Acoustic Analysis of Nasal Initials in Xiahe dialect of Tibetan

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Abstract: This paper uses the method of experimental phonetics acoustic analysis nasals in Xiahe dialect, we found that the nasals in Xiahe dialect has been divided into three parts: single nasals, nasals after clear fricative /h/ and nasals after voiced fricative /ɦ/. By comparing the time length, energy and formant, it is found that there is a great difference between the time length and energy of /h/ and /ɦ/. In addition, fricatives has little effect on the energy of nasal, while has a great effect on the time length.

1. Introduction

Xiahe county, located in the southwest of Gansu province, is named for its proximity to the Daxia river. It is a multi-ethnic area, comprising 18 ethnic groups including Tibetan, Han and Hui, among which the majority are Tibetans. The Tibetan language in China can be divided into three types: Wei-Tibetan, Kang and Ando. Xiahe dialect belongs to the indigenous language group of Ando. Due to the characteristics of multi-ethnic living, Xiahe dialect has great phonetic characteristics and has gradually become a research hotspot of linguists in recent years. Up to now, there have been many people on the Xiahe dialect research, for example, zhou Yixin used the method of acoustic analysis to study the initials and finals of Xiahe dialect from the perspective of syllables, and analyzed the duration, energy and formants of the initials of Xiahe dialect. Ma Li focused on the analysis of unaspirated plosive /p//t///k/. Lv Shiliang found that the consonants of Xiahe dialect gradually decreased during the process of language evolution, which was in line with the internal trend of language evolution. In addition, Zhang Dongxu analyzed the labial position of the consonant syllable in Xiahe dialect.

2. Experiment method

2.1 Pronunciation Text

In Xiahe dialect, nasal initials mainly divided into three categories: single nasals, nasals after clear fricative [h] and nasals after voiced fricative [ɦ]. So there are 12 nasal initials in Xiahe dialect, they are /m//n//ɳ//ŋ//hm//hn//hɳ//hŋ//ɦm//ɦn//ɦɳ//ɦŋ/. According to the Investigation form of Tibetan Dialect, a total of 60 words and characters are selected from the pronunciation text of this paper, and a part of them are listed here.

Table 1 Pronunciation text

Nasal	Tibetan	Chinese	The phonetic symbol
m	瞘	人	mə
	瞘繳	眼睛	mou
n	胦鑑	西方	nəp
	繼鱉	内部	naŋ
ɳ	耩	买	ɳo
	耡纋	坍塌	ɳət
ŋ	鱉	我	ŋa
	鱉繼	坏	ŋan
hm	膕繼	药	hman
	膛繼	成熟	hmən
hn	肯繼	添加	hnon
	肵	鼻子	hna
hɳ	螻繼	疯	hɳon
	鑑耬纐纍	平整	hɳam
hŋ	鑑翑繳纍	称赞	hŋak
	鑑罼繳纍	翻找	hŋok
ɦm	繻纐鱉纍	平民	ɦmaŋ
	膙	苦	hme
ɦn	繳繼纍	地点	hni
	繳繼纐	阴雨	hnam
ɦɳ	鑑穫纍	到达	hɳi
	穖繻	枯萎	hɳət
ɦŋ	繻鱉鱉纍	恐惧	hŋaŋ
	繻軦	边缘	ɦŋo

2.2 Articulator

The speaker is a local male resident of Xiahe. He lives in Xiahe all year and seldom goes out. He can speak a native Tibetan Xiahe dialect, without throat diseases.

2.3 Sound Recording

The recording equipment includes the clip microphone, the mixer and the computer. The recording software is Audition 3.0 and the sampling frequency is 22050Hz. The monophonic recording is carried out with the sampling accuracy of 16 digits. When recording, the speaker is required to read all the example words in the pronunciation list with natural intonation and speed. Each word is read three times and saved as.wav format.

2.4 Collection and Processing of Experimental Data

The intensity, formants and duration data were extracted in Praat.

During the analysis, the voice with the best recording effect of each example was selected for analysis, and the acoustic characteristics of the nasal initials of Xiahe dialect in Tibetan were analyzed by observing the waveform and tri-dimensional language diagrams and combining the corresponding parameters. The parameters to be extracted include formant, duration, and intensity.

A formant is an acoustic mark common to both vowels and nasals and refers to the resonant frequency of the vocal tract. From bottom to top, the first, second and third formants of nasal sounds are represented by F1, F2 and F3 respectively.

Intensity reflects the energy and loudness of the sound.

Duration reflects the length of the time of speech. When distinguishing initials, length can play a role in distinguishing features. In addition, the time of clear fricatives is longer than that of voiced fricatives.

3. The experiment result

This part is analyzed from the two angles of single nasals and compound nasals.

3.1 Single Nasals

There are four single nasals in Xiahe dialect, they are /m//n//ɳ//ŋ/. By observing the waveform of and tri-dimensional language diagrams of them, we found the amplitudes of all nasals vary periodically. The amplitudes of /n/ and /ŋ/ are larger and show a trend of gradual expansion, but /m/ and /ɳ/ are smaller and the change is relatively stable. In addition, the four nasals all have formants and F1 and F2 are far apart. In this part, four nasal sounds are analyzed by means of Long Term Average Spectrum (LTAS). LTAS can reflect all the frequency components in a speech and also reflect the relationship between the energy in the frequency domain.

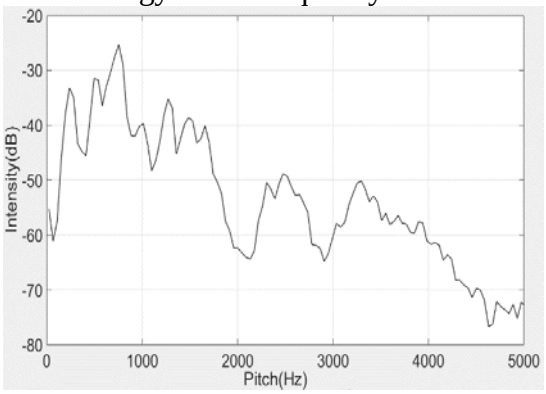

Figure 1. The LTAS of /m/

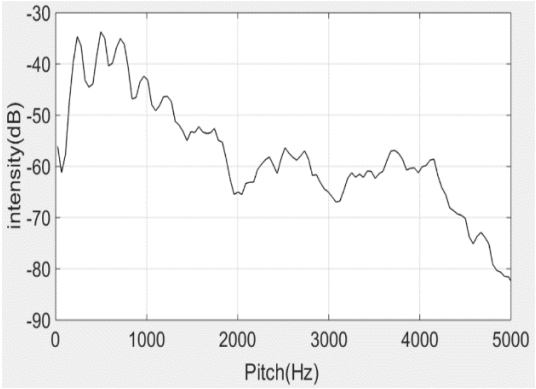

Figure 2. The LTAS of /n/

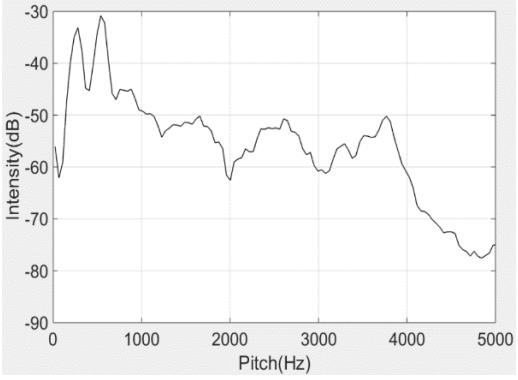

Figure 3. The LTAS of /ɳ/

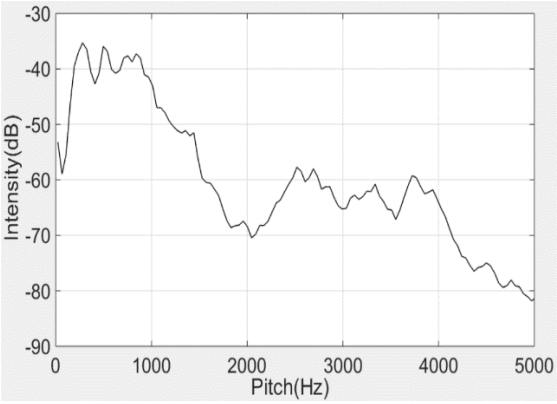

Figure 4. The LTAS of /ŋ/

Figure 1to Figure 4 are the LTAS of four single nasals, they reflects the variation of energy in the frequency domain when each nasal sound is made. It can be seen that the energy of the four nasal initials presents a decreasing trend in the frequency domain. The most concentrated region of energy is below about 800Hz, and the energy decreases significantly at about 2000Hz. Another energy concentration region appears between 2500Hz-4000Hz, and the energy in this region has two obvious peaks.

3.2 Compound Nasals

There are eight compound nasals in Xiahe dialect, they are /hm//hn//hɳ//hŋ//ɦm//ɦn//ɦɳ//ɦŋ/. /h/ is clear fricative and /ɦ/ is voiced fricative. By observing the language diagram, we found the nasals after fricative are similar with the single nasals, so in this part we only analysis the fricatives.

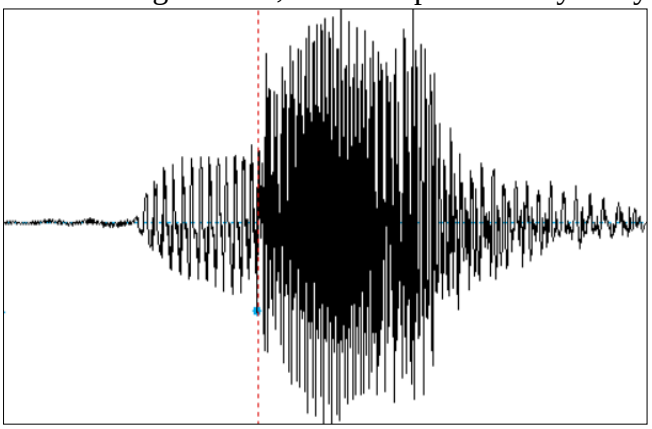

Figure 5. Waveform of /hm/

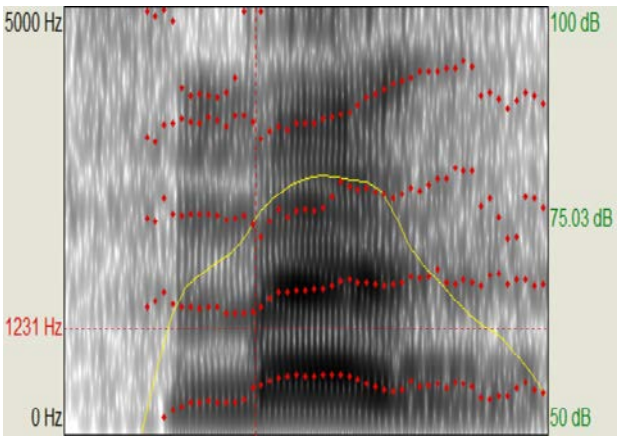

Figure 6. Sonogram of /hm/

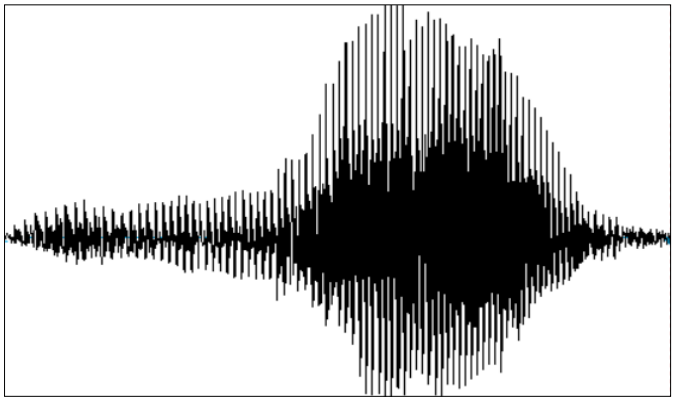

Figure 7. Waveform of /ɦŋ/

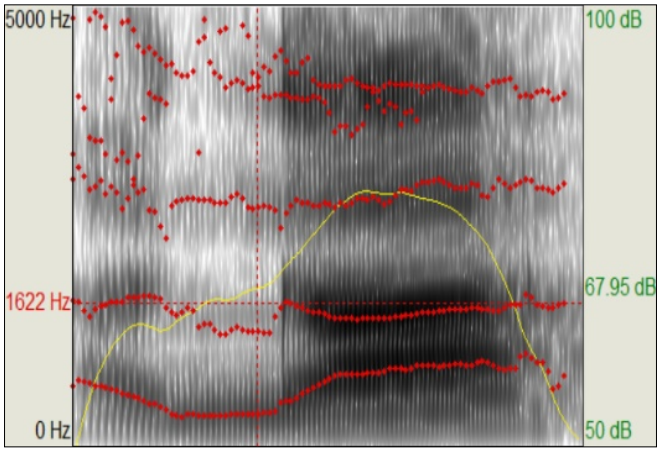

Figure 8. Sonogram of /ɦŋ/

Take the language diagram of /hm/ and /ɦŋ/ as example, we found the amplitude of clear fricative is small, while the voiced fricative is bigger and it is vary periodically. The fricatives at the sonogram is fills. The clear fricative has no formants but the voiced fricative has.

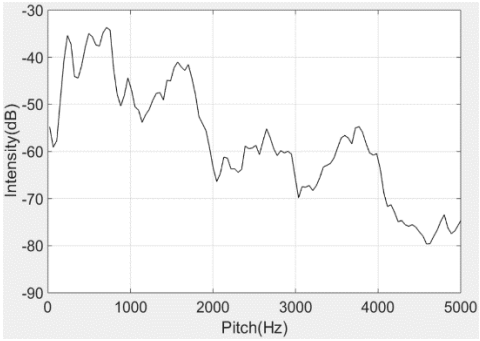

Figure 9. The LTAS of /h/

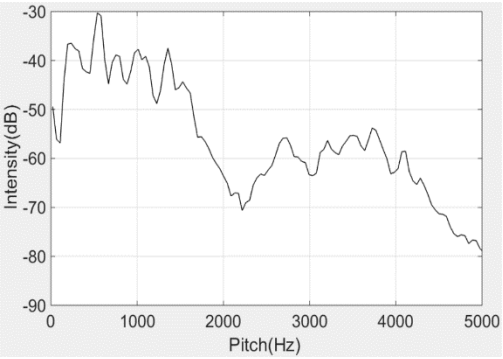

Figure 10. The LTAS of /ɦ/

Figure 9 and figure 10 are the LTAS of /h/ and /ɦ/. The energy of them shows a trend of decreasing in frequency domain. There are low values of energy at about 2000Hz and the main ones are blow 2000Hz. After 2000Hz, there are two energy peaks in the sonogram of clear fricative but the voiced fricative does not.

Table 2 The statistical table of duration, energy and formant

	Intensity（dB）		Duration times (ms)			Formant （Hz）		
	Fricative	Nasal	Fricative	Nasal	Time	F1	F2	F3
m	/	63.36	/	188.1	188.1	264.4	1413.2	2627.7
n	/	64.23	/	142.29	142.29	303.7	1740.8	2629.1
ɳ	/	60.19	/	122.25	122.25	379.0	2187.4	3053.6
ŋ	/	64.96	/	126.9	126.9	311.8	1454.9	2640.8
hm	36.9	66.1	118.6	64.4	183	341.3	1459.0	2546.7
hn	35.7	67.5	105.1	66.5	171.6	321.0	1621.4	2709.9
hɳ	37.4	67.2	99.7	60.1	159.8	338.4	1717.5	3042.1
hŋ	35.6	68.2	102.1	68.8	170.9	341.7	1868.2	2657.3
ɦm	56.4	66.7	82.5	127.6	210.1	427.3	1368.2	2701.2
ɦn	52.6	66.2	62.7	134.5	197.2	371.8	1704.0	2787.5
ɦɳ	55.1	65.6	79.6	101.2	180.8	407.6	1733.6	2856.5
ɦŋ	56.6	65.9	81.9	115.6	197.5	363.2	1409.8	2710.5

Table 2 is the statistical table of duration, energy and formants of nasal initials. It can be seen from the table that the energy of voiced fricative /ɦ/ is bigger than clear fricative /h/, but the duration time of /ɦ/ is much smaller than /h/. In addition, from the total duration time perspective, the nasals with /ɦ/ is longest, the nasals with /h/ take second place and the single nasals are shortest. The following is a comparison of the energy and length of the nasal segments, to explore whether the fricative segment has an effect on the nasal, and if so, what effect it will have.

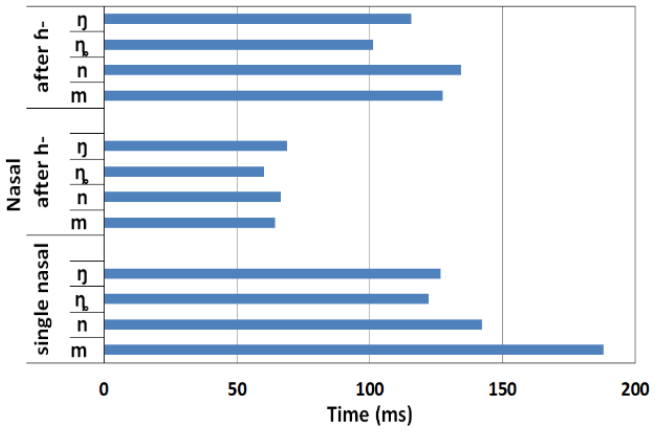

Figure 11. The duration time of nasals

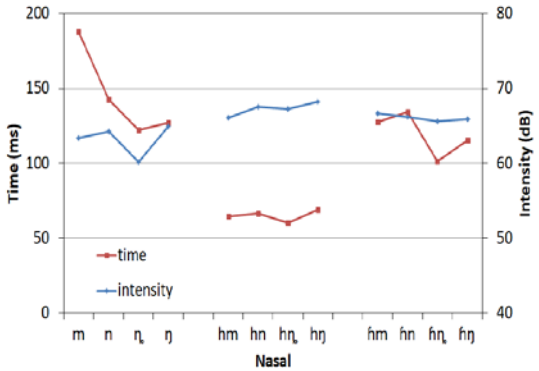

Figure 12. The relationship of energy and time

Figure 11 and figure 12 respectively analyze the nasals of Xiahe dialect and compare the differences in duration and energy between single nasals and complex nasals. On the duration, the nasals after the voiced fricative /ɦ/ are longest, the single nasals take second place and the nasals after the clear fricative /h/ shortest. So, it can be argued that clear fricative shortens the duration of nasals, while the voiced fricative lengthens it. In addition, the energy of nasals after fricative is slightly bigger than single nasals, but the difference of them is negligible. So, the fricative has little effect on nasals in Xiahe dialect.

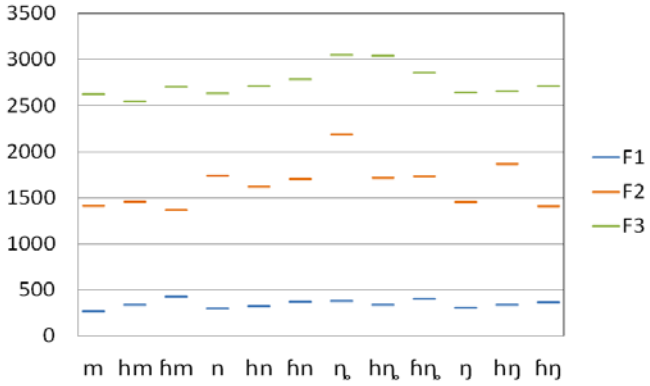

Figure 13. The formant of nasals in Xiahe dialect

From the perspective of formant, the three sets of nasals were ranked by F1 as /ɳ/>/ŋ/>/n/>/m/, /hŋ/>/hm/>/hɳ/>/hn/, /ɦm/>/ɦɳ/>ɦn/>ɦŋ/. The order by F2 is /ɳ/>/n/>/ŋ/>/m/, /hŋ/>/hɳ/>/hn/>/hm/, /ɦɳ/>/ɦn/>/ɦŋ/>/ɦm/. According to the F1, F2 and the relationship between them and tongue, it can be infer that, in Tibetan Xiahe dialect, the tongue of the /ɳ/ is lowest but the /m/ is highest.

However, influenced by clear fricative /h/, the tongue of /ŋ/ become the lowest, the tongue of /ɳ/ and /n/ drive up but the /ŋ/ and /m/ reduced. At the same time, the tongue of /ɳ/ and /ŋ/ are backward. Influenced by voiced fricative /ɦ/, the tongue of /m/ become the lowest, the tongue of /ɳ/ and /ŋ/ drive up. It can be seen from this that the clear affricate has a greater influence on the nasal articulation than the voiced affricate.

4. Conclusion

This paper use the method of experimental phonetics to study the nasals of Tibetan Xiahe dialect: single nasals, nasals after clear fricative /h/ and nasals after voiced fricative /ɦ/. The energy of /h/ is obviously less than /ɦ/, while the duration of /h/ is obviously greater than /ɦ/.

The fricatives has little effect on the energy of the nasals, but has a great effect on the duration of them. Both clear fricative and voiced fricative shorten the duration of nasals, and the effect of /h/ is greater than /ɦ/. In addition, /h/ and /ɦ/ affect the formants of nasals in different degrees. The fricatives lifts the F1 of all nasals. About F2, there are little impact on /m/ and /n/ from fricatives, but it make the F2 of /ɳ/ F2 fallen dramatically, and /h/ make the F2 of /ŋ/ rise significantly.

Acknowledgements

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