

Acoustic Analysis of Western Yugur Language Monophthong Based on Experimental Phonetics

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Abstract: Yugur language is the language used by the Yugur ethnic group with a small population in China. Yugur's native language is divided into two parts because of the factors of history, geography and language integration. Some people use the western Yugur language of the Turkic language family of the Altaic language family, while others use the eastern Yugur language of the Mongolian language family of the Altaic language family. Among them, the western Yugur language retains more features of the ancient Turkic language and is greatly influenced by the Chinese in its development and change. In this paper, experimental phonetics research methods are used to study the vowels of Western Yugur language. Through the analysis of the acoustic parameters of vowels, the acoustic characteristics of the vowels of Western Yugur language are finally obtained.

1. Introduction

Vowels produce sound source signals through vocal cord vibration in the process of pronunciation. Through the regulation of the articulatory organs, it affects the resonance and shows different timbres. Unlike consonants, vowels last a long time in pronunciation[1]. Airflow is exhaled from the lungs and is not obstructed in the pronunciation organs. The vowel timbre will be affected by the changes of the tongue position and the roundness of the lips.

In any language, there are vowels. There are 8 basic vowels in the western Yugu language, namely [ɑ] [ə] [e] [i] [o] [u] [ø] [y]. These vowels can be pronounced separately. From the perspective of the distribution of tongue position, they are divided into pre-vowels and post-vowels, and there are differences in tongue height. Also includes round vowels and lip vowels, except for [ø], all vowels can appear in words or syllables.

In the past studies, the traditional linguistic research method has been used to record the tongue position distribution of the basic vowels in the western Yugur language. Chen Zongzhen (2004) detailed the vowels of the western Yugur language and described the pronunciation parts of each vowel[2]. In this paper, the experimental phonetics method is used to collect the acoustic signals of the Yugur language in the west, and the distribution of the vowels in the western Yugur language is analyzed by the parameters of the formants.

2. Experimental Method

During the experiment, the western Yugur language speech signal is mainly collected in units of words, mainly based on monophthong. If there is no word of the monophthong, will select a word with less phonemes in the syllable to acquire the signal. Signal acquisition is performed using Praat software. After the acquisition is completed, the signals are screened and signals of better quality are selected. The signal is then marked, marking the stable segment of the vowel, excluding the effects of coordinated pronunciation. Finally, the parameters are extracted from the vowel portion of the marker, and the extracted parameters are statistically analyzed and plotted.

2.1 Experimental Equipment.

Experimental equipment includes the use of professional microphones, mixers, and external sound cards. The signal acquisition and parameter analysis software used was Praat software. Set the sampling frequency of the signal acquisition to 40KHz, using mono recording, 16bit. During the signal acquisition process, the speaker first familiarizes with the vocabulary, then performs pronunciation, and each word is read 3 times during the pronunciation process. The signal is saved in .wav format. In the process of post-analysis, each word will be segmented, and then the signals will be marked according to different vowels[3].

2.2 Vocabulary and Speaker.

In the pronunciation vocabulary, the words in the western Yugur language are mainly used. Because of history, population migration and language development and change, Yugur's native language has been lost. In the vocabulary, the vocabulary is mainly recorded by the Latin alphabet and the international phonetic symbol, and the speaker is prompted by the Chinese word meaning.

The pronounciators chose the Yugur people whose mother tongue was the Yugur language in the West and who lived in Sunan County of Gansu Province for a long time. Finally determined 2 male and female speakers, a total of 4 speakers. The pronunciation person familiarizes with the pronunciation vocabulary before the signal acquisition, and then performs signal acquisition after the overall pronunciation training.

2.3 Parameter Extraction Method.

The formant is the most important acoustic sign of the vowel. The resonance frequency of the finger channel has five resonance peaks. The first two formants play a major role in the vowel sound. Bandwidth is a method for analyzing formants. The formant bandwidth is also called the half-power bandwidth[4]. It is defined by the width at 3dB below the resonance peak value. The bandwidth is mainly determined by the loss of acoustic wave transmission in the channel. Regardless of the sound quality of the vowel, it is related to its order. In general, the bandwidth of the first formant is the narrowest, the second resonance peak is the second, and so on[5].

In this experiment, the first two formants of vowels were extracted by Praat and recorded as F1 and F2 respectively. The first two resonance peaks are affected by the height of tongue position: F1 is negatively correlated with the height of tongue position, the higher the tongue position, the smaller the frequency of F1; F2 is positively correlated with the front and back of tongue position, and the higher the frequency of F2, the smaller the back of tongue position.

3. Analysis of Experimental Results

The formant can reflect the resonance frequency of the sound source signal in the vocal organ. The formant is also an important parameter in speech signal processing, and the vowel can be distinguished and identified by the parameter ranges of different formants. When the speech signal passes through the resonance chamber, it is filtered by the resonance cavity, so that the distribution of the speech frequency in the frequency domain is redistributed. Some frequencies are boosted, some frequencies are attenuated, and the formants determine the tone of each vowel. In order to analyze the tongue position distribution of the western Yugur vowel, the first formant (F1) and second formant (F2) parameters of the eight monophthong were extracted. It is thus possible to determine the tongue height and front and back of the vowel by the formant parameters.

3.1 Vowel Formant Analysis.

In the process of pronunciation, the vowel is mainly represented by the difference of the formant frequency. Before the parameter extraction, the speech signal is simply marked, and in addition to the unit sound word, the vowel portion of the syllable of the word is mainly marked. Parameter extraction was performed using Praat software, and statistical analysis of the parameters was performed in an Excel table.

Table 1 Vowel formant average frequency (Unit: Hz)

	i	e	ə	u	ø	y	o	ɑ
F1	460.26	460.37	708.26	481.36	485.35	424.39	491.14	898.15
F2	2750.46	2452.65	1731.88	992.31	2067.03	1966.26	1005.42	1636.71

From the data in Table 1, we can see that among the eight basic vowels, the minimum value of the formant of F1 is vowel [y], the frequency is 424.39 Hz, the maximum is vowel [ɑ], and the frequency is 898.15 Hz. F1 reflects the height of the tongue position, [y] is a high vowel, and [ɑ] is a low vowel, which corresponds to the correspondence between the first formant and the tongue. Similarly, in the F2 parameter, the maximum frequency value is 2750.46 Hz, which is the frequency of the vowel [i]. The smallest is the frequency value of the vowel [u], and the frequency is 992.31 Hz. From the point of view of the parameters of F2, it also conforms to the relationship between the second formant and the tongue position.

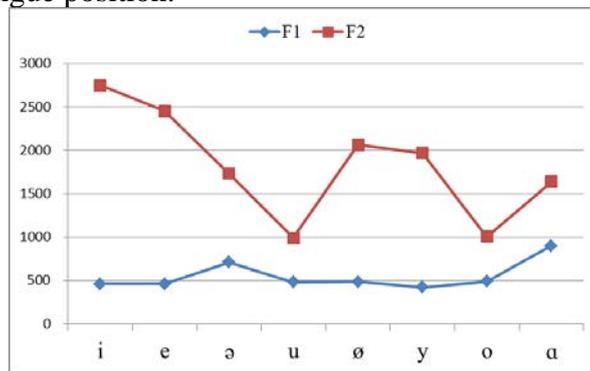


Figure 1. Vowel F1 and F2 frequency comparison chart

In order to further compare the formant parameters of each vowel, the parameters of F1 and F2 are compared, as shown in Fig. 1. In general, the characteristics of different vowels can be distinguished by the distances of the formants F1 and F2. The higher the tongue position is, the larger the distance between F1 and F2 is, the lower the tongue position is, and the smaller the distance between F1 and F2 is.

From the parameter curve in Figure 1, the difference between the first formant of the western Yugur language vowel is small and the curve is relatively stable. It shows that during the pronunciation process, the change of the tongue position is relatively stable, and there is a small difference between the vowels. The second formant has a large variation range, and the position of the tongue position is pronounced. The vowel with the tongue position is higher [e] [i] [ø] [y] The overall parameters are larger, and the remaining vowels such as [u] and [o] have smaller parameters, which are consistent with the distribution of vowels in western Yugur language.

3.2 Formant Distribution of Vowels.

In order to observe in detail the distribution of the vowels in the western Yugur language, all vowel parameters are counted and plotted. As shown in Figure 2. The frequency of the first formant (F1) of a vowel is chosen as the ordinate, which mainly reflects the height of the tongue. The frequency of the second formant (F2) is in the abscissa, reflecting the front and back of the tongue. Zeros are in the upper right corner of the figure.

As shown in Figure 2, for ease of viewing, the frequency range of F1 is set to 0-1000 Hz, and the frequency range of F2 is set to 0-3000 Hz. The approximate range of each vowel parameter is marked with a circle, and the tongue position of the vowel is visually displayed according to the vowel tongue position. From the distribution of the formant, in the order of the tongue position from high to low, the vowels [i] and [y] belong to the front high vowel, and [u] and [o] belong to the post-high vowel. Followed by [e] and [ø], [ə] in the middle position, [ɑ] belongs to the post-low vowel.

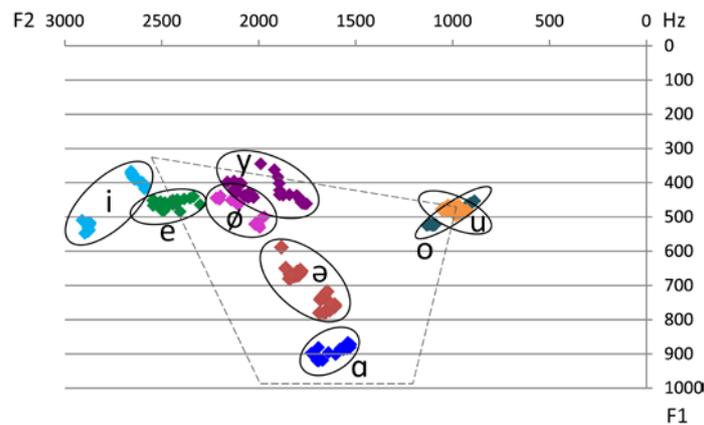


Figure 2. Vowel formant distribution pattern

Among all vowels, the more concentrated vowels are [e] [u] [a] vowels [i] [o] [ə] [y] scattered in two parts, and the difference of tongue position is mainly related to the difference of pronunciation partners. The position of the vowel [a] is higher than the position of [a] in the international phonetic table, and the vowel [ə] is in the middle position, which is consistent with the characteristics of the central vowel. The vowel [e] and [ø] tongues are between the vowels [i] [y] and [ə] and correspond to the positions in the international phonetic table. In the vowels [i] and [y], [i] is affected by the influence of the left and right phonemes, and the difference between [i] and [y] is [y] round lip, [i] is not. The vowels [u] and [o] are pronounced behind the tongue, and both are round vowels, and the tongue height of [o] is between [u] and [ə].

3.3 The Tongue Position of Vowels.

In order to reduce the individual differences of different speakers, close to the actual hearing experience distance, convert the formant frequencies of all vowels into Bark values, and then normalize the formant parameters by the method of V value calculation[6]. The vowel phonemes of each language can be visually represented by the vowel tongue position map. The acoustic vowel map can be used to describe the distribution of vowels by acoustic experiments.

In order to further observe the distribution of each vowel energy parameter, the V-value parameter normalized by the western Yugur language monophthongs is plotted and plotted according to the distribution of the vowel tongue position, as shown in Fig. 3.

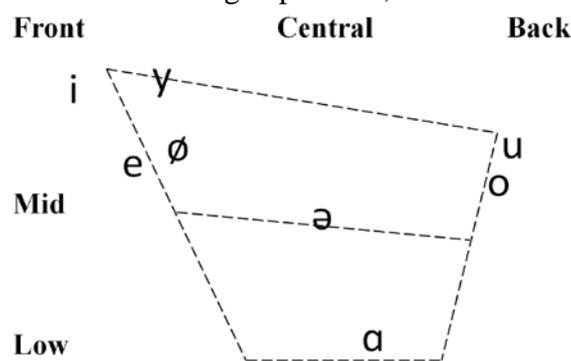


Figure 3. The tongue position for vowels in Western Yugur language

After normalizing the frequency of the western Yugur vowel formant, the individual differences of the speaker were excluded. From the vowel tongue position map of Figure 3, the tongue position distribution of the western Yugur vowel can be obtained. Except for the vowels [a] and [o], the tongue position distribution of the remaining vowels is roughly consistent with the distribution of the vowels of the international phonetic symbols. In the western Yugur language vowel [a], the position of the tongue position tends to the center, and the vowel [o] has a higher tongue position.

In the future experiments, the number of experimental samples will continue to increase, and the distribution of the tongues of vowels [a] and [o] will be studied in detail. According to a large number of data statistics, the specific tongue distribution range of the western Yugur language [a]

and [o] is determined.

4. Summary

Based on the research methods of traditional linguistics, this paper analyzes the acoustic parameters of the western Yugur language unit sounds by using the experimental phonetics research method. By formulating the pronunciation vocabulary, the speech signals of the eight monophthongs in the western Yugur language are collected. The parameters of the first formant and the second formant are extracted, and the formant distribution of the vowels in the western Yugur language is obtained after the formant frequency is normalized.

Due to the small number of speakers in this experiment, the age difference of pronunciation is not considered comprehensively. In future experiments, more experimental parameters will be further calculated to make the experimental results more accurate.

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References

- [1] Zhong Jinwen. Study on Yugur Language in the Western and Western China in the 20th Century. *Language and Translation* 3 (2000): 6-12.
- [2] Chen Zongzhen. An Overview of Yugur Language in Western China. *Ethnic Language* 6 (1982): 66-78.
- [3] Shiliang Lyu, and Z. Luxin. The Application of Acoustic Analysis in the Study of Yugur Traditional Folk Songs. *International Conference on Social Network* (2017) .
- [4] Catford, J. C., and J. H. Esling. Phonetics, Articulatory. *Encyclopedia of Language & Linguistics* (2006):425-442.
- [5] Ladefoged, Peter, and D. E. Broadbent. Information Conveyed by Vowels. *Journal of the Acoustical Society of America* 29.1(2005):98-104.
- [6] Shi Feng. Vowel pattern of Beijing dialect. *Nankai Linguistics Journal* 1 (2002): 30-36.