AN EXPERIMENTAL INVESTIGATION OF THE INTER-RELATIONSHIP BETWEEN THE DIPHTHONG AND THE TONE IN FUZHOU CHINESE

PENG GONGGUAN

Phonetics Laboratory, Department of CTL, City University of Hong Kong
50007433@student.cityu.edu.hk

ABSTRACT

An interesting phenomenon in Fuzhou Chinese is the co-variation of the rhyme and the tone. The alternating rhymes will assume one form when associated with the citation tones yinping(55), yangping(53), shangsheng(33) and yangru(5)[1], and the vowel quality will change when associated with citation tones yinqu(212), yangqu(242) and yinru(24). Several suggestions have been put forward to explain the relation between the pitch height and vowel height. However, these suggestions rely on different sources which differ somewhat in their descriptions of the number of the diphthongs which show alternations depending on the tone. The considerable variation in the use of symbols suggests the desirability of more acoustic data. Results show that the frequency values of those finals with /e, o, a/ as the nucleus are affected by the tone difference but the effect is not systematic. This result may shed light on the various hypotheses on the relationship between the vowel and tone in this dialect.

Keywords: Fuzhou Chinese, diphthong, tone

1. INTRODUCTION

Fuzhou Dialect (hereafter FD) has a rich inventory of diphthongs which include /ie/iɛ, ia/iɑ, uo/uɔ, ua/uɑ, ai/ɑi, au/ɑu, ɛu/ɑu, øy/ɔy, /ɛi, /ou, /øy/[2]occurring in the (C)D syllables (C = syllable-initial consonant; D = diphthong) and /ieʔ/iɛʔ, uoʔ/uɔʔ, yoʔ/yɔʔ, iaʔ/iɑʔ, uaʔ/uɑʔ, ɛiʔ/aiʔ, ouʔ/auʔ, øyʔ/ɔyʔ, /ɛiʔ, /ouʔ, /øyʔ/[3] occurring in the (C)DS syllables (S = syllable-final glottal stop [ʔ]). Literature has indicated the co-variation between the tone and the vowel quality. Some ([1], etc) said that the nucleus of the diphthongs have tense-lax distinction when occurring with different sets of tones. With respect to the diphthongs with the mid vowels as the nucleus, they have a higher tongue position when co-occurring with the four tones 55, 53, 33 and 5 than with the tones 212, 242 and 24. The diphthongs with the low vowel as nucleus will surface as a front low vowel or a back low vowel when co-occurring with different sets of tones. Others ([2], etc) do not mention such kind of alternation. The aim of the present study is to determine, by spectrographic means, the average formant frequencies for each of the two elements involved in the transcription of a diphthong when associated with different tones so as to have a deeper understanding of the influence of tone on vowel quality.

2. METHOD

2.1. Test material

A list of test words is made up, consisting of one example from each FD diphthong as shown in Table 1. Three repetitions of each syllable are recorded, which is placed in the same carrier sentence, [ŋuai^{33} puoʔ^{5} tʰuʔ^{5} '__' køyʔ^{24} ny^{33} tʰiaŋ^{55}] 'I want to read ___ for you to listen'.

2.2. Speakers and Recording

The speakers are three native speakers of FD, aged in their fifties. The recordings were made with a digital audio recorder and a dynamic microphone, placed at a distance of 20 cm from the speakers' mouth. The test syllables were uttered at a normal rate of speech. The entire procedure was recorded in a quiet room.

2.3. Analysis

Praat 4.2.34 speech analysis software was used for the spectral analysis of the diphthongs. Speech data were captured at a sampling rate of the 10,000 samples per second, producing an upper frequency cut-off of 5,000 Hz. For each diphthong, formant trajectory was performed to see if there was steady state of the target elements of the diphthong. A wideband spectrogram of each test syllable was

made simultaneously for reference. The formant frequencies of the onset and offset vowels were taken at the mid-points of steady state portions.

Table 1: Test words consisting the diphthongs of FD

Diphthongs	Test Syllable	Gloss
ai	[ai^{55}]	'sad'
ɑi	[hai^{242}]	'bane'
ia	[hia^{55}]	'split'
iɑ	[iɑ^{242}]	'night'
au	[hau^{55}]	'weed'
ɑu	[ɑu^{242}]	'back'
ua	[ua^{55}]	'moppet'
uɑ	[uɑ^{242}]	'picture'
ie	[p^{h}ie^{55}]	'letter'
iɛ	[iɛ^{242}]	'greedy'
uo	[uo^{55}]	'nest'
uɔ	[uɔ^{242}]	'taro'
iaʔ	[hiaʔ^{5}]	'trim'
iɑʔ	[hiɑʔ^{24}]	'fall'
uaʔ	[uaʔ^{5}]	'socks'
uɑʔ	[uɑʔ^{24}]	'scratch'
ieʔ	[ieʔ^{5}]	'hot'
iɛʔ	[iɛʔ^{24}]	'benefit'
uoʔ	[huoʔ^{5}]	'wonder'
uɔʔ	[uɔʔ^{24}]	'water'
yoʔ	[yoʔ^{5}]	'medicine'
yɔʔ	[yɔʔ^{24}]	'date'

3. RESULTS AND DISCUSSION

Table 2 shows the mean frequency values obtained for the first two formants of the diphthongs occurring in the (C)D syllables associated with 55 and 242 respectively and the diphthongs occurring in the (C)DS syllables associated with 5 and 24 respectively. For each formant, onset (initial) and offset (final) values are given.

Table 2: Mean F1 and F2 values (in Hz) for the two elements of each diphthong for the three speakers (standard deviation in parentheses)

Diph-	First element		Second element	
thongs	F1	F2	F1	F2
[ai^{55}]	889(47)	1430(75)	314(27)	2415(232)
[ɑi^{242}]	891(40)	1334(47)	405(122)	2043(105)
[ia^{55}]	398(27)	2190(175)	842(73)	1478(50)
[iɑ^{242}]	366(30)	2307(250)	856(56)	1481(59)
[au^{55}]	854(59)	1222(70)	355(48)	789(85)
[ɑu^{242}]	897(59)	1309(37)	446(103)	918(67)
[ua^{55}]	456(41)	711(59)	769(94)	1193(69)
[uɑ^{242}]	464(28)	730(67)	796(97)	1149(73)
[ie^{55}]	333(31)	2378(185)	417(46)	2115(178)
[iɛ^{242}]	295(17)	2448(186)	415(17)	2145(182)
[uo^{55}]	344(26)	683(48)	469(44)	841(70)
[uɔ^{242}]	338(31)	614(68)	479(41)	828(44)
[iaʔ^{5}]	364(61)	2184(299)	837(105)	1494(102)
[iɑʔ^{24}]	408(42)	2300(216)	884(82)	1518(64)
[uaʔ^{5}]	463(44)	738(31)	824(60)	1171(117)
[uɑʔ^{24}]	472(40)	727(54)	853(53)	1212(73)
[ieʔ^{5}]	307(17)	2460(224)	465(34)	2192(197)
[iɛʔ^{24}]	291(20)	2410(234)	493(48)	2010(136)
[uoʔ^{5}]	395(32)	711(25)	513(58)	876(101)
[uɔʔ^{24}]	354(35)	628(80)	515(61)	861(76)
[yoʔ^{5}]	319(24)	2017(144)	521(83)	1086(179)
[yɔʔ^{24}]	294(15)	2040(120)	512(83)	1097(172)

The F1 and F2 values for the two elements of the diphthongs are plotted in the following acoustic vowel chart on bark scale, with F1 on the ordinate and F2 on the abscissa. Each IPA symbol that appears in the chart represents a data point based on the F1 and F2 values for each element of a diphthong. Each cluster contains 9 data points (3 repetitions × 3 speakers) in the F1/ F2 plane for each element of a diphthong.

Figure 1: Ellipses for the diphthongs ai/ɑi in FD in the F1/F_2 plane (from three speakers).

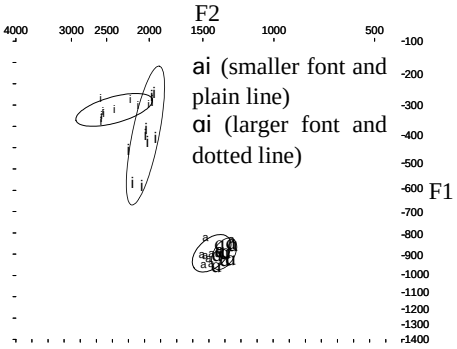


Figure 2: Ellipses for the diphthongs ia/iɑ in FD in the F1/F2 plane (from three speakers).

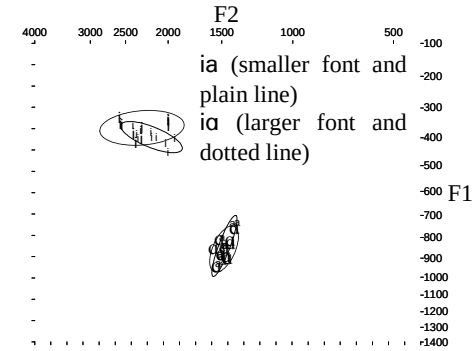


Figure 3: Ellipses for the diphthongs au/ɑu in FD in the F1/F2 plane (from three speakers).

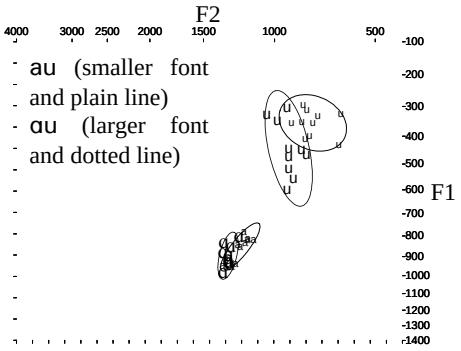


Figure 4: Ellipses for the diphthongs ua/uɑ in FD in the F1/F2 plane (from three speakers).

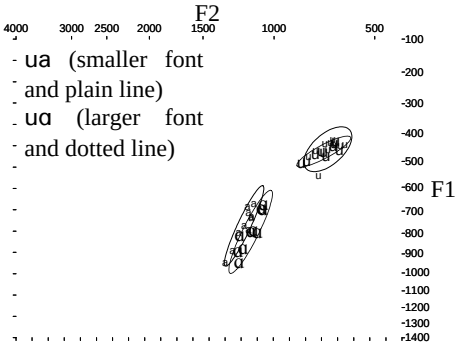


Figure 5: Ellipses for the diphthongs ie/iɛ in FD in the F1/F2 plane (from three speakers).

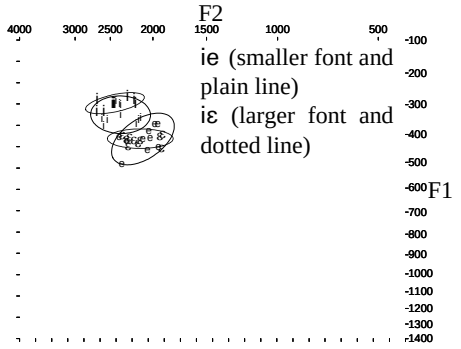


Figure 6: Ellipses for the diphthongs uo/uɔ in FD in the F1/F2 plane (from three speakers).

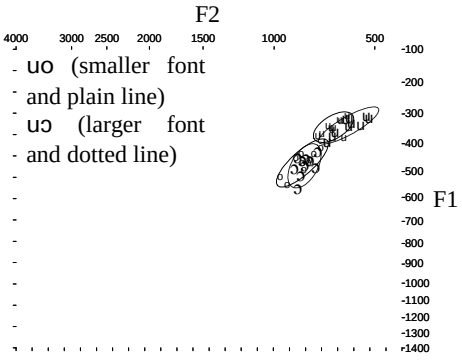


Figure 7: Ellipses for the diphthongs iaʔ/iɑʔ in FD in the F1/F2 plane (from three speakers).

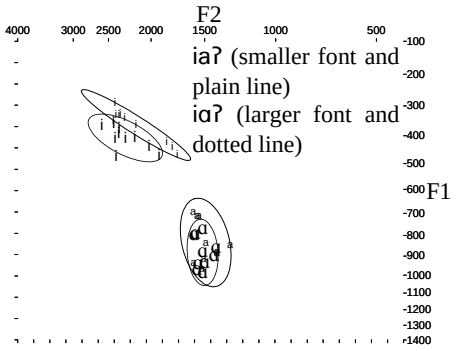


Figure 8: Ellipses for the diphthongs uaʔ/uɑʔ in FD in the F1/F2 plane (from three speakers).

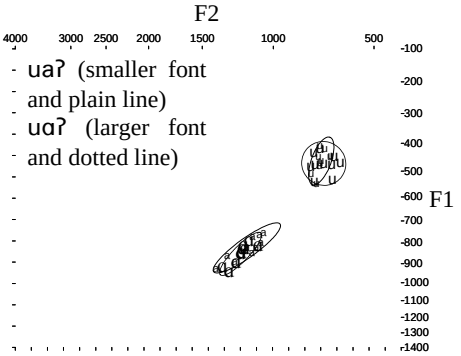


Figure 9: Ellipses for the diphthongs ieʔ/iɛʔ in FD in the F1/F2 plane (from three speakers).

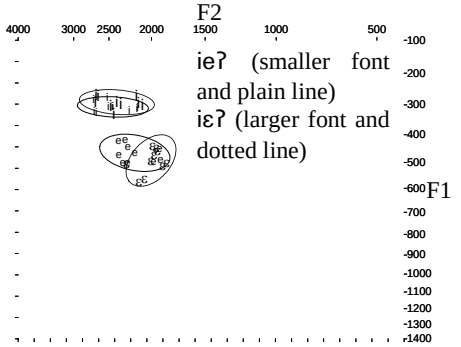


Figure 10: Ellipses for the diphthongs uoʔ/uɔʔ in FD in the F1/F2 plane (from three speakers).

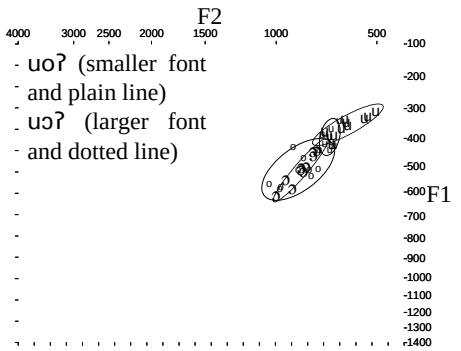
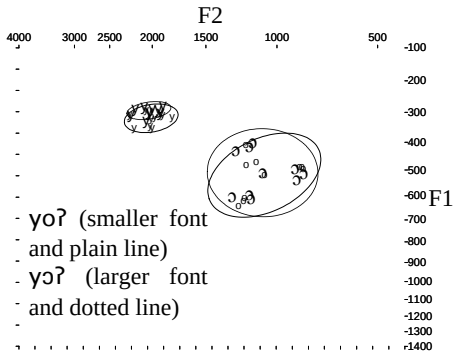


Figure 11: Ellipses for the diphthongs ɣo/ɣɔ in FD in the F1/F2 plane (from three speakers).



The formant frequency values obtained for the eleven pairs of diphthongs were subjected to a one-way analysis of variance. The hypothesis being tested is whether there is backness distinction for the low vowels when occurring with different tones and whether there is height distinction of the two mid vowels when occurring with different tones. Results show that for the two pairs of diphthongs ai/ɑi and au/ɑu, there are significant differences, but in the opposite direction, in F2 at the 0.05 level for the low vowel nucleus. These differences in F2, because of their opposite directions, seem not to be the result of the differences in the tone height. This may be caused, however, by the longer duration of the low vowel nucleus in the falling diphthongs when associated with the tone 242, relative to the duration of it when associated with the tone 55. For all other pairs with the low vowel as nucleus, no significant differences are found in F2 and for those pairs of diphthongs with the mid vowel as nucleus, no significant differences are found in F1. A well-known phenomenon in FD is the co-variation of tone and vowel. Several suggestions have been put forward to explain the relation between the intrinsic pitch of the vowel and the tongue height of the vowel. Lehiste [3] believes that the alternation of tones induce the alternation of vowels based on the observation of Fuzhou data where "high tones morphophonemically raise vowels from low to mid and from mid to high". Maddieson [4], on the other hand, proposes that there is no intrinsic association between the vowel height and pitch and vowel alternation and tone alternation have different historical processes. As suggested by the phonetic data in this study, there is no systematic correlation between the vowel height and the tone height. Therefore, acoustic data in this study is more in agreement with Maddeison's claim.

4. CONCLUSION

The paper presents the spectral characteristics of the diphthongs in FD. FD has the well-known phenomenon of the co-variation of tone and vowel height. The acoustic data in this study seems to suggest that the frequency values of the diphthongs are affected by the tone difference but the effect is not systematic.

5. REFERENCES

[1] Feng, A.Z. 1996. *Fuzhou Fangyan Cidian*. Nanjing: Jiangshu Jiaoyu Chubanshe.

[2] Tao, Y.M. 1930. *Minyin Yanjiu.* Beijing: Ke Xue Chubanshe.

[3] Lehiste, I. 1970. *Suprasegmetals*. Cambridge: M.I.T. Press.

[4] Maddieson, I. 1976. The intrinsic pitch of vowels and tone in Foochow. *U.C.L.A Working Papers in Phonetics* 33: 191-202.

[1] The underlined tone marks indicate the short *ru* tones. The *ru* tones whether yin (24) or yang (5) are associated with the syllable ending with a glottal stop in FD.

[2] The last three diphthongs [ɛi, ou, øɣ], whether in the (C)D syllables or in the (C)DS syllables, form alternating pairs with the three monophthongs [i, u, ɣ] respectively.

[3] This study will examine the first six pairs of diphthongs occurring in the (C)D syllables and the first five pairs occurring in the (C)DS syllable. The remaining pairs, where the reason of their vowel alternation may have become opaque, will not be dealt with in this study.