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The Effect of Cavity Resonance on the Timbre of Vowels

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ABSTRACT
Vocal music is an art that combines music and language which is the foundation of vocal music. From the subjective hearing point of view, people generally think that the sound position of Bel Canto is backward, and the sound is produced through nasal resonance. The timbre is relatively dim. People usually use their throats to vocalize rather than the nasal cavity, chest cavity or even head cavity to resonate, making a thick loud and penetrating sound. This paper used the method of experimental research, which asked several professional student studying bel canto using two types of pronouncement method to show the differences of the performances of resonance and non-resonance of vowels in Bel Canto. Besides, this paper used praat which is an audio analysis software to analyze the formants of different causes and drew the following conclusions: firstly, because vowels are in Bel Canto. When singing, there will be a back movement of the resonance point; secondly, at the same pitch, the pronunciation of the back vowel is clearer than the pronunciation of the front vowel.

Keywords: *Bel Canto, Phonetics, Vowels*

1. INTRODUCTION

Under the influence of the Renaissance, opera gradually came into being, and the bel canto method was gradually improved. Perrigan wrote the first Italian opera "Daphne". The composer's creation made the opera a breakthrough in the previous singing method. The opera requires the combination of aria and recitative, and the combination of chorus and recital. The recitative requires sufficient breath support, and the bright and beautiful sound can penetrate the symphony and reach the ears of the audience. Its appearance has caused the continuous development and change of Bel Canto. Bel Canto entered China after the May 4th Movement, and has gradually developed vigorously. Most scholars nowadays study the character analysis of Bel Canto in the Chinese language, the head cavity resonance of Bel Canto, and the relationship between timbre and voice of ethnic singing. Some scholars believe that common singing voices put more emphasis on the use of labial and dental sounds than bel canto [1]. There are also scholars who believe that many learners pay more attention to the training of generative skills, often practice Italian bel canto singing skills, and do not pay enough attention to the bel canto singing training of Chinese songs, and ignore the practice of biting and articulating Chinese songs, which directly leads to the skills of biting and articulating. Methods are relatively scarce [2]. Few people have studied the influence of vocal resonance in Bel Canto on the vowel tone. Therefore, the author took the influence of cavity resonance on the timbre of vowels as the subject of this article, and studied the influence of vowels on formants in depth. This paper uses the method of experimental research which ask several professional student studying bel canto using two types of pronouncement method to show the differences of the performances of resonance and non-resonance of vowels in Bel Canto, and uses praat which is an audio analysis software to analyze the formants of different causes which is the main research method of this article, and the conclusions drawn from the analysis can enable scholars and bel canto learners to better understand the resonance mode of vowels.

2. VOWELS IN SINGING

2.1. Chinese vowels and singing timbre

The sound of Chinese characters is composed of vowels and consonants. The sound at the beginning of each word is “consonant” and the ending sound is “vowel”.. Singing is mainly to sing the abdomen part of the vowel. Therefore, the influence of voice on timbre of

singing is mainly reflected in the vowels. Different consonants have different obstruction parts and methods. In addition, consonants also have differences in voiceless, aspiration, and various additional sounds. The acoustic characteristics are often composed of several aspects. Its acoustic characteristics are more complex than vowels. Consonants can be distinguished on the sonogram. The difficulty of distinguishing consonants is much more than distinguishing vowels, so this article focuses on the influence of vowels on singing timbre.

2.2. Vocal resonance

2.2.1. Resonance

Resonance refers to a sound produced by an object due to vibration. This phenomenon that the sound crosses to other objects and causes resonance of other objects is called resonance. Sound production requires a vibrating body, a medium (air and others) and an eardrum to listen to the sound. The ripples produced by the medium when an object is struck and vibrated are called sound waves. This kind of sound wave is transmitted through the eardrum of people by the medium to become sound. When a sound body is vibrating, it can emit a fundamental tone, meanwhile, emit some small sounds at the same time. For example, the vibration rate of a string is 400. When its microwave reaches an object that vibrates 440 times per second, the object will be affected by the vibration to cause resonance. The process of forming resonance in the human body is from singing and vocalizing to using the many resonance-generating spaces in the human body to make the breath impact the vocal cords and the fundamental tone appears. Although this fundamental tone is very weak, it produces different forms of acoustic resonance as soon as it enters the inherent resonance space of the human body, thus a beautiful and pleasant singing voice appears.

2.2.2. The relationship between vocal resonance and vowels

Vocal resonance is the determinant of vowel tone. There are two main steps in the vocal process of vowels. The first is the vibration of the vocal cords to produce vocal cord sounds. The second is the rise of the soft palate and uvula. The passage to the nasal cavity is blocked and the vocal cord sounds can be transmitted from the oral cavity. Among the many human vocal cavities, the oral cavity is the most flexible and variable cavity. In addition, the different vowel timbres are formed by the influence of every subtle change in the oral cavity on the resonance of the vocal cords. The sound channel formed by the larynx, pharyngeal cavity, oral cavity and lip cavity constitutes a resonant cavity that is curved slightly at a right angle. The resonant cavity is known as a tube with one end opened and the other closed. According to the principle of acoustics, this kind of tube has a certain resonance frequency. Human's vocal cords are located at the closed end of this tube. When air flows through the vocal cords, the air flow will drive the vocal cords to vibrate to produce vocal cord sounds. The vocal cord sounds enter this tube and resonate in the tube, and finally exit from the open end of the tube. Vowels are formed. The resonance of the tube is related to the shape of the tube, and different shapes of tubes also form different vowels.

2.3. The way of resonance in bel canto

The resonance cavity of singing is divided into chest cavity resonance, oral cavity resonance, nasal cavity resonance and head cavity resonance. The actual vibration of chest resonance comes from the oral cavity. Because there are human organs such as the heart and liver in the chest cavity, but it cannot vibrate. The chest cavity and the oral cavity are connected together. To a large extent, they are the sound of mind and imagination. Oral resonance is the largest resonance cavity, which plays a role in the convergence of high school and bass in singing. When people are yawning, any movement of our mouth will affect the sound quality and timbre of singing. Nasal cavity resonance is also called “nasopharyngeal cavity resonance”. The upper part of the nasopharyngeal cavity is the skull and the lower part is the soft palate. The nasal cavity and the nasopharyngeal cavity form a resonance space. When the sound enters the nasal cavity, it is controlled to produce a resonance effect. To emphasize, the nasal cavity is the passage leading to the resonance of the head cavity. Do not take it as the end point. Many people mistakenly think that the nasal sound is the resonance of the nasal cavity. This is completely wrong. This will make the sound tight to the throat, and the high pitch will not go up. Head cavity resonance refers to the parts above the eyes and forehead, using the soft palate and pharyngeal wall power of the nasopharyngeal cavity to control the sound entering the nasal cavity and directly into the head cavity. Many people do not use cephalic resonance when singing songs, leading to thinking that there is no treble.

3. METHOD

3.1. Data collection

The four singers selected in this experiment are all students of the Central Conservatory of Music, who have received professional guidance and training for many years. The purpose of the experiment is to study the formats of vowels in bel canto. In this experiment, the author asked each singer to sing the entry, mi, ma, mu, twice with ordinary singing and bel canto, respectively, while keeping the same pitch. Then, the author used professional audio analysis software praat to analyze the frequency and amplitude of its format.

3.2. Data analysis

3.3. Results and discussion

It can be clearly seen in figure 1 that when mi and ma are in normal singing, H1-H2 are positive values, which are breathy voice; in Bel Canto, H1-H2 are negative values, which are breathy voice. On the contrary, when mu is in common singing and bel canto, H1-H2 are negative values, which is creaky voice.

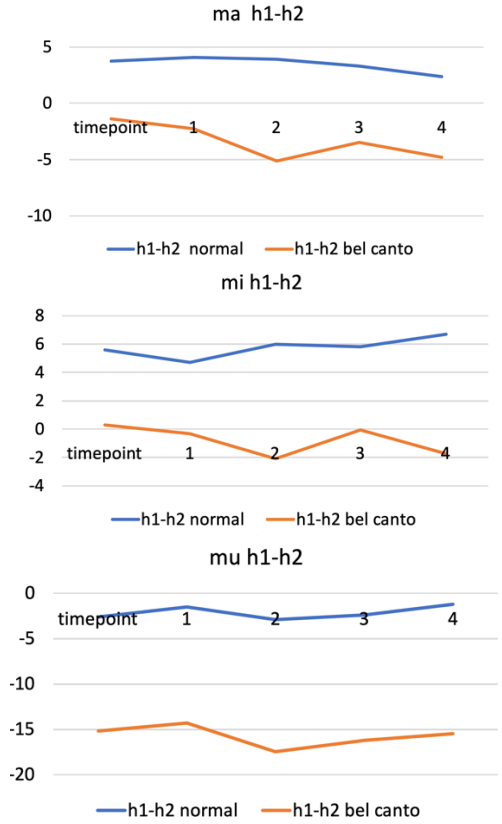

Figure 1. Result of the first trail.

When studying F1, the author found that mi, ma, and mu all have low F1. The reason is that a, i, and u have higher tongue positions in pronunciation, but the F1 value of u is significantly lower than that of a, i, because u when vocalizing, there is an obvious pinch, and the resonance point also slightly shifts back.

When studying F2, it was found that mi has high F2, indicating that i is a front vowel, and the sound is mainly produced through nasal vibration; while ma and mu have low F2, indicating that a, u are back vowels, and the sound mainly passes through the back of the oral cavity. The part vibrates and makes a sound. At the same pitch, the pronunciation of the back vowels when the singer sings is cleaner than the pronunciation of the front vowels.

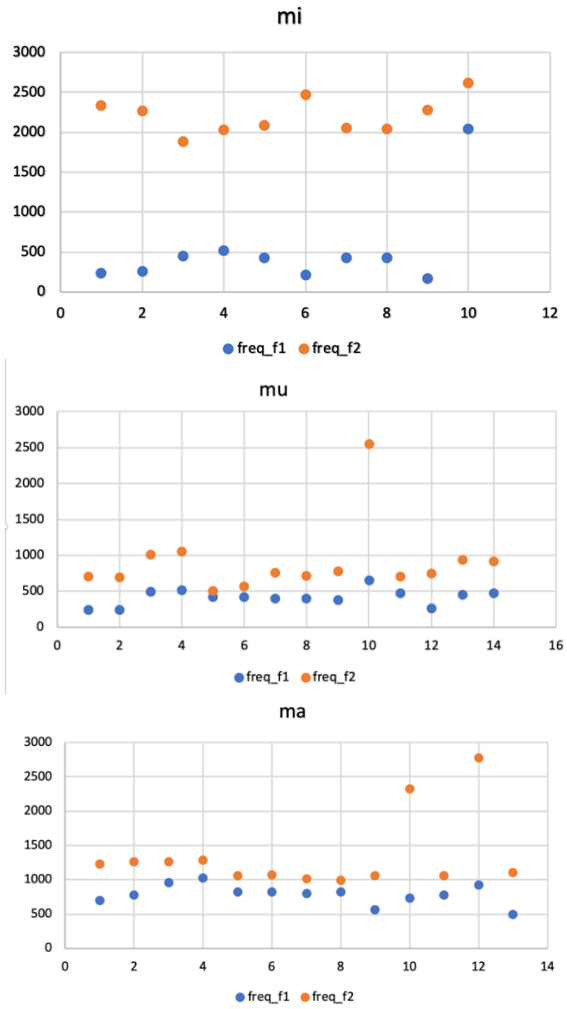

Figure 2. Result of the second trail.

4. CONCLUSION

This article has some shortcomings in the research. Due to the tight scientific research time, the sample size selected in the experiment is small, and there may be some one-sidedness. If there is sufficient scientific research practice, the sample size will be expanded to about 100 people for more comprehensive analysis and research. At the same time, the two vowels that are not studied in the article will also be added to the entry to make the article more comprehensive.This paper analyses the difference of cavity resonance and resonance point between bel canto and general singing. Compared with previous studies, previous scholars focused more on the analysis of articulation by comparing bel Canto and common long hair, and few scholars analysed vowels. My research can fill this gap and make the whole academic research more complete.

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