Study on the Airflow of Chinese Mandarin in Mandarin based on Glottal MS-110

Jing Wang [a], Yonghong Li [b, *]

Key Laboratory of China's Ethnic Languages and Information Technology of Ministry of Education Northwest Minzu University, Gansu 730030, China

[a]756646910@qq.com, [b, *] lyhweiwei@126.com

Abstract. In this paper, vowels of Mandarin Chinese are selected as pronunciation materials. According to the data of pronunciation time, average airflow velocity and airflow collected, the pronunciation time, average airflow velocity and airflow of [y] [u] are relatively large. It can also be seen that the pronunciation of [ɤ] is greatly influenced by the average airflow velocity. The pronunciation of the [i] [ʅ] [ɿ] is greatly affected by the duration. From the perspective of dispersion [ʅ] [ɿ] the stability of the pronunciation airflow is poor, and the stability of the pronunciation airflow of [ᴀ] is high.

Keywords: Vowel, airflow, dispersion, Mandarin Chinese.

1. Introduction

Beginning in the 1950s, the study of phonetics began to develop in the direction of experiments. Linguists began to explore the pronunciation physiology, including the air pressure mechanism and the voice mechanism of the pronunciation. The phonetician initially studied speech activity and changes in lung volume during respiration [Draper, 1959] [1]. With the gradual improvement of experimental equipment, through the efforts of many linguists, great progress has been made in speech aerodynamics research, not only to objectively and systematically study the pronunciation of normal speech, but also its experimental data can be Used to assess and treat speech and pronunciation disorders.

Ohala believes that only the phonetics and related psychology and social culture-related research can be fully integrated into practice, and the traditional phonology will go out of the current infinite loop and predicament. In the mathematical model paper of speech dynamics, he discusses the establishment of speech models based on the acoustic parameters obtained from different pronunciation parts, and discusses the different high and low opening and closing vowels in the aerodynamic research papers of phonology. The influence and variation of acoustic parameters of consonant speech [2] [3] [4]. Richard W. Trullinger (1989) studied the characteristics of airflow, air flow volume, and duration produced by normal children with persistent vowels. Tested the airflow and pronunciation duration of individual vowel pronunciations. The relationship between air flow volume and vital capacity and duration of pronunciation was tested [5]. Enrich (2003) measured the maximum airflow rate of 75 different children's 6-10 years old at the same pitch, and finally the maximum airflow rate decreases with age as the vocal fold vibration frequency increases [6]. Huiwen Goy (2013) used a standardized recording program to collect a large number of healthy adult samples. The type and extent of changes in the age of men and women associated with different ages, but the overall age-related differences are limited [7].

2. Experimental Explanation

2.1 Experimental Materials

There are mainly 10 vowels in Mandarin Chinese. Mainly divided into tongue vowels, tip of the tongue vowels and retroflex-vowel. In order to avoid the influence of different tones on the experimental data, all the syllables are 55-tone. The pronunciation materials selected in this paper are as follows:

Table 1. Three Scheme comparing

	Tongue vowels					Tip of the tongue vowels		Retroflex-vowel
	Front		Middle	Back		Front	Back	Middle
High	[i]	[y]			[u]	[ɿ]	[ʅ]	
Mid-high				[ɤ]	[o]			
Middle								[ɚ]
Mid-low	[ɛ]							
Low			[ᴀ]					

2.2 Participants

This article selects five female students as the speaker, selects the standard of the speaker's Mandarin, and has good vocal cord conditions, normal hearing ability and normal sound characteristics. The pronunciation of the speaker was trained before the experiment, and it was required to read each tone five times according to the pronunciation word table.

2.3 Instruments

The aerodynamic data acquisition device of this experiment consisted of a circular ventilatory breathometer mask connected to a narrowband pressure sensor (PTL-1) and a separate broadband pressure sensor (PTW-1) (Glottal Enterprises MS 110). The calibration gas flow volume was 1.4 L and the flow rate was 0.5 L/s. The data collection work was carried out in the professional studio of Northwest University for Nationalities. The following figure shows the original airflow pattern collected by the MS110.

The parameters collected during airflow data analysis are:

Expiratory airflow duration (ms): refers to the length of time that the vowel is pronounced in the syllable.

Average airflow speed (ml/s): refers to the change of the velocity of the airflow over time in a relative time.

Airflow volume (ml): refers to the total amount of airflow exhaled during the process of pronunciation. The size of the airflow depends on the speed of the airflow and the length of the pronunciation.

3. Analysis of Airflow Data

The duration of the vowel pronunciation, the average airflow velocity, and the airflow data can be collected by the airflow barometer. The following table shows the average data of ten vowels sent by the five speakers.

Table 2. Airflow data sheet

	[y]	[u]	[ɿ]	[i]	[ʅ]	[ɛ]	[o]	[ɚ]	[ɤ]	[ᴀ]
Expiratory airflow duration	786.2	781.2	749.5	690.8	675.6	659.2	641.1	607.0	587.1	550.4
Average airflow speed	150.2	210.0	112.6	122.1	140.4	138.8	132.5	164.5	128.5	114.8
Airflow volume	119.4	165.1	84.1	83.9	94.7	91.8	84.9	97.8	75.4	63.2

By plotting the data in Table 2, you can see the relationship between the length of the vowels, the average airflow velocity, and the airflow.

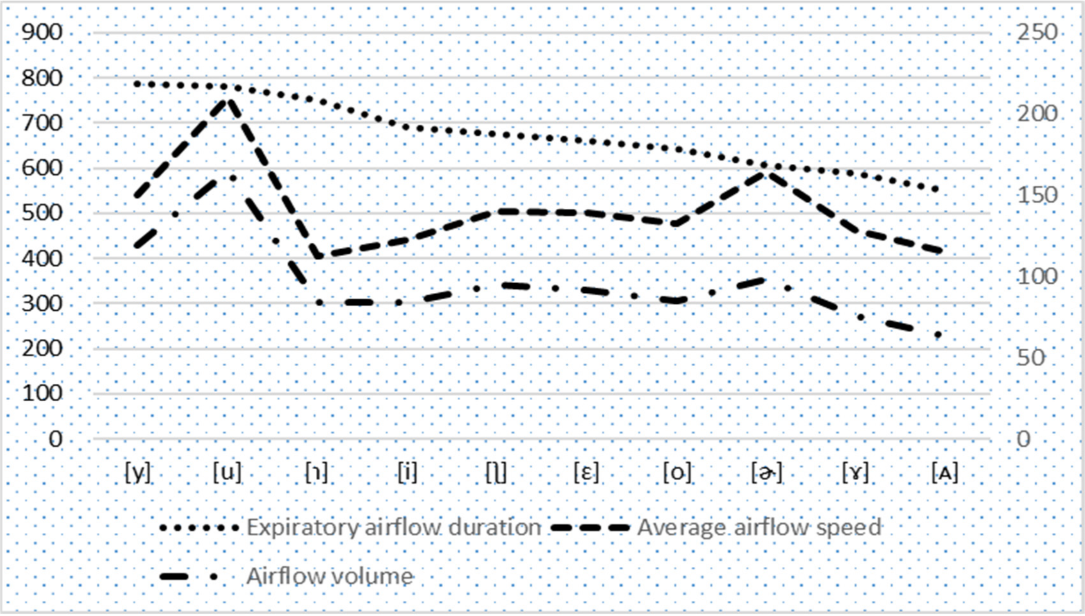

Figure 1. Vowel pronunciation parameter comparison chart

As can be seen from Fig. 1, the vowel [y] [u] has the longest pronunciation time, followed by the vowel [ɿ] [i] [ʅ], and the vowel [ʌ] has the shortest pronunciation time. It can be concluded that the general rule is that the vowel with high tongue position has longer pronunciation time than the vowel with low tongue position. According to the line diagram of the average air velocity of vowels, it can be seen that the average air velocity of vowels [u] is the largest, followed by curling vowels [ɚ], rounded lip vowels [y] and back vowels [ʅ], and the average air velocity of high vowels [ɿ] before the tip of the tongue is the smallest. The vowel air flow broken line chart is consistent with the vowel average air velocity line chart. The vowel air flow is mainly affected by the pronunciation time and the average air velocity. The vowel [u] [y] air flow is the largest and the vowel [ʌ] air flow is the smallest.

4. Discrete Analysis of Vowel Pronunciation Airflow Data

The data of vowel pronunciation time and average airflow velocity are normalized and the following scatter plots are obtained.

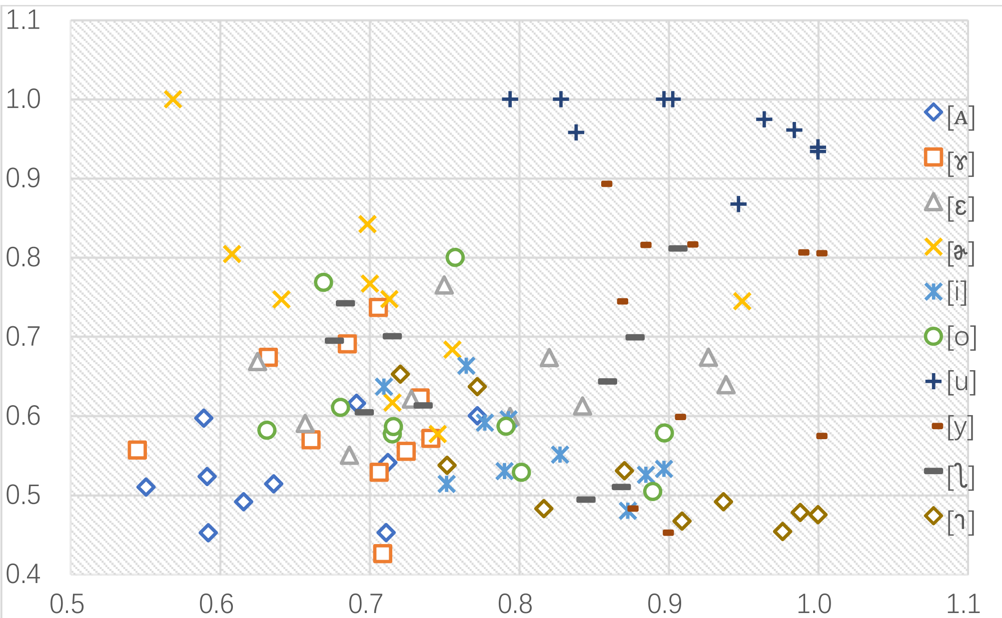

Figure 2. Vowel distribution scatter plot

Figure 2 shows the distribution of normalized vowel duration and average airflow velocity data. It can be seen that each vowel has its own airflow distribution range. The general value of [u] is the largest regardless of the duration of pronunciation or the average airflow velocity, and the pronunciation duration and average airflow velocity are generally the smallest. It can also be seen that the normalized data of [ɤ] are distributed vertically in the table, which shows that the average air velocity of [ɤ] pronunciation is greatly affected by the different pronunciation habits of each person. [i][ɿ][ʅ] The distribution of the three front vowels at the tip of the tongue is generally transverse, which is greatly affected by the pronunciation time. Their pronunciation time will be different because of the pronunciation method of the pronunciation. [u][y] Has the largest pronunciation flow.

After calculating the average value of the pronunciation time and air velocity of different vowels according to the formula, the obtained data indicate that the air flow of the vowel is affected by the individual pronunciation methods and differences.

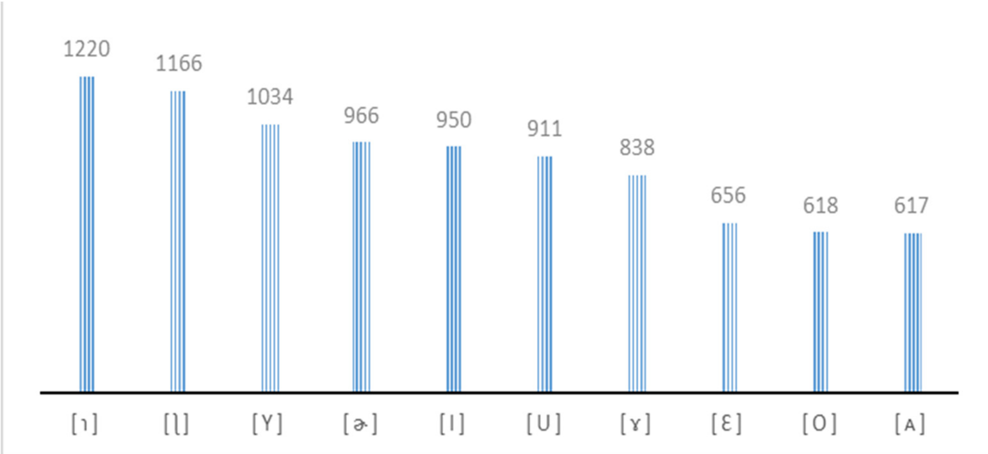

Figure 3. Vowel dispersion histogram

Drawing a histogram of the obtained data, we can see that the stability of the pronunciation airflow is poor, and that the stability of the pronunciation airflow is higher. The order of the stability of the pronunciation airflow is as follows: [ᴀ] > [o] > [ɛ] > [ɤ] > [u] > [i] > [ɚ] > [y] > [ʅ] > [ɿ]. As the tongue position increases, the stability of the pronunciation airflow data becomes worse.

5. Summary

It is clearly that the main factors affecting vowel pronunciation are the height of the tongue, the front and back of the tongue, and the roundness of the lip. However, the air flow in vowel pronunciation is still unclear. With the development of speech aerodynamics, these physiological mechanisms of pronunciation that are not easily explained will be gradually explained. In this experiment, the basic vowels of Mandarin Chinese are taken as the research object, and the differences in pronunciation duration, average pronunciation airflow velocity, airflow volume, and the stability of the pronunciation airflow data of different vowels are studied in the process of transmitting different vowels. The basis for the study of vowel pronunciation and airflow related data in the future.

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