The Vowel Inventory in the Xinfeng (Tieshikou) Hakka Dialect

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ABSTRACT

Based on an acoustic phonetic analysis, this paper reports a unique vowel inventory in the Tieshikou Hakka. Results show that Tieshikou vowels have four levels of height, and three degrees of backness. This is completely different from Meixian, the well-known representative dialect of Hakka. And the discrepancy between Tieshikou and Meixian Hakka sheds light on general issues concerning vowel inventory typology.

Keywords: vowel inventory, monophthong, (falling) diphthong, Hakka dialects, Xinfeng (Tieshikou)

1. INTRODUCTION

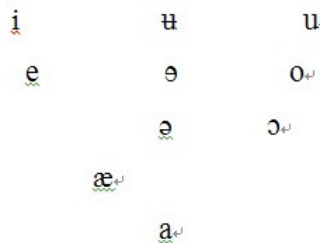
The Xinfeng county is located in the south of Jiangxi province, China. The dialect in the downtown Xinfeng belongs to the Mandarin dialect family, and is spoken by about 60,000 people, which is about 10% of the whole population. The dialects in the surrounding area belong to Hakka dialect, and are spoken by about 600,000 people, which is about 90% of the population ([1]). On the one hand, Hakka dialects in Jiangxi province differ greatly from the Meixian Hakka, which is taken as the representative dialect of Hakka, and were less documented in the literature. On the other hand, Hakka dialects in Jiangxi vary from each other both in terms of historical development and synchronic phonology ([2]).

A prominent difference between Meixian and Jiangxi Hakka dialects is in vowel inventory. Meixian has a limited number of monophthongs [ɿ i u a ɛ ɔ], and a rich inventory of falling diphthongs [ai ɔi ui au ɛu] ([3]). Jiangxi Hakka dialects have totally different vowel phonologies. And the Tieshikou Hakka is a representative one. This paper is an acoustic phonetic analysis on the vowel inventory of the Xinfeng (Tieshikou) Hakka.

Tieshikou Hakka has a rich inventory of monophthongs, but has no falling diphthongs. In addition to an apical vowel [ɿ], there are 10 monophthongal vowels [i u a æ e ə ɘ ɯ ɔ o], which appear in (C)V syllables, and 3 of them also occur as nasal vowels [ĩ ã ẽ]. There are 11 rising diphthongs [ia ua iæ uæ ie ue uə iɘ iɯ iɔ io], which appear in (C)D syllables, and 4 of them [ia ua uə iɔ] can also occur in (C)DN syllables, i.e., before the nasal ending [ŋ], and 1 of them occur as nasal diphthong [uã].

This paper focuses on the 10 monophthongal vowels in (C)V syllables, and reports a typologically unique vowel inventory, which is schematically represented in Figure 1.

Figure 1: A schematic representation of the vowel in Tieshikou Hakka.



2. METHODOLOGY

2.1.Test material

Meaningful monosyllabic words containing target vowels were used as test words. All the test words are associated with a high level tone, and most of them have a zero initial or a bilabial stop initial. That is, every target vowel has two test words.

2.2. Speakers and recording

8 Tieshikou native speakers, 4 male and 4 female, provided the speech data. All speakers were born and raised in Tieshikou and did not have a history of speech or hearing problems. At the time of recording, the ages of the speakers ranged from 22 to 49.

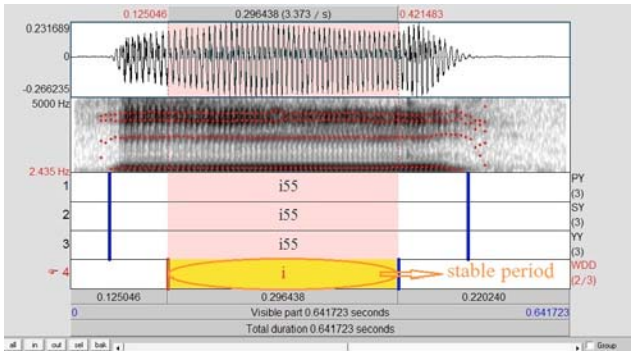
The speech data were recorded during the first author's fieldwork in Tieshikou in the summer of 2012. The recording was made directly into a laptop PC by using a Terratec 6 Fire USB digital audio sound card and a Shure SM-86 microphone. Each test word was placed in a carrier sentence [ŋiæ^{325} tʰu^{55} _ sɿ^{55}] 'I read _character'. The 20 test words in the word list were randomized, and the speakers were asked to read both the citation form and the word in the carrier sentence in a natural way and at a

normal speech rate. Five repetitions of the word list were recorded for each speaker. The recording sample is 11,025 Hz.

2.3. Data analysis

Sampled audio data were analyzed using Praat ([4]). As illustrated by the example in Figure 2, each target vowel was annotated, and then the first three formant values (F1, F2, F3) were extracted from each of the 10 points equidistantly along the stable period for each vowel, and the average formant values were used for each sampled target vowel. The acquired formant data were used for further analysis.

Figure 2: Annotation of [i[55]] 'to *meet*' from Male speaker 1.



3. RESULTS

Table 1 and 2 summarized the mean values in Herz, with standard deviations in the parentheses, of the first three formants for each vowel from 4 female and 4 male Tieshikou speakers, respectively.

Based on 20 data points for each vowel (5 repetitions × 4 speakers), Figure 3 and 4 show the vowel ellipses with radii of two standard deviations for the Tieshikou vowels from male and female speakers, respectively. The ellipses were plotted in a two-dimensional acoustic plane (F1 against F2), with the origin of the axes to the top right of the plot. The axis scale has been converted to Bark, and the scale on the ordinate is double that on the abscissa. Therefore, the acoustic vowel plane could better approximate the perceptual distances between vowels in such a way that the plots are more in accord with the auditory judgments of vowels. However, the values along the axes still correspond to the original values in Hertz.

Table 1: Means and SDs (in Hz) of the first three formants for Tieshikou vowels (Female speakers).

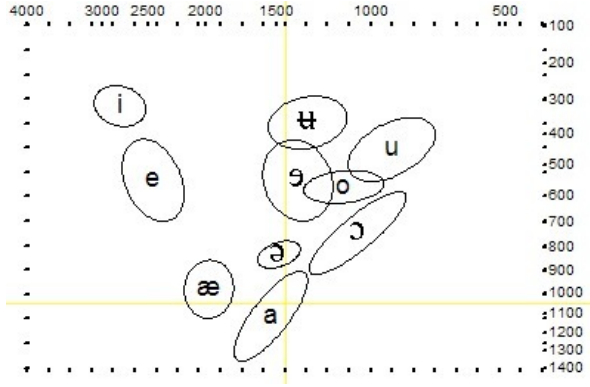
	F1	F2	F3
a	1116 (117)	1542 (116)	3062 (281)
æ	981 (68)	1978 (97)	3046 (248)
ɔ	742 (82)	1069 (114)	3127 (177)
e	549 (70)	2471 (128)	3083 (142)
ə	826 (28)	1490 (66)	3123 (100)
ɘ	550 (69)	1379 (100)	2955 (111)
i	317 (30)	2804 (136)	3448 (169)
o	571 (28)	1135 (99)	3147 (161)
u	449 (50)	916 (92)	3108 (193)
ʉ	366 (39)	1324 (111)	2918 (105)

a. citation form

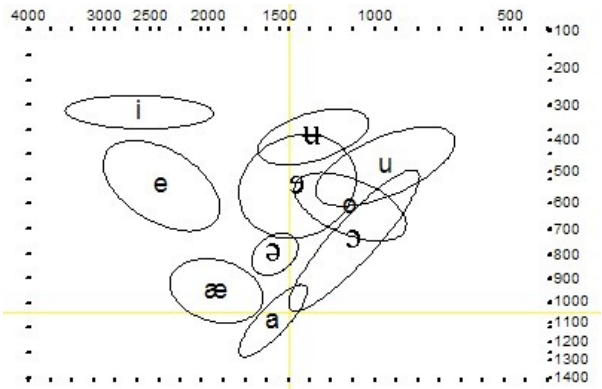
	F1	F2	F3
a	1091 (91)	1549 (109)	3042 (169)
æ	950 (72)	1946 (159)	3003 (286)
ɔ	744 (136)	1108 (156)	3104 (197)
e	545 (75)	2417 (262)	3101 (213)
ə	792 (42)	1537 (71)	3157 (152)
ɘ	548 (86)	1406 (173)	3004 (147)
i	318 (24)	2645 (351)	3311 (210)
o	616 (60)	1124 (134)	3224 (164)
u	481 (63)	965 (155)	3180 (168)
ʉ	390 (41)	1317 (163)	2981 (141)

b. in carrier sentence

Figure 3: vowel ellipses (Female speakers).



a. citation form



b. in carrier sentence

Table 2: Means and SDs (in Hz) of the first three formants for Tieshikou vowels (Male speakers).

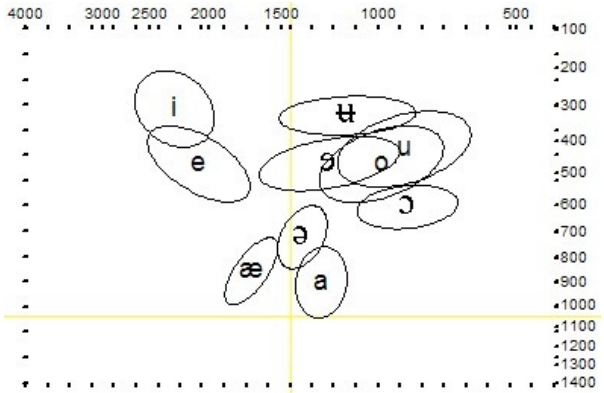
	F1	F2	F3
a	898 (75)	1280 (67)	2710 (288)
æ	851 (69)	1696 (89)	2650 (202)
ɔ	609 (37)	884 (102)	2767 (235)
e	470 (59)	2090 (202)	2753 (194)
ə	717 (58)	1383 (70)	2735 (164)
ɘ	469 (42)	1247 (197)	2622 (174)
i	310 (54)	2289 (169)	3173 (197)
o	471 (59)	996 (133)	2575 (154)
u	425 (57)	900 (173)	2672 (157)
ʉ	326 (25)	1164 (158)	2491 (163)

a. citation form

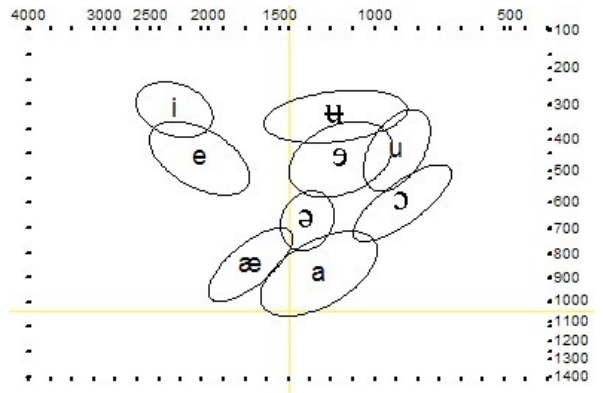
	F1	F2	F3
a	879 (92)	1288 (187)	2762 (196)
æ	840 (76)	1698 (143)	2645 (168)
ɔ	605 (67)	888 (100)	2783 (276)
e	458 (59)	2082 (201)	2820 (180)
ə	668 (54)	1344 (75)	2780 (171)
ɘ	461 (60)	1171 (130)	2615 (151)
i	314 (40)	2293 (167)	3188 (223)
u	434 (64)	910 (70)	2658 (215)
ʉ	332 (38)	1202 (211)	2546 (197)

b. in carrier sentence

Figure 4: vowel ellipses (Male speakers)



a. citation form



b. in carrier sentence

The vowel ellipses in citation form and in carrier sentence have a similar distribution pattern in the acoustic vowel plane for both male and female speakers. The only difference lies in that the vowel ellipses in carrier sentence generally have a larger distribution than their counterparts in citation form, suggesting more variations in carrier sentence vis-à-vis citation form. For instance, variations in F2 increase for [i ʉ u æ] in female speakers; variations in F1 increase for [e ə] in female speakers and [æ ɔ ʉ] in male speakers; variations in both F1 and F2 increase for [o ɘ ɔ] in female speakers and [a] in male speakers. However, there are also a few exceptions. That is, less variation in carrier sentence than in citation form. For instance, variations in F1 decrease for [a] in female speakers and [i] in male speakers; variations in F2 decrease for [ɘ u] in male speakers.

In general, Tieshikou vowels display four levels of height and three levels of backness in the acoustic vowel plane: [i ʉ u] are high, [e ɘ o] are mid-high, [æ ə ɔ] are mid-low, and [a] is low; [i e æ] are front, [ʉ ɘ ə a] are central, and [u o ɔ] are back. As compared with female speakers, male speakers have more variations. First, the front [æ] is as low as the low vowel [a] in male speakers, so that they actually form a distinction in backness. In other words, the vowels have a triangular distribution for female speakers while a quadrangular distribution for male speakers. Second, vowel ellipses of [ɘ u o ɔ] overlap more in male speakers than female speakers. And in carrier sentence in male speakers, [o] changed into a very new development [uə] or merged into [ɘ] due to the influence of Standard Chinese, and was thus excluded in the discussion.

4. DISCUSSION AND CONCLUSION

The Hakka dialects were typologically described as having the smallest number of monophthongal vowels in average among Chinese dialect families ([5], [6]). The claim was mainly based on the Hakka dialects in Guangdong and Fujian provinces. But this is obviously not true for the Hakka as a dialect family. The Tieshikou Hakka discussed so far has 11 monophthongal vowels (including an apical vowel). Meanwhile, Hakka dialects are also known as having both rising and falling diphthongs. For instance, the Meixian dialect has 6 monophthongs and 5 falling diphthongs. An interesting fact is that the number of monophthongs in Tieshikou equals that of monophthongs and diphthongs in Meixian. In other words, Tieshikou and Meixian have comparable vowel distinctions. This observation discredits the traditional typological survey of vowels, which usually treats monophthongs and

diphthongs as different categories. A famous case comes from [7] and the subsequent criticism from [8]. [7] tries to establish that the linguistic diversity of the world's languages corroborates human genetic and phenotypic diversity and thus supports an African origin of modern human languages. [8] proposes a completely difference model by using the same argumentation of [7]. An essential issue concerns the computation of phonetic/phonological complexity. [8] uses vowel inventory data from lesser documented dialects and languages and thus have a complete different generalization from [7]. But both generalizations from [7] and [8] are not reliable, as the computation of vowel complexity includes monophthongs only and excludes (falling) diphthongs. Recent researches from Chinese dialects show that monophthongal vowels and falling diphthongs are distinctive in vocalic position in syllables and they should both be included in the vowel inventory ([9], [10]).

The Tieshikou Hakka has a balanced distribution of vowels in the acoustic vowel plane. It is typologically common that front and back vowels have a predictable lip rounding, that is, all front vowels [i e æ] are unrounded and back vowels [u o ɔ] are rounded. But it is rare that Tieshikou has four central vowels [ʉ ɘ ə a], which is not reported in the world's languages ([11], [12]).

5. ACKNOWLEDGEMENT

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