ISSN 2618-1568 Vol. 6, Issue 12: 107-113, DOI: 10.25236/FAR.2024.061216

Research on the intonation problems and countermeasures in bamboo flute performance

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Abstract: *The bamboo flute is a traditional Chinese folk instrument with a long history. It has a pleasant sound and strong national characteristics. In bamboo flute performance, the intonation problem of the bamboo flute greatly affects the expressiveness of bamboo flute performance. Due to the influence of factors such as the production process of the bamboo flute, the skill level of the performer, and the performance environment, the intonation problem has always been a challenge faced by performers. Therefore, in order to ensure a good performance effect, the problems that affect the intonation of the bamboo flute must be solved in advance. This article will be divided into four parts. The first part explains the influence of objective factors on the intonation of the bamboo flute, the second part is the influence of subjective factors on the intonation of the bamboo flute, the third part will propose effective countermeasures to solve the intonation problem in bamboo flute performance based on the influencing factors, and the fourth part summarizes the intonation problems and countermeasures in bamboo flute performance.*

Keywords: *bamboo flute performance; intonation; countermeasures*

1. Introduction

As one of the traditional Chinese wind instruments, bamboo flute has a long history and carries rich cultural connotations. Bamboo flute has a unique timbre and soft sound quality. It is widely used in various types of folk music and art performances in China and has an irreplaceable position. With the diversification of musical expressions and the continuous development of playing skills, the performance of bamboo flute has higher and higher requirements in terms of timbre, skills and artistic expression. However, in the actual performance of bamboo flute, the problem of intonation is always a challenge that cannot be ignored.

The problem of intonation directly affects the artistic effect of bamboo flute performance. As an instrument made of natural materials (bamboo), the bamboo flute has great differences in its production process, and the pitch, timbre and other characteristics of different bamboo flutes are often different. In addition, the differences in skills and musicality of bamboo flute players, and factors such as temperature and humidity in the performance environment will also have a great impact on the intonation of bamboo flute. Therefore, the intonation problem of bamboo flute is usually the result of multiple factors, both objective and subjective.

At present, there are relatively few studies on the intonation problem of bamboo flute. Most of the studies focus on the timbre characteristics and playing skills of bamboo flute, and few of them explore the specific causes and solutions of intonation problems. With the continuous advancement of bamboo flute playing technology and the improvement of the requirements for musical expression, the solution of intonation problems is particularly urgent. Therefore, in-depth analysis and research on bamboo flute intonation problems and the proposal of effective coping strategies are not only of great significance to improving the level of bamboo flute playing, but also helpful to promote the inheritance and development of bamboo flute art.Based on this, this paper will conduct a systematic study on the intonation problem in bamboo flute playing, analyze the main factors affecting intonation, and propose corresponding solutions, in order to provide practical guidance for bamboo flute players and promote the improvement and development of bamboo flute playing art.

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2. Analysis of Factors Affecting Bamboo Flute Intonation

2.1 The influence of the instrument itself on pitch

The quality of bamboo flutes is a basic issue that affects the accuracy of bamboo flutes. The three elements that measure the quality of bamboo flutes are: bamboo material, sound quality, and pitch. As the saying goes, "If you want to do your job well, you must first sharpen your tools." If the quality of the bamboo flute itself makes the pitch inaccurate and the interval relationship inaccurate, it will be difficult for the performer to adjust the pitch accurately, thus affecting the pitch effect when playing. There are two factors that affect the quality of bamboo flutes: one is the quality of the bamboo, and the other is the production process of the bamboo flute.

Zhou Linsheng, a contemporary master of flute making in my country, once said that a good bamboo may not necessarily make a good flute, but a good flute must come from a good bamboo [1]. The raw materials for making bamboo flutes are bamboos that grow under the influence of the natural environment, including bitter bamboo, white bamboo, purple bamboo, water bamboo, etc. The growth environment and soil conditions of bamboo are different, and the quality of bamboo varies, so bamboo flutes cannot be mass-produced by machines. In the process of making bamboo flutes, many processes are required, such as material selection, bamboo sawing, bamboo roasting, polishing, hole opening, and tuning [2]. Each process requires careful production and adjustment to ensure the quality and pitch of the bamboo flute. If the production process is rough or the tuning is inaccurate, the bamboo flute will have problems with pitch. Therefore, it is very important to choose brands and manufacturers with exquisite production process and accurate tuning.

From the perspective of traditional musical habits, the musical temperament of traditional Chinese music is not fixed. It does not completely follow the twelve-tone equal temperament or pure temperament, such as Guangdong music and Kunqu opera. This special temperament system representing the Chinese national style is also more or less reflected in the production of bamboo flutes. For example, an average value is found between the twelve-tone equal temperament and the special temperament system for punching. This kind of design requires the performer to adjust the mouth wind and breath according to the needs of the music to make up for the defects of the temperament. For the C-tuned bamboo flute, the second tone hole B and the first tone hole A are always narrow to a full-tone relationship, but the degree of accuracy is always unclear, which makes it difficult to change the key.

At present, the current situation of bamboo flute punching and tuning has brought challenges to the pitch control in bamboo flute performance. But this also reflects the diversity and complexity of the use of musical tones in traditional Chinese music, and it also shows the unique artistic charm of the bamboo flute as an instrument.

2.2 Impact of environmental factors on pitch

Environmental factors are important factors that affect the pitch of bamboo flutes. They are mainly manifested in the following two aspects: one is the temperature of the playing environment, and the other is the air humidity of the playing environment.

The bamboo flute is one of the national musical instruments that is more sensitive to temperature changes. Bamboo has the characteristics of thermal expansion and contraction, so the external temperature will affect the pitch of the bamboo flute. For example, in summer, the bamboo flute is affected by the high temperature outside, and the moisture inside and on the inner wall continues to evaporate, resulting in a high pitch. Similarly, in winter, the bamboo flute is affected by the low temperature outside, and some moisture condenses inside, making the bamboo flute pitch relatively low. According to calculations, if the ambient temperature increases or decreases by ten degrees, the flute will change by thirty cents [3]. Even if the temperature varies greatly within a day, it may have a certain impact on the pitch of the bamboo flute. The human body temperature is 37°C. Wind instruments produce sound by blowing the breath exhaled by the human body into the bamboo tube. As the playing time increases, the actual temperature in the tube increases. This temperature change will have different degrees of influence on the vibration frequency of the bamboo flute[4]. Temperature is extremely unstable, which greatly affects the stability and accuracy of the bamboo flute's pitch when playing. The ambient temperature affects the tightness of the flute membrane, which directly affects the timbre and pitch of the performance.

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Air humidity is also an important factor affecting the pitch. The bamboo flute produces sound by the vibration of the breath in the tube. Therefore, the density of the bamboo and the degree of dryness of the material have a great influence on the vibration frequency of the bamboo, which also directly affects the pitch of the bamboo flute. The sound of the flute is low when it is wet, and high when it is dry[5]. In a humid environment, the bamboo flute easily absorbs moisture, which affects the frequency of the breath vibrating in the tube, and the pitch of the bamboo flute will be low; in a dry environment, the pitch of the bamboo flute will be high. Therefore, maintaining the proper humidity level is crucial to keeping the bamboo flute in tune.

2.3 The influence of the flute membrane on the intonation of bamboo flute

The flute membrane is a thin film attached to the membrane hole of the bamboo flute, usually taken from the stem of bamboo or reed. After the flute membrane is attached, the air flows through the vibration to produce a clear and bright sound. The pronunciation, timbre and volume of the bamboo flute are closely related to the quality and attachment method of the flute membrane, especially the impact on the intonation. A high-quality flute membrane should have good air permeability, moderate elasticity and strong durability, which can make the timbre of the bamboo flute clearer and more beautiful. On the contrary, a poor-quality flute membrane may cause problems with intonation and timbre. For example, if the flute membrane is too thick, the pronunciation will appear dull and lack brightness; if the flute membrane is too thin, the pronunciation will be hoarse and lack sensitivity, thus affecting the performance effect. Therefore, choosing a high-quality flute membrane is crucial to ensuring the intonation and timbre of the bamboo flute. The tightness of the flute membrane also has a direct impact on the intonation. If the flute membrane is attached too loosely or too tightly, it will not only affect the timbre, but also make some sounds abnormal. A flute membrane with moderate tightness can make the timbre brighter and the pronunciation louder. If the membrane is slightly loose, the pitch may be low; if the membrane is too tight, the pitch may be high. In addition, the tightness of the membrane is also affected by changes in ambient temperature. When the room temperature is high, the membrane will be tight; when the temperature is low, the membrane will become loose. This change will further affect the stability of the bamboo flute's pitch.

2.4 The influence of subjective factors on bamboo flute intonation

The intonation problem in bamboo flute performance is closely related to the player's performance skills. The main performance technical factors that affect the intonation are breath and mouth shape. Breath refers to a relatively concentrated and uniform airflow blown into the blowing hole by the bamboo flute player. It not only determines the timbre, volume and other important factors of the bamboo flute, but also affects the expression of the rhythm and melody of the music during performance. The sound-generating mechanism of the bamboo flute relies on the friction vibration generated by the player's breath and the edge of its blowing hole. Instruments with similar principles are collectively called edge vibration instruments [6]. From the perspective of the sound-generating mechanism of the bamboo flute, the player's breath control plays a vital role in ensuring the pitch. Breath factors include: breath speed, airflow angle, etc. The influence of these two aspects on the pitch is both complementary and mutually restrictive. There are three basic breathing methods for bamboo flute performance, namely chest breathing, abdominal breathing and chest-abdominal breathing. Among them, chest-abdominal breathing is the best breathing method. When using chest-abdominal breathing, the chest, waist and abdomen should be actively expanded when inhaling. When playing the flute, the waist and abdomen should be stretched to ensure smooth and controlled breathing [7].

Mouth shape refers to the shape of the mouth when playing bamboo flute. The control of breath angle depends on the coordination of mouth shape and abdomen. When playing, the lips should be closed naturally, and the lip muscles and facial muscles should be coordinated organically. Avoid puffing up the cheeks to affect the strength of pronunciation. Inaccurate mouth shape is one of the main reasons for intonation problems during the performance. During the bamboo flute performance, the performer adjusts the position of the upper and lower lips, changes the size and angle of the wind gate, and thus adjusts the flow rate and angle of the breath. When the pitch is too high, the performer needs to raise the lower lip appropriately, reduce the distance between the upper and lower lips, slow down the air flow speed, and thus reduce the pitch. The nervousness of the performer during the performance will also affect the pitch. In addition to having a good sense of pitch and solid basic skills, the performer must also have a stable mentality during the performance, which can not only reduce the pitch problems caused by tension, but also calmly deal with factors that affect the performance pitch

ISSN 2618-1568 Vol. 6, Issue 12: 107-113, DOI: 10.25236/FAR.2024.061216

and make corresponding adjustments. A nervous mentality can cause breathing problems, which in turn affects the control of breath, and can also cause tremors in the mouth shape and hands, which in turn affects the mouth shape and wind direction, causing deviations in pitch. Therefore, having a good performance mentality is the basis for perfectly displaying the results of daily practice.

3. Effective countermeasures to solve the problem of intonation in bamboo flute playing

3.1 Improve the performers' ability to select and identify musical instruments

For bamboo flute players, in order to improve their performance and present music perfectly, they first need to choose a high-quality bamboo flute. As a handmade instrument, the quality of the bamboo flute is affected by many factors. Therefore, when choosing a bamboo flute, the player must have a certain ability to identify to ensure that the selected instrument can provide sufficient guarantee for the performance effect. Since the precision of the craftsmanship cannot be fully controlled in the production process of the bamboo flute, the player should pay special attention to the quality of the raw materials of the bamboo flute and the rigor of the production process. First of all, when choosing a bamboo flute, the player needs to carefully observe the raw materials of the bamboo flute and understand the type, source and treatment of the bamboo. These factors directly affect the timbre and pitch stability of the bamboo flute. High-quality bamboo usually has clear texture, is tough and elastic, and has good sound conductivity. In addition, the player should also understand the process and technology used in bamboo flute production, and choose those instruments produced by well-known brands or experienced bamboo flute masters. Although the price of these bamboo flutes may be higher, their exquisite production process and strict quality control can effectively ensure the purity of the timbre and the accuracy of the pitch. When choosing a bamboo flute, in addition to considering the brand and production process, actual timbre testing should also be carried out. By playing repeatedly, the player can have a comprehensive understanding of the bamboo flute's timbre, pitch, responsiveness, etc. The balance of timbre, the stability of volume, and the accuracy of pitch are important manifestations of the quality of the bamboo flute. Therefore, the player needs to choose the most suitable bamboo flute according to his or her needs and playing style. In order to more accurately evaluate the pitch of the bamboo flute, the player should also use tuners and other equipment as standard references to conduct scientific pitch tests. Through comparative analysis with the standard pitch, the player can better understand the pitch of the bamboo flute and ensure that the selected bamboo flute can provide stable pitch performance during the performance. Through this systematic testing and analysis, the player can choose the bamboo flute with the most comprehensive quality, thereby providing the best instrument support for his or her performance. In short, when choosing a bamboo flute, the player should not only pay attention to the appearance and production process of the bamboo flute, but also have a deep understanding of the various performances of the bamboo flute through actual timbre testing and pitch comparison. This process can not only help the player find the most suitable instrument for himself or herself, but also lay a solid foundation for improving the overall performance effect.

3.2 Improve the performers' musical literacy and establish a good concept of pitch

For bamboo flute players, establishing a good concept of pitch is not only the basis for completing the performance of the work, but also the basic musical literacy they must possess. Pitch is one of the core elements of music, and accurate pitch perception is crucial for performers. For those performers who have difficulty in grasping pitch, it is necessary to gradually improve their pitch perception ability by strengthening sight-singing and ear-training training and pitch hearing exercises. Through systematic training, performers can gradually master the pitch relationship between each note and transform this relationship into muscle memory, so that they can naturally and accurately grasp the pitch during performance and avoid pitch deviation.

In bamboo flute performance, in order to ensure the accuracy of pitch, performers must constantly strengthen their concept of fixed pitch and form a stable perception of pitch. The stability of pitch is not only related to the accurate performance of a single note, but also directly affects the musical performance of the entire work. Therefore, performers should strengthen pitch training in various ways to improve their ability to identify and control pitch.

A relatively effective training method is to use a tuner for long tone training. When playing long notes, the performer can observe the pitch displayed by the tuner to understand the accuracy of the

ISSN 2618-1568 Vol. 6, Issue 12: 107-113, DOI: 10.25236/FAR.2024.061216

notes he plays in real time. If the pitch displayed by the tuner deviates from the standard pitch, the performer can adjust his breathing control and blowing angle according to the feedback of the tuner to ensure that the notes are within the correct pitch range. This method helps the performer to form a sensitivity to pitch and a stable pitch concept during the performance. Especially for those performers with weak pitch concepts, this real-time feedback training can effectively improve their pitch control ability and cultivate their intuitive grasp of pitch.In addition, the performer can also combine sight-singing and ear training with rhythm training to comprehensively improve their music perception ability. Through continuous practice, the performer can deepen his understanding of the pitch relationship, so that he can more accurately grasp the pitch of each note in actual performance. This comprehensive training can not only help the performer to accurately play the pitch of the bamboo flute, but also improve his overall musical literacy, so that he can better express the emotion and connotation of music during the performance.

In short, improving the performer's pitch concept and pitch control ability is the key to bamboo flute performance. Through systematic auditory training, long tone tuning training and other pitch perception exercises, players can gradually establish a stable pitch concept, providing a solid foundation for high-quality bamboo flute performance. This not only helps players improve their performance skills, but also enhances their overall grasp of music and improves the expressiveness and artistry of their works.

3.3 Strengthen the basic skills training of performers

Bamboo flute playing skills can be roughly divided into four basic skills: breathing, fingering, tongue technique and mouth shape. The mastery of each skill directly affects the performance of bamboo flute playing, especially in the stability and expressiveness of intonation. In the process of bamboo flute playing, the coordinated use of these basic skills is crucial. Therefore, strengthening the training of these basic skills is the basis for improving the performance level and solving intonation problems.

First of all, breathing control is a difficult point in bamboo flute playing and a key factor affecting intonation. Players need to control the speed, diameter and angle of the airflow to ensure the stability of breath and the accuracy of intonation. In order to enhance breathing control ability, players can perform long tone training. Long tone training requires players to maintain a stable and firm volume during the performance, while ensuring the accuracy of pitch and maintaining intonation consistency between high and low scales. In addition, players can also improve the stability of breath by strengthening waist and abdominal strength training, such as scientific fitness training such as plank support and sit-ups. Through these comprehensive breathing training, players can better control their breath and maintain stable intonation during the performance.Secondly, the flexibility and accuracy of fingering are particularly important when playing fast passages or pressing half-hole notes. If the finger is not flexible enough, or the pressing force is too large or too small, the accuracy of the pitch will be affected. Therefore, fingering training must pay attention to the elasticity and flexibility of the fingers. The performer should practice independent finger bouncing every day, gradually enhance the flexibility and lightness of each finger, and ensure that each finger can move freely and harmoniously. Especially when playing quickly, the performer should pay attention to the independence of each finger and the accuracy of the movement, which helps to ensure the fluency of the performance and the accuracy of the pitch.When discussing the pitch of bamboo flute, mouth shape and tongue method also play an important role. The distance between the upper lip and the lower lip, the flexibility of the tongue, and the coordination of the lips and tongue will directly affect the pitch performance of the bamboo flute. In order to improve the basic skills of the lips and tongue, the performer can enhance the flexibility and coordination of the mouth through pronunciation exercises. These exercises can help the performer better control the flow of breath when playing, while ensuring that the tongue and lips cooperate more tacitly, thereby effectively avoiding pitch problems caused by uncoordinated mouth shape or tongue method.

The performance of bamboo flute is not just a single aspect of technology, but the organic coordination of breathing, lips, tongue and fingering. Any slight mistake or disharmony in any aspect may lead to deviation of pitch. Therefore, it is very necessary for bamboo flute players to practice these four basic skills every day. Through continuous basic training, players can gradually improve the stability of pitch and the expressiveness of performance, so as to achieve a higher artistic level in bamboo flute performance.

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Bamboo flute performance is a skill that requires multi-faceted coordination. Players must strengthen the training of basic skills such as breathing, fingering, tongue method and mouth shape in order to accurately control pitch and avoid deviation of pitch during performance. Through systematic basic skills training, players can not only improve their technical level, but also ensure the stability of pitch during performance, thus providing strong support for the performance of music and emotional communication.

3.4 Improve the performance experience of performers

In order to achieve the control of the pitch when playing the bamboo flute, the performer should not only strengthen the hearing and basic skills of pitch in daily practice , but also constantly accumulate his own performance experience. Since the venue environment and stage equipment will affect the pitch during the bamboo flute performance, the performer is required to combine his own skills and experience, and take appropriate measures to adjust the timbre and pitch when facing the influencing factors to ensure that the performance achieves the expected effect.

Therefore, performers need to pay attention to the possible impact of different environments on pitch in daily training , and strive to improve their personal pitch recognition ability. Through continuous simulation practice, performers can gradually improve their skills and accumulate rich performance experience. In this way, during the formal performance, performers can grasp the pitch more accurately and effectively avoid mistakes in the performance . Rich practical experience can also help performers maintain a calm mentality on stage, avoid performance problems caused by excessive tension, and thus reduce the occurrence of pitch errors.

3.5 Improve the craftsmanship of bamboo flute makers

Bamboo flute makers should strive to improve their craftsmanship, because the sophistication of the craftsmanship directly affects the pitch of the bamboo flute and determines the quality of the bamboo flute.

Bamboo flute makers should first select raw materials. Choosing high-quality bamboo as raw material is the key to making high-quality bamboo flutes. High-quality bamboo has the characteristics of clear texture and uniform density, which provides a good foundation for making bamboo flutes with good intonation. Secondly, during the processing process, manufacturers need to master precise hole position and shape processing techniques. The location, shape, and size of the openings have a significant impact on intonation. The tuning link is also crucial. The pitch should be determined by referring to the frequency of the pitch meter to ensure that the pitch of the bamboo flute reaches its optimal state. In addition to the above specific process requirements, producers should also pay attention to the coordination and balance of the overall process. The production of bamboo flutes involves many links and steps. The maker needs to comprehensively consider the impact of each link on the intonation to ensure the coordination and balance of the overall process. For example, during steps such as roasting bamboo and peeling it, producers should control the heat and intensity to avoid adverse effects on the acoustic properties of the bamboo.

By improving the production process, bamboo flute makers can effectively reduce the problem of bamboo flute quality affecting the intonation of bamboo flutes. This will not only help improve the performance of bamboo flutes, but also help promote the inheritance and development of bamboo flute production skills.

4. Conclusion

The outstanding performance of the bamboo flute is largely determined by its timbre, volume, and pitch, with pitch being the most crucial element directly influencing the musical expression and emotional impact of the piece. A well-controlled pitch can elevate a performance, while pitch issues can detract from the overall musicality. The pitch of the bamboo flute, however, is subject to a variety of influencing factors, both objective and subjective. Objective factors, such as ambient temperature and humidity, are largely unavoidable, as these elements can cause natural fluctuations in the pitch during a performance. On the other hand, subjective factors, particularly those relating to the performer, such as breath control, playing technique, and physical coordination, require substantial practice and mastery over time.

ISSN 2618-1568 Vol. 6, Issue 12: 107-113, DOI: 10.25236/FAR.2024.061216

Through a thorough review of existing literature, research, and practical experience, it becomes clear that addressing the pitch problems in bamboo flute performance requires a multi-faceted approach. Specifically, five key strategies can be employed to improve pitch accuracy and overall performance quality: First, the performer must enhance their ability to select and identify high-quality bamboo flutes. Since the quality of the instrument has a direct impact on its pitch stability and tonal characteristics, it is essential that performers learn to choose bamboo flutes that are crafted with care and precision. This involves being knowledgeable about the materials, craftsmanship, and reputation of the flute maker, as well as understanding the relationship between the flute's physical attributes and its sound production. Second, performers must work on improving their overall musical literacy and establishing a strong sense of pitch. A solid understanding of pitch relationships, intervals, and tuning systems is fundamental to achieving accurate pitch control. This can be accomplished through ear training, sight-singing exercises, and the development of muscle memory for pitch, allowing performers to better internalize the correct pitch for each note and achieve greater consistency and precision. Third, strengthening basic technical skills is essential for improving pitch accuracy. The primary technical aspects of flute playing—breath control, finger dexterity, and articulation—are directly linked to the ability to maintain correct pitch. Exercises aimed at improving breath support, finger flexibility, and tongue coordination can help performers gain better control over the airflow and articulation, reducing the risk of pitch deviations during performance. Fourth, an accumulation of performance experience plays a crucial role in refining pitch control. As performers gain more experience, they develop a deeper understanding of their instrument's nuances and how environmental factors (such as temperature and humidity) affect the pitch. By regularly performing in different settings, musicians can become more attuned to the subtle changes in pitch and learn to make real-time adjustments, improving their overall pitch accuracy. Finally, the quality of the bamboo flute itself is critical, and flute makers must continue to improve their craftsmanship. The precision in the crafting process, including the selection of materials and the tuning of the instrument, plays a significant role in ensuring consistent pitch accuracy. Flute makers should focus on refining their techniques to produce instruments with better tonal consistency and more reliable pitch performance, which in turn allows performers to focus on their artistry without being hindered by instrument limitations.

In summary, solving the pitch issues in bamboo flute performance requires a comprehensive approach that addresses both the technical aspects of the performer's skill set and the quality of the instrument itself. By improving the ability to select the right bamboo flute, enhancing musical literacy, strengthening basic technical training, accumulating performance experience, and ensuring high-quality craftsmanship in instrument production, performers can achieve more accurate pitch control, leading to a more expressive and impactful musical performance.

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