located around vowel /i/ and /e/ (for /^a-i/ and /^{ua}-i/) and /o/ (for /^a-u/). Also, it can be observed that the triphthong is usually starts from /o/, though it is transcribed as /uai/.

Figure 9: Ellipses of /ai³²/ (top) and /ai¹³¹/ (bottom) of males (left) and females (right).

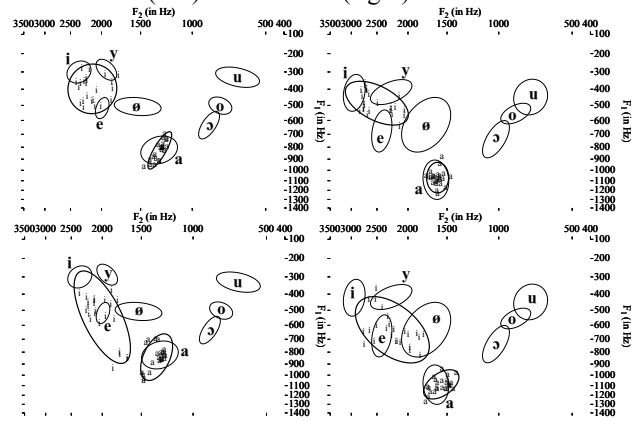


Figure 10: Ellipses of /au³²/ (top) and /au¹³¹/ (bottom) of males (left) and females (right).

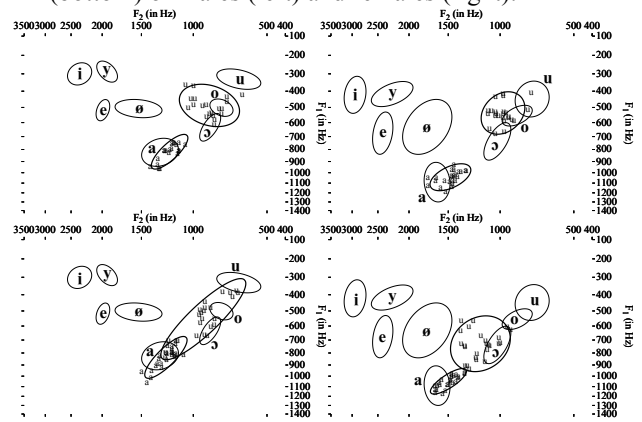
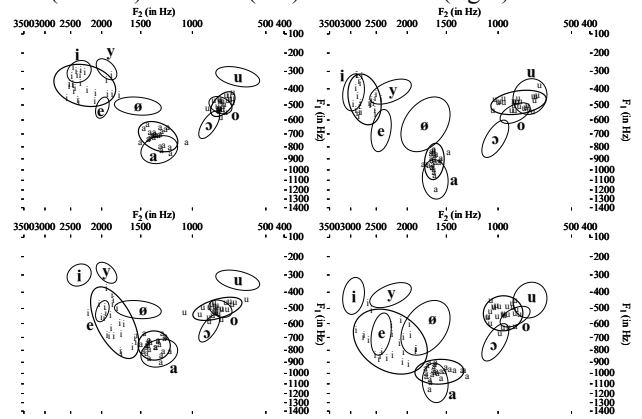


Figure 11: Ellipses of /uai⁴⁴/ (top) and /uai¹³¹/ (bottom) of males (left) and females (right).



Regarding diphthong /yo/, many data points of the two elements are located between vowels /y/ and /ø/ (Figure 12), a formant pattern inconsistent with the transcription. But in [6], such great inconsistency is not found, though we used the same test word (橋 ‘bridge’ /kyo⁵¹/). Two speakers in this study produced /yo/ as a monophthong [y] (Figure 13). This may indicate a sound change and the emergence of a new monophthong in Fuzhou Chinese. More researches are needed to corroborate it.

Figure 12: Ellipses of /yo/ of males (left) and females (right).

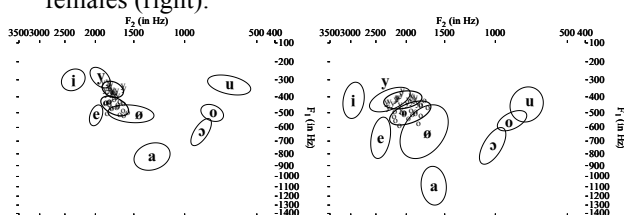
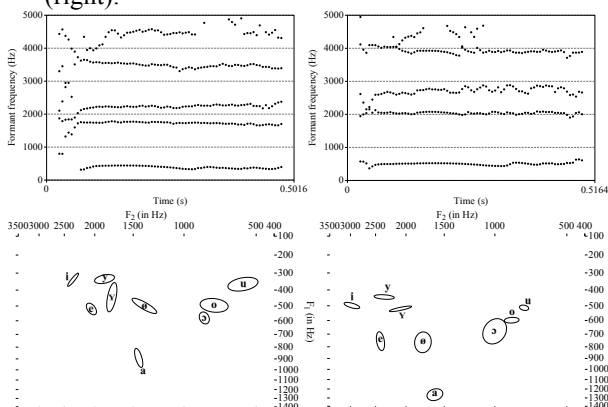
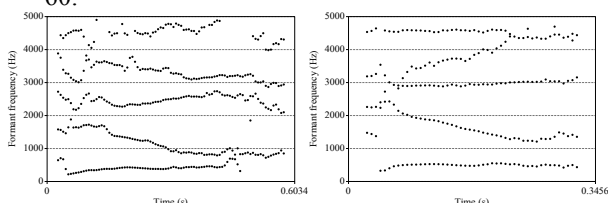


Figure 13: Formant trajectories and ellipses of /yo/ (realized as [ɣ]) of one male (left) and one female (right).



The author also recorded speeches from 6 speakers aged above 60 (their data not included in this study) and did not found a similar inconsistency. Figure 14 displays two samples of formant trajectory from them.

Figure 14: Formant trajectories of /yo/ in /kyo⁵¹/ of one male (left) and one female (right) aged above 60.



All participants produced the test word for /ɔy/ (袋 ‘bag’ /tɔy¹³¹/) as [tuai¹³¹], which is identical to the test word for triphthong /uai/. Based on the pronunciations of one native speaker, who is in her forties and not included in the analysis above, a comparison between past and current pronunciations is made as presented in Table 1. The differences may imply that /ɔy/ has merged with /uai/ and /øy/ in open syllable, and further investigation is required.

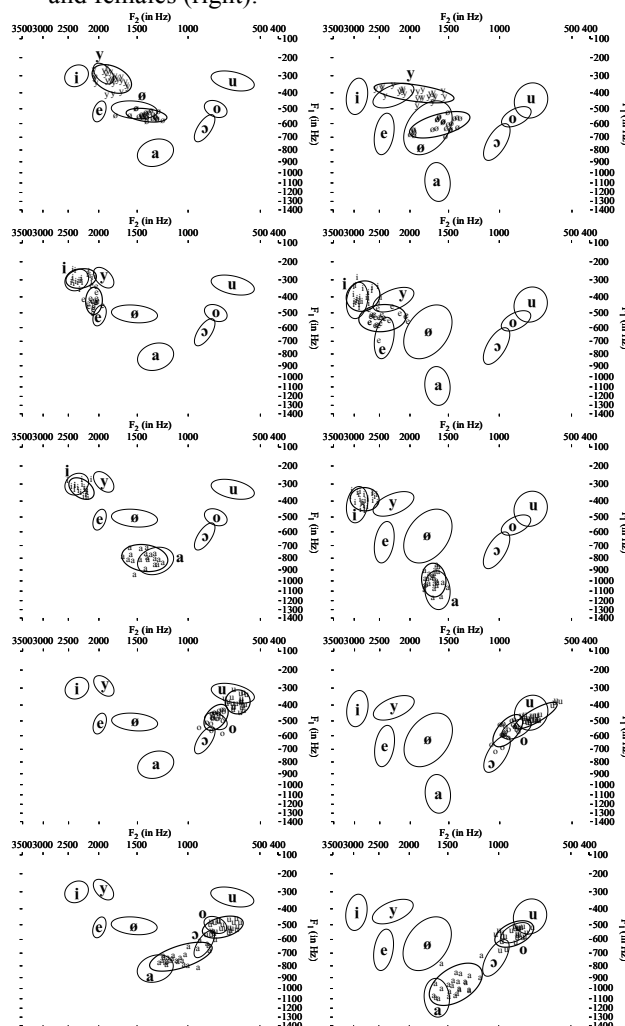
Table 1: A comparison between past and current pronunciations of /ɔy/.

Words	Past	Current
塊 (‘a monetary unit’)	[tɔy ²¹]	[tuai ²¹]
對 (‘opposite side’)		[tɔy ²¹] or [tuai ²¹]
代 (‘generation’)	[tɔy ¹³¹]	[tuai ¹³¹]
兌 (‘to cash’)		[tɔy ¹³¹]

袋 (‘bag’)	[tɔy ¹³¹]	[tuai ¹³¹]
碎 (‘one year old’)	[tsɔy ²¹]	[tsuai ²¹]
最 (‘most’)		[tsɔy ²¹]
剉 (‘to chop’)	[ts ^h ɔy ²¹]	[ts ^h øy ²¹]
碎 (‘fragmentary’)		[ts ^h øy ²¹] or [ts ^h uai ²¹]
坐 (‘to sit’)	[sɔy ¹³¹]	[suai ¹³¹]
欲 (‘to like’)	[ɔy ²¹]	[øy ²¹]

Figure 15 presents the vowel ellipses of diphthongs /øy ie ia uo ua/. It shows that /ie/ is generally realized as [iɪ]. And /^ua/ has large variation, though this second element accounts for more than 40% as shown in the temporal structure. It seems that no specific target is required for /^ua/.

Figure 15: Ellipses of /øy ie ia uo ua/ of males (left) and females (right).



5. CONCLUSION

This study provides an acoustic description of the vowels in Fuzhou Chinese and reveals some potential sound changes. Further studies are needed for corroboration.

6. REFERENCES

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¹ This study employs the tone letters described in [2], where the tones are numbered from 1 (lowest) to 5 (highest). And this study uses the values determined in [6] by acoustic analysis.

² Since there is no corpus for Fuzhou Chinese, this is based on the experience of the author (who was born and raised in Fuzhou).