

A STUDY OF DOCTORAL DOCUMENTS AT THE JACOBS SCHOOL OF MUSIC

by

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# **Abstract**

## **Introduction**

With the increasing number of students studying abroad, brass educators are challenged with teaching students who speak different native languages. This research project aims to investigate the relationship between the native language and brass playing, focusing on horn players who are either native English speakers or native Mandarin speakers.

## **Method**

The research was based on a self-evaluated survey sent to horn players worldwide. The survey asked the participants to rate their perceived difficulty levels in executing various horn techniques, describe their general tone qualities and articulation styles, and experience with players from different native language backgrounds and horn educations outside their home country.

## **Results**

The research results showed that there were significant differences between the native English speakers and the native Mandarin speakers in terms of their general articulation styles and their perceived difficulty levels of some techniques. Specifically, native English speakers found the following techniques to be easier to perform: ‘consistent sound quality through a phrase’, ‘rhythmic precision and stable pulse’, ‘gentle front ends of notes (softer attacks)’, ‘light-connected articulations in articulated scale passages’, ‘clear separated staccato articulation in scale passages’, ‘clear separated staccato articulation in scale passages’, and ‘flutter tongue’. Also, majority of the native Mandarin speakers described that they have a softer and more mellow articulation styles

versus to majority of the native English speakers described that they have a brighter and heavier articulation styles.

However, these differences were only found in the more experienced group of horn players who had studied/ played the horn for 20 years or more. No significant differences were found between the native English speakers and native Mandarin speakers in the less experienced group of horn players who have studied/ played the horn between 3 and 19 years.

### **Conclusion**

These findings indicate the need for developing teaching methods and exercises to help horn players overcome the barriers created by their native language and leverage the strength brought with their native language. They also suggest that brass educators should be aware of the linguistic backgrounds of their students and tailor their instruction correspondingly. Accordingly, four teaching methods are developed in this project to bridge the barriers and effectively enhance students' learning outcomes and experience.

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# Chapter 1: Introduction

## 1.1 Introduction

For many years, even today, many musicians, teachers, and scholars have treated music and language differently because they believe that music functions in the right hemisphere of the brain and language functions in the left hemisphere. However, the concept was challenged around 2004. Scientists and musicians started to closely examine the relationship between music and languages from various aspects, such as pedagogical methods for language learning, medical treatments, and brain activities. In the book '*Music and language: A developmental Comparison*' by Erin McMullen, the author found that the mechanisms of learning and memorizing music and language are similar (Erin McMullen 2004). Besides the similar learning mechanisms, music and language are both used for conveying ideas and thoughts, suggesting that they have strong connections and can interfere with each other.

This dissertation began in 2015 when I heard that players from different countries sounded differently from a trumpet teacher, Mr. Chen-Ho Yang. After hearing the idea, I started to observe players from other countries and notice the differences, such as tone quality, how the staccato sounds, and similar playing features among players who share the same native language. However, I did not understand the mechanism behind the fact. In 2016, when I came to America, I found two significant differences between horn players who are native Mandarin speakers and native English speakers. First, the percentage of native English speakers, who can play legato passages smoothly and efficiently, is far higher than native Mandarin speakers. Secondly, fewer native Mandarin speakers are challenged by clean and precise articulations. For native Mandarin speakers, playing staccato passages with energetic and focused tone color is much easier than for native English

speakers. Also, the tone color of the staccato is quite different. Native Mandarin speakers produce a brighter and bouncier sound, and native English speakers have a darker and less concentrated tone color in staccato passages.

Besides being aware of the differences in tones and performances between players from different native language backgrounds, various articles written by linguistic or language educators support the idea that different languages have different pronunciations, phrasings, etc. In 2013, Feifei Han mentioned, *'Even when a vowel exists in both Chinese and English, the sound's manner of articulation and place of articulation is different from that in English.'* (Han 2013)

Despite different training systems and brands of instruments, my hypothesis is that musical playing, especially brass playing, is highly affected by the native language. Since the native language is the first language we are exposed to and use daily, the setting of the inner mouth shape, the tongue placement, and how to use the airstream becomes the most comfortable and natural setting for us. While learning a second language or instrumental playing, the setting of the native language could be either beneficial or an obstacle for us.

## **1.2 Purpose of the study**

The purpose of this study is to research whether there is a relationship between native languages and brass playing or not. This paper will include discussion of the relationship between language and music, the benefits and obstacles created by languages, survey answers by volunteered horn players, and, more importantly, provide a solution and new pedagogical idea for learning, teaching, and performing brass instruments with people from different countries. The paper is separated into five chapters: Chapter 1. Introduction; Chapter 2. The mechanism of language and music; Chapter 3. Survey: Native languages and the brass playing; Chapter 4. Statistical analyses; Chapter 5. Summary and discussion.

### **1.3 Research questions guiding the study**

The leading questions include: 1) Whether horn players from different native language backgrounds perform differently or not? 2) Does the native language indicate a certain tone quality or articulation styles? 3) Do horn player think there are relationship between native language and brass playing?

## **Chapter 2: Personal reflections on the mechanism of Language and music**

### **2.1 How the native language interacts with brass playing/ learning**

Having experienced learning and performing the horn in the United States of America and Taiwan, I sensed the differences in horn playing and education between these two countries. The significant difference I found was that most native English speakers seemed to have different struggles and challenges than me. Playing melodies smoothly and connectedly was much easier for the native English-speaking horn players around me while I struggled to figure out how to play the phrases more smoothly. Conversely, it was easier for me to play fast single-tongued articulations and stronger front-end of notes while the other native English-speaking horn players around me were having more difficulty articulating notes more precisely and more directly.

Starting from that moment, I listened carefully to the music performed by horn players with different native language backgrounds and focused on comparing their tone qualities and articulation styles. From the music played by players from different native language backgrounds, I could feel and identify the differences.

About five years ago, I started learning a new language: Persian (Farsi). Persian language and English both belong to the Indo-European language family. While learning Farsi, my first difficulty was pronouncing the ‘rolled R’. To learn the sound of the ‘rolled R’, I had to force myself to get familiar with the vibration of the tongue and the force of the air, which I had never experienced while speaking in Mandarin. I gradually learned how to produce the ‘rolled R’ sound.

After this success of producing the sound of the ‘rolled R’, I thought about a couple of horn players and teachers who told me that ‘if you know how to pronounce the ‘rolled R’, you would

be able to play flutter tongue without effort.’ With that thought and curiosity, I started to practice the flutter tongue with the feeling of pronouncing rolled ‘R’. Suddenly, I could execute the flutter tongue. (I could not produce the flutter tongue before learning Persian.) Even though the ‘rolled R’ I produced did not sound as natural as the natives, creating a similar pronunciation helped me a lot in speaking Persian and elevating the horn-playing technique of flutter tonguing.

Following this achievement, I put lyrics to the horn music. I experiment with the *Lied, op. 28*, composed by Leone Sinigaglia. First, I wrote down two sets of lyrics: the English version and the Mandarin version. Second, during the experiment, I recorded singing in two languages with the same melody. Then, I played it in front of various horn players and professors to listen carefully to my articulations, phrasing, and tone color. We agreed that the melody I played and sang in different languages made the music, phrasing, and tone colors sound different.

When singing with Mandarin lyrics, I tend to have a brighter tone. Also, it is more challenging for me to sing the melodies without separating the notes. However, when I sang in English lyrics, the voice became darker than in Mandarin lyrics, and the melodies did not have severe clunkiness.

Then, I recorded myself playing the melody on the horn two times. The first time, I played the melody while thinking of the Mandarin lyrics in my head, and the second time, I played the melody while thinking of the English lyrics in my head. It turned out that the articulations were more direct but clear when I was singing the Mandarin lyrics. However, the phrases were noticeably chunkier. I sounded smoother on the recording playing while thinking of the English lyrics, but the articulations were relatively blurred.

With the experiments I mentioned above, I felt the strong connections between native languages and horn playing. Also, I felt the ease of learning new techniques and practicing music



from the angle of languages. I tried to learn the flutter tongue for more than six years without success and gained a hatred for learning it. However, after learning the vibration and the mechanism from the language, I felt less stressed about trying and learning the flutter tongue techniques.

Different teaching approaches and pedagogical methods would help students engage more. Also, it could be helpful for students who failed to learn with the original methods.

*‘Learning to speak a foreign language, particularly as an adult, can be challenging and time-consuming. Some modern language teachers use songs in the classroom or employ musical and rhythmical mnemonic devices as ways to reinforce the learning of foreign language material.’ (Anton 1990)*

Music has proven helpful in learning a second language. I believe it would also be useful the other way around. However, before proposing new horn pedagogical methods, it is necessary to know more about the mechanisms of the languages.

## **2.2 Comparison between English and Mandarin speaking**

### **Stress accent language and tonal language**

English is a stress accent language. The stress or accent is the emphasis that adds to a particular syllable in a word or important informational words within a sentence. There are two types of stress: ‘Stress of the word’ and ‘Stress(es) of the sentences’ in English. ‘Stress of the word’ adds stress to the designated syllable. Each word can only contain one primary stress, though some may contain secondary stress. Primary stress is more substantial and louder compared with the secondarily stressed syllables. Knowing the stress of the word is one of the critical factors to expertise in speaking in English. ‘Stress(es) of the sentences’ emphasizes the content word(s) within a phrase and makes the sentence more understandable. For example, the phrase “It is good

to see you” emphasizes ‘Good’, ‘See’, and ‘You’ since they are vital to the sentence. Adding stress to a sentence is like adding accents to music. The correct placements of the accents make the music more expressive and exciting.

However, accents and stresses do not alter the pitches. The words and phrases of English are relatively smooth and stable even it has subtle pitch contour. Due to the relatively monotonous tone, the airstream used while speaking in English is straight and direct compared with speaking in Mandarin. The straight and direct airstream is valued highly in brass playing since it helps players to play the music in a clean and relaxed manner. Especially in lyrical playing, it helps players smooth and fills the gap between notes.

Mandarin is a tonal language, which means the tones determine the meaning of the words even when words share the same pronunciation. Take words 歌 (Ge-)、隔 (Ge´)、葛 (Geˇ)、各 (Ge`)、个 (Ge·) as an example. All of them are enunciated with ‘Ge’, but because of adding different tones, none of them share the same meaning: 歌 (Ge-) means ‘Song’; 隔 (Ge´) means ‘Separation’; 葛 (Geˇ) refers to a specific type of the plant; 各 (Ge`) refers to ‘Each’; 个 (Ge·) is a quantifier.

To produce different tones, adjusting the direction of the airstream becomes essential. For example, on the first tone: flat tone (-), the airstream stays straight and forward, which equally vibrates both tongue and the soft/ hard palate, like the common airstream used while speaking in English; on the second tone: uplifting tone (´), the airstream pushes upward and ends with vibrating on the soft/ hard palate in the mouth; on the third tone: the ‘down and up’ tone (ˇ), the airstream needs to be bent down first, then change the direction toward the soft/hard palate in the mouth; on the fourth tone (`), the air is bent down and vibrates only on the bottom parts of the

inner mouth and the bottom lip; on the fifth tone: the light articulated tone ( · ), the sound is similar to the staccato, which is produced by the air attack from the back of the inner mouth.

With various types of airstreams and placements of vibrations, most brass instrument players, whose native language is Mandarin, struggle with unifying and straightening the airstream. The instinct of the native language would easily dominate the inner mouth shape and how to use the air unconsciously. However, luckily, a tonal language brings not only disadvantages but also some benefits. The training in identifying and reproducing various tones sharpens the sensitivity of pitches. As Ryan Giuliano mentioned that ‘Behaviorally, Mandarin speakers were more accurate than controls (English speakers) at detecting both pitch and interval changes, showing a sensitivity to small pitch changes and interval distances that was absent in the control group.’(Giuliano et al. 2011) Being more sensitive to the changes in tones and details of the music benefits music learning, teaching, and performing. Moreover, in January 2013, Catherine Joanna Stevens wrote, “As hypothesized, the tonal language group was significantly faster and more accurate at discriminating intact speech items on the basis of pitch contour. The tonal language group was also significantly faster in response to musical contour and intervals, although accuracy was equivalent across language groups. The results provide some support for the contention that a tonal language environment fosters perceptual attunement to contour in spoken items and this can generalize to relatively fast responding to contour in a more musical setting.” (Catherine J. Stevens 2011)

### **Single and Multi-Syllable Words**

English vocabulary words can be made of either single or multiple syllables. Multi-syllable words are supposed to sound connected without pausing or breathing between syllables. Since English contains many multi-syllable words, it is considered natural for native English speakers to

speak with a continuous air and have full support while articulating various syllables. The habit of using a straight and non-stop air stream impacts brass players dramatically. A supportive air stream eases and refreshes the body while playing a brass instrument and helps players create gentle and smooth melodic phrases. Instrumental playing is closely related to speaking in the mother tongue. Articulating syllables in words uses a similar mechanism to articulating notes; both highly rely on the air's direction and flow, the inner mouth shape, and tongue placement.

In Mandarin, all words are single-syllable words. It is vital to add tones and articulate words precisely. Separating each word gently while speaking and learning Mandarin helps to learn and understand the language better. Even though the words may group to create another meaning, they are considered a combination of words instead of a single word. In other words, the connections between words in Mandarin are weaker and less important than in English. It is obvious to notice when native Mandarin speakers try to learn English. A common issue for native Mandarin speakers is that they unconsciously speak English syllable by syllable without eloquence. For example, the phrase "*Grammar is so hard to understand.*" native Mandarin speakers commonly speak as "*Gram Mar Is So Hard To Understand.*" Separating syllables makes pronouncing words and processing verbal information easier for Mandarin speakers since it is the exact mechanism of Mandarin speaking.

Additionally, in Mandarin-speaking, most words create strong air attacks, making the air inconsistent. In English speaking, the air flows milder and smoother without too many interruptions by air attacks. The speaking airstreams affect how brass players breathe and use the air while practicing and playing the instrument. For native Mandarin speakers, it would be more challenging to keep a supportive and non-stopping airstream.

### Stress-timed language and syllable-timed language

In stress-timed language, the rhythm is adjusted based on the stress(es), which prolongs the duration of the word. With stresses, the durations of words are not equal. Even though words share the same number of syllables, they are not necessarily equal in length. Mandarin is the opposite; all words are single-syllable and share the same duration. However, sharing the same duration does not mean that the language sounds boring and without any rhythm. While speaking in Mandarin, the rhythm is created by grouping the words. For example, the grouping and the rhythm of the sentence ‘我們的蘋果樹長得很好 (Wǒ men • de • ping ´ guo ˘ shu ˘ jiang ˘ de • hen ˘ hao ˘ ) would be ‘我們的- 蘋果樹- 長得- 很好’; 我們的 means ‘ours’, 蘋果樹 means ‘apple tree’, 長得 means ‘grows’, 很好 means ‘very well’. There could be either a slight pause between groups or a little emphasis on the first word of the group. It is similar to musical playing, slightly pausing between phrases or adding accents on the group’s first or most important notes to distinguish the rhythmic patterns. Grouping words makes the sentence more understandable and meaningful.

The duration of words affects how we interpret the rhythm of the language and influences our musical interpretation. Since words have fixed duration, it is less comfortable for native Mandarin speakers to naturally stretch the words, like sustaining a long note. However, things are often two-sided. Because of the gentle cuts between words, native Mandarin speakers can articulate notes on instruments cleaner and more precisely. In addition, the fixed duration would also create a habit of making short pauses between each note, making it less smooth while playing the music.

## **Chapter 3: Survey: Native language and brass playing**

### **3.1 Introduction of the survey**

#### **Structure and estimated time for completing the survey**

The questionnaire includes three sections: 1) Personal information 2) Self-evaluation on horn playing 3) Studying experiences. (See Appendix II. for the complete survey.)

Participants are asked to answer in the personal information section: 1) Have you played horn for over three years? 2) Are you currently a horn teacher, a contracted/ freelance horn performer, or taking private lessons? 3) What age are you? 4) Current career/ status? 5) What is your native language? 6) What is the brand of the horn you are regularly using? 7) What material is the horn are you using made of?

The second section of the survey includes the following questions: 1) Please rate the difficulty of these techniques in your playing (including ‘clean articulations’, ‘smooth and connected phrases’, ‘consistent sound quality through a phrase’, ‘rhythmic precision and stable pulse’, ‘clear front ends of notes (pure and clear attacks)’, ‘gentle front ends of notes (softer attacks)’, ‘light connected articulations in articulated scale passages’, ‘clear separate staccato articulations in scale passages’, ‘flutter tongue’) 2) How would you describe your general tone quality? 3) How would you describe your current articulation style in general?

The third section of the survey includes the following questions: 1) Do you study, or have you studied the horn in a country that speaks a native language different from your own? Do you study/ have studied with a teacher who speaks a native language other than your own? 2) What is the native language of the professors you are studying with/ have studied with? And in which country are you studying/ have studied? 3) What differences in educational approaches have you

noticed between your native country and the country you studied in? 4) Have you noticed that some of the struggles you faced through learning the horn differ from other horn players from different native language backgrounds?

The estimated completion time for this survey is about seven to ten minutes, depending on whether they participate in the third section. The participants would not contribute to the third section if they did not have experience studying abroad or with teachers that have a different native language from their own. (See Appendix II.)

### **Procedure and Recruiting Process/ Requirements**

Before launching the survey, I consulted with esteemed IU Jacobs School of Music faculty members Professor Richard Seraphinoff and Professor Peter Miksza. With their professions and experience, the survey was reviewed and refined into a more accessible and transparent form for participants to answer fully. The changes included wording, the format of the questions, and the setting of requirements for the participants.

The questionnaire was developed in English and translated to Mandarin. In order not to lose the meaning and the characters of the survey in the translation, I asked three native Mandarin horn players who had majored/are currently majoring in horn for more than two years in the United States to preview and provide suggestions on the translation. After the survey was formed, reviewed, tested, and refined, it was sent to Indiana University Institutional Review Board and approved on September 1<sup>st</sup>, 2022.

For this study, I targeted participants who have played the horn for over three years and are above 18 years of age. In addition, participants had to either be students who routinely take lessons, horn teachers, or horn performers/ freelancers.

The survey was published on various social media platforms for recruiting participants, such as ‘horn people’, ‘the Cor community’, ‘artists from Taiwan’, etc. The recruitment letter (Appendix I.) was sent to various horn performers/ teachers and musicians in the United States, Taiwan, Japan, China, and Mexico on September 24<sup>th</sup>, 2022. For this paper, I will focus on native Mandarin and English speakers. The rest of the data collected from speakers of other languages will be applied and presented partially.

The reason for publishing the survey on social media platforms and sending out links individually to various countries and school systems is to reduce the chances of having participants from the same regions or same educational backgrounds. In order to compare native English speakers and native Mandarin speakers better, I tried to balance the number of participants between these two groups. The initial data collection time was on October 15<sup>th</sup>, 2022. At that time, I collected responses from 57 native English speakers and 30 native Mandarin speakers. The imbalanced numbers of participants between the two groups would increase the risk of obtaining false positives on the test results. To prevent the false positive test result, I sent recruitment letters targeting native Mandarin speakers to teachers and performers from China, Hong Kong, and Taiwan on October 15<sup>th</sup>, 2022, and extended the data collection time. Final data collection ended on November 9<sup>th</sup>, 2022.

There were 220 responses involved in the survey, and 137 participants qualified and completed the survey. Among the 137 valid responses, there were fifty native Mandarin speakers, three native Spanish speakers, two native Cantonese speakers, sixty-five native English speakers, one native German speaker, one native Japanese speaker, one native Thai speaker, one native Portuguese speaker, one native Latvian speaker, one native Danish speaker, and eleven bilingual speakers.



### **3.2 Survey design & data analysis**

The survey was built on the Qualtrics survey software. It includes various question types: multiple choice questions, rating scale questions, and open-ended questions. The analysis methods changed based on the needs and types of questions.

There were seven questions within the first section- personal information. The second section- the primary questionnaire- has three major questions. The first question was designed to collect data about the level of challenge of each technique for players from different native language backgrounds. This question was designed as a rating scale, allowing participants to compare and better evaluate the level of challenge. I used the Mann-Whitney U test (two-tailed results) to calculate whether they were statistically significant differences between groups.

The other two questions were designed as multiple choice questions and analyzed with the Chi-square test. Participants were asked to self-evaluate their playing and choose at least three options to give us more complete dimensions of their playing.

The Mann-Whitney U and Chi-square tests would calculate the  $p$  value (also known as ‘probability value’) between two independent groups. When the  $p$  value is below 0.05, the probability of the hypothesis of no difference being incorrect is less than 5 percent. In other words, the possibility of an incorrect hypothesis is extremely low. To analyze the survey answers, I would look for  $p$  value below 0.05.

In the third section, I focus on analyzing the participants’ experiences of studying abroad. Participants would not participate in this section if they had not studied abroad. This set of questionnaires combined four-level Likert questions and open-ended questions to verify their study status and gather data about their experiences.

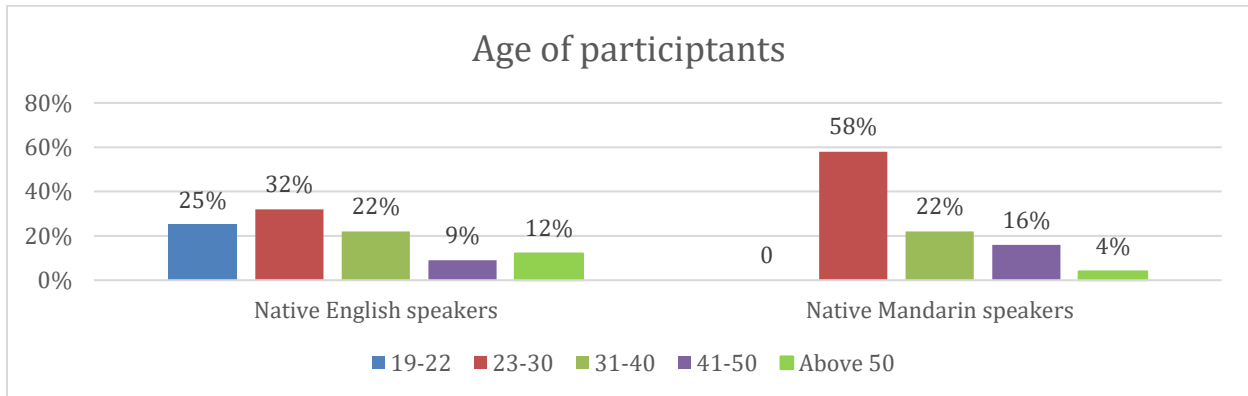
### **3.3 Information about participants & groupings**

#### **Age of participants**

Among 65 native English speakers, we have 16 people aged between 19-22 (25% of the native English speakers), 21 people aged between 23-30 (32% of the native English speakers), 14 people aged between 31-40 (22% of the native English speakers), 6 people aged between 41-50 (9% of the native English speakers), and 8 people aged above 50 (12% of the native English speakers).

Among 50 native Mandarin speakers, we have 0 people aged between 19-22 (0% of the native Mandarin speakers), 29 people aged between 23-30 (58% of the native Mandarin speakers), 11 people aged between 31-40 (22% of the native Mandarin speakers), 8 people aged between 41-50 (16% of the native Mandarin speakers), and 2 people aged above 50 (4% of the native Mandarin speakers). (See Figure 1.)

**Figure 1. Age of participants**



#### **Number of years of studying/ playing the horn**

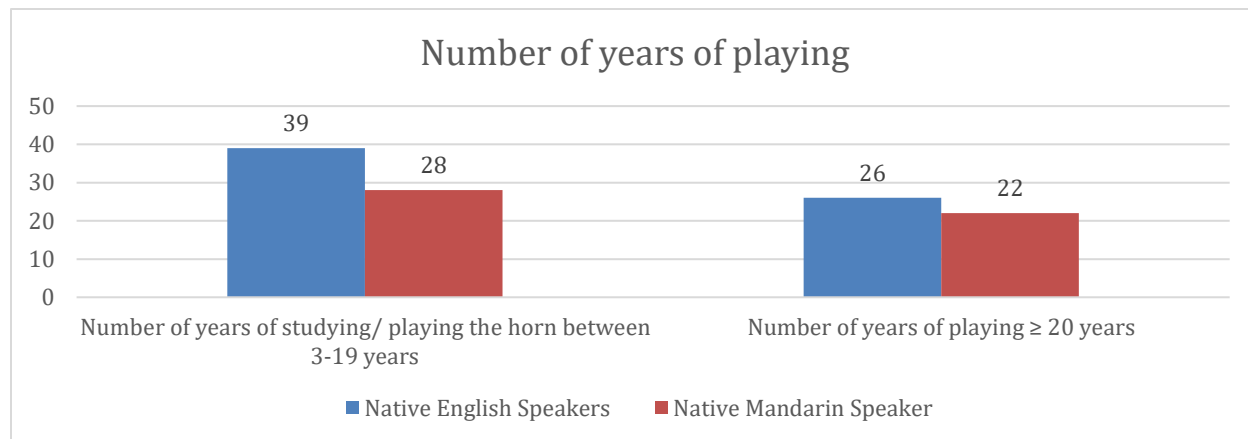
For the paper, I divided participants into four different groups: Group 1- native English speakers who have studied/ played the horn between 3 and 19 years (39 participants); Group 2- native English speakers who have studied/ played the horn equal to/ more than 20 years (26

participants); Group 3- native Mandarin speakers who have studied/ played the horn between 3 and 19 years (28 participants); Group 4- native English speakers who have studied/ played the horn equal to/ more than 20 years (22 participants).

The data I have collected shows that the average number of years of studying/ playing the horn is 20 years among 115 participants. Grouping participants by their native language and years of experience helps to target and specialize the group of participants.

Among 65 native English speakers, the shortest period of studying/ playing the horn is 7 years, and the most prolonged period is 55 years. Among 50 native Mandarin speakers, the shortest period of studying/ playing the horn is 8 years, and the longest is 45. For this study, the experience of years is one of the standards of organizing the groups instead of the ages of the participants because the years of horn playing are more vital for this research purpose. (See Figure 2.)

**Figure 2. Number of years of playing**

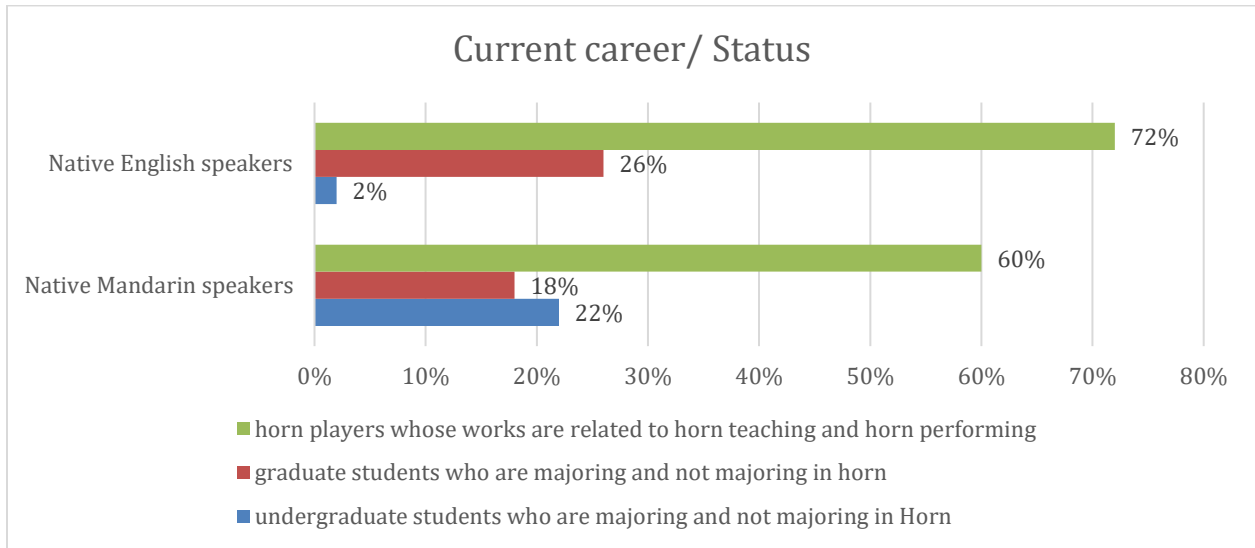


**Current career/ status**

Among 65 native English speakers, 14 undergraduate students are either majoring or not majoring in horn (22% of the native English speakers), 12 graduate students are either majoring or not majoring in horn (18% of the native English speakers), and 39 horn players whose work is related to horn teaching and horn performing (60% of the native English speakers).

Among 50 native Mandarin speakers, there is one undergraduate student who is either majoring or not majoring in horn (2% of the native Mandarin speakers), 13 graduate students who are either majoring or not majoring in horn (26% of the native Mandarin speakers), and 36 horn players whose work is related to horn teaching and/ or horn performing (72% of the native Mandarin speakers). (See Figure 3.)

**Figure 3. Age of participants**



## Chapter 4: Statistical analysis

### 4.1 Data analysis

#### Primary questions- Q8, Q9, and Q10:

Question 8 collects information about how players rate their difficulty levels of each technique while playing the horn. Difficulties include ‘clean articulations’, ‘smooth and connected phrases’, ‘consistent sound quality through a phrase’, ‘rhythmic precision and stable pulse’, ‘clear front ends of notes (pure and clear attacks)’, ‘gentle front ends of notes (softer attacks)’, ‘light connected articulations in articulated scale passages’, ‘clear separate staccato articulation in scale passages’, and ‘flutter tongue’.

To analyze whether the native languages influenced horn playing and whether it was related to years of playing the horn, I organized participants into four groups: Group 1- native English speakers who have studied/ played the horn between 3 and 19 years; group 2- native English who have studied/ played the horn equal to/ more than 20 years; group 3- native Mandarin speakers who have studied/ played the horn between 3 and 19 years; group 4- native Mandarin who have studied/ played the horn equal to/ more than 20 years.

**Table 1. Mann-Whitney U test results for topics included in question 8**

	<i>p</i> value of groups 1 & 3	<i>p</i> value of groups 2 & 4
8-1 Clean articulations	0.803	0.087
8-2 Smooth and connected phrases	0.201	0.226
8-3 Consistent sound quality through a phrase	0.653	0.029
8-4 Rhythmic precision and stable pulse	0.197	0.033
8-5 Clear front ends of notes (pure and clear attacks)	0.968	0.051
8-6 Gentle front ends of notes (softer attacks)	0.395	0.037
8-7 Light-connected articulations in articulated scale passages	0.617	0.042
8-8 Clear separated staccato articulation in scale passages	0.842	0.029
8-9 Flutter tongue	0.337	0.010

\**p* value < .05 is considered statistically significant (shown in blue color).

For the purpose of the study, I compared groups of participants within the same range of years of playing experience: 1) Groups 1 and 3 compared with each other and 2) Groups 2 and 4 compared with each other. These comparison methods have been used throughout the entire study.

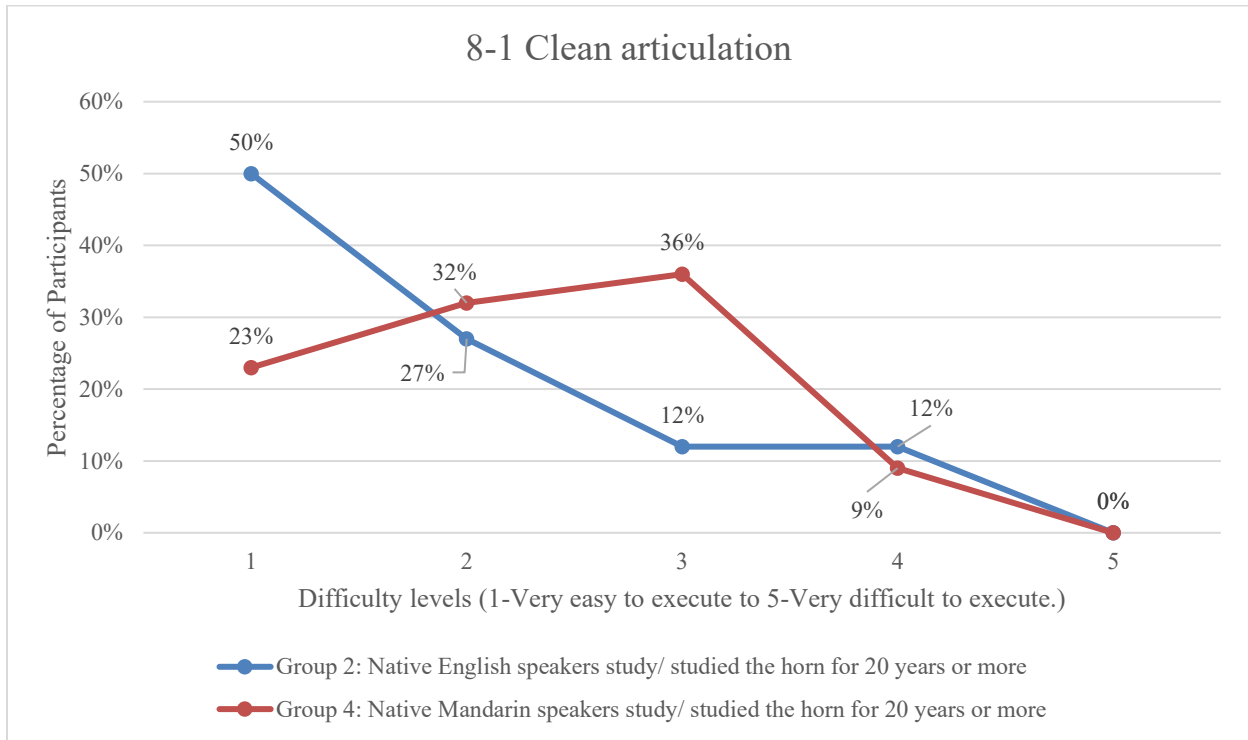
Based on the result, native languages show more influence in the groups of participants who have studied/ played the horn for more than 20 years (Group 2 and Group 4) (See Table 1.).

In testing among native English and native Mandarin players who have studied/ played the horn between 3 and 19 years (Group 1 and Group 3), all  $p$  values were greater than .05, which is considered not to be statistically significant. In other words, the difficulty levels of all the techniques between participants in Group 1 and Group 3 are similar.

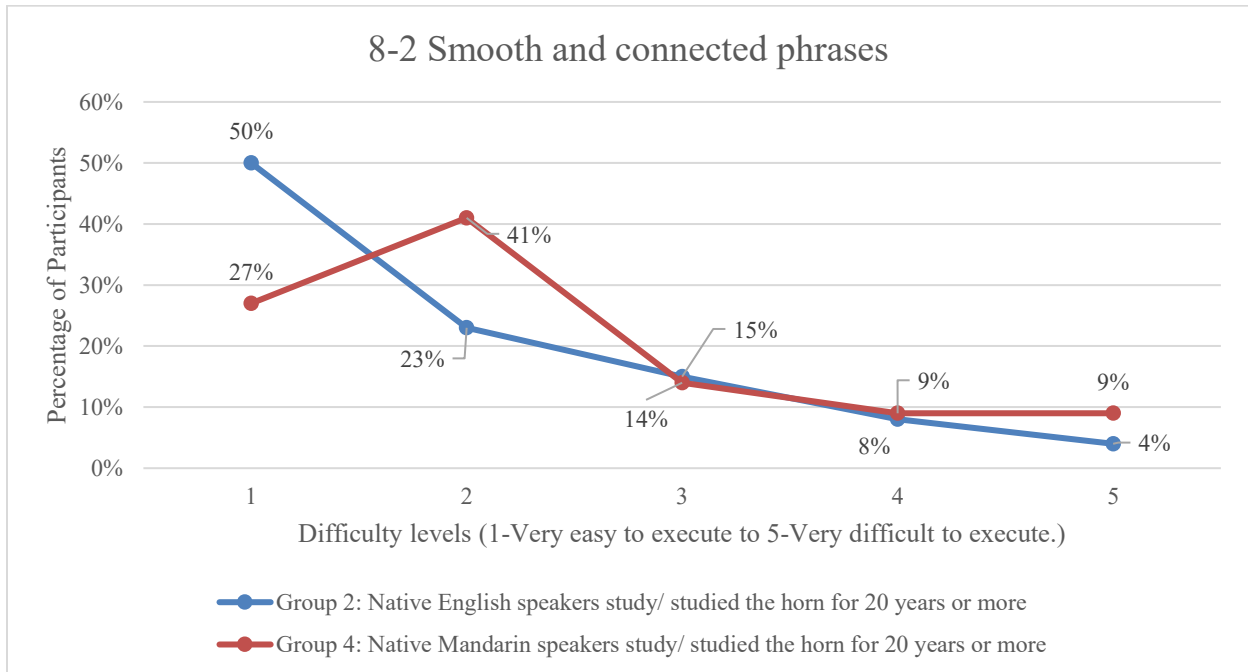
Between Group 2 and Group 4, the techniques: ‘consistent sound quality through a phrase’, ‘rhythmic precision and stable pulse’, ‘gentle front ends of notes (softer attacks)’, ‘light connected articulations in articulated scale passages’, ‘clear separate staccato articulation in scale passages’, and ‘flutter tongue’ result in  $p$  values lower than .05.

Among the techniques listed above, the difficulty levels are sensibly different between native English speakers who have studied/ played the horn for 20 years or more (Group 2) and native Mandarin speakers who have studied/ played the horn for 20 years or more (Group 4). The only variant between participants from Group 2 and Group 4 is the native language. (See Figure 4 to Figure 12.)

**Figure 4. Clean articulation<sup>1</sup>**

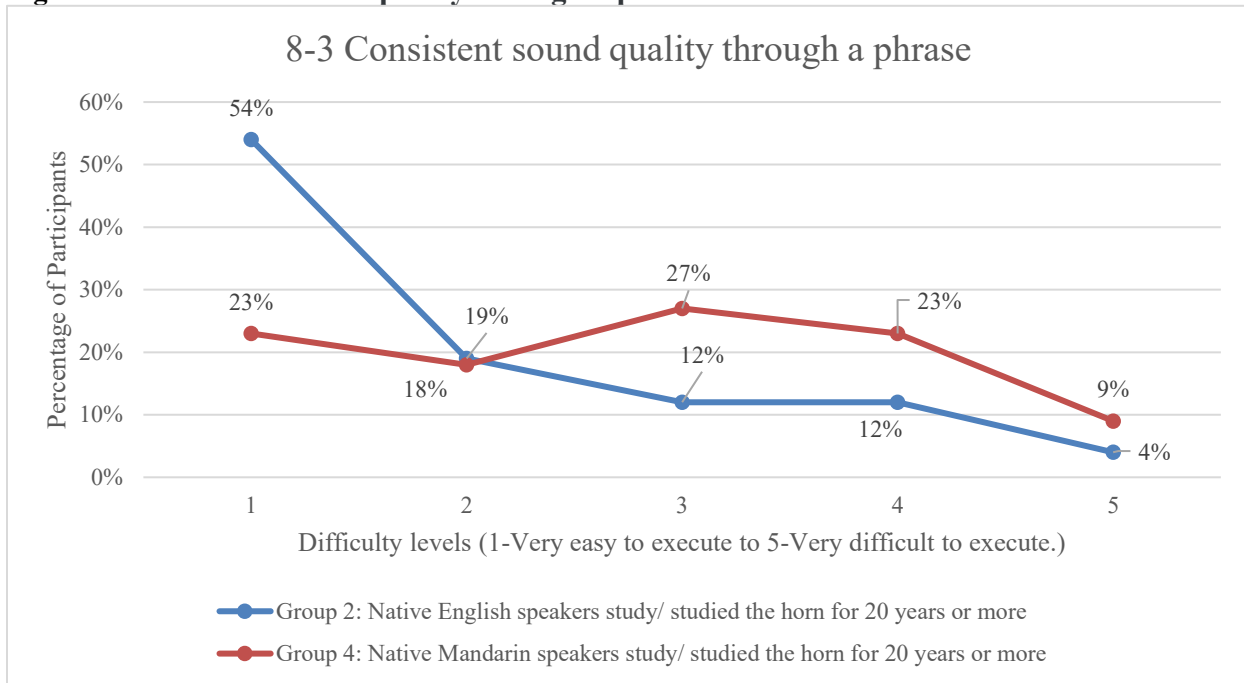


**Figure 5. Smooth and connected phrases**

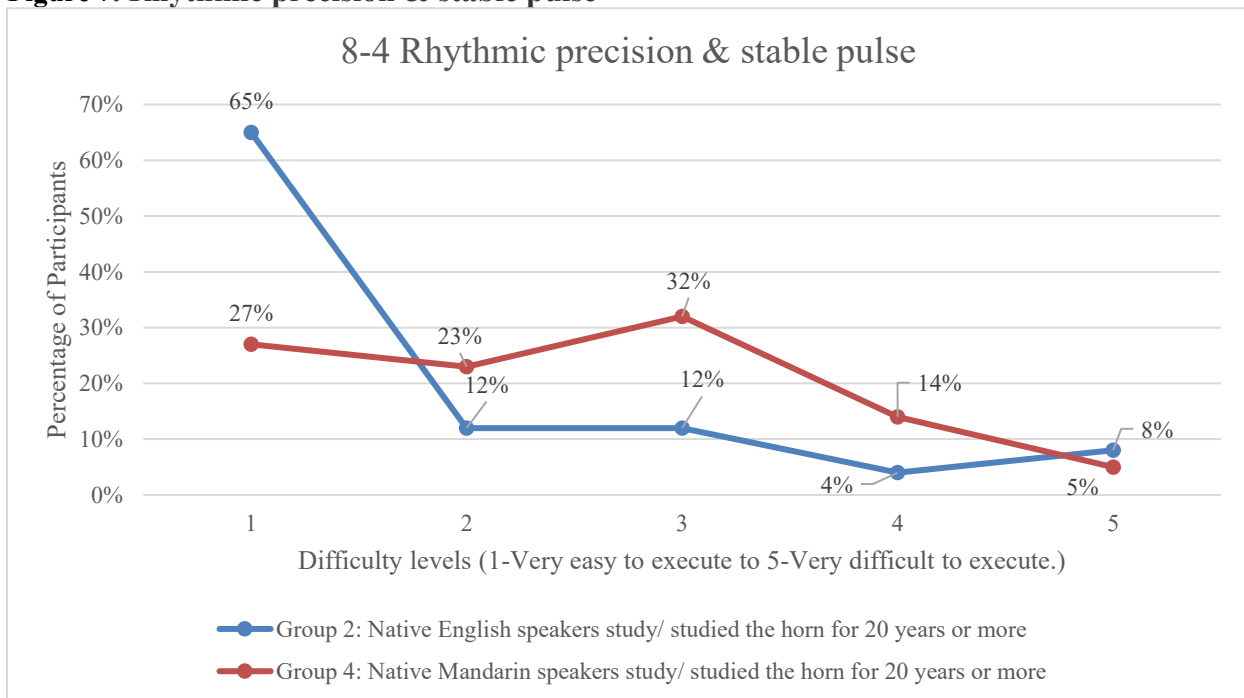


<sup>1</sup> With the test result  $p$  value  $> .05$ , the indication line of Group 2 and Group 4 are not significantly different.

**Figure 6. Consistent sound quality through a phrase<sup>2</sup>**



**Figure 7. Rhythmic precision & stable pulse<sup>3</sup>**

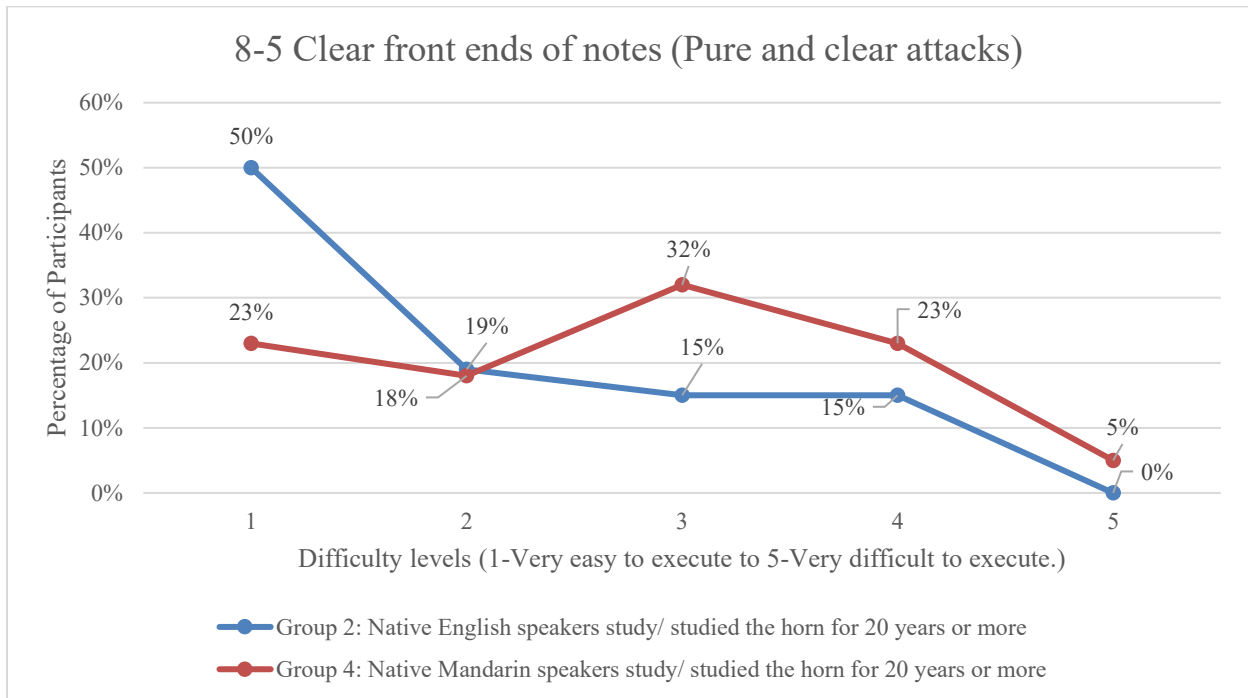


<sup>2</sup> On this subject, there is a statistically significant ( $p$ -value < .05) for the comparison of Group 2 and Group 4.

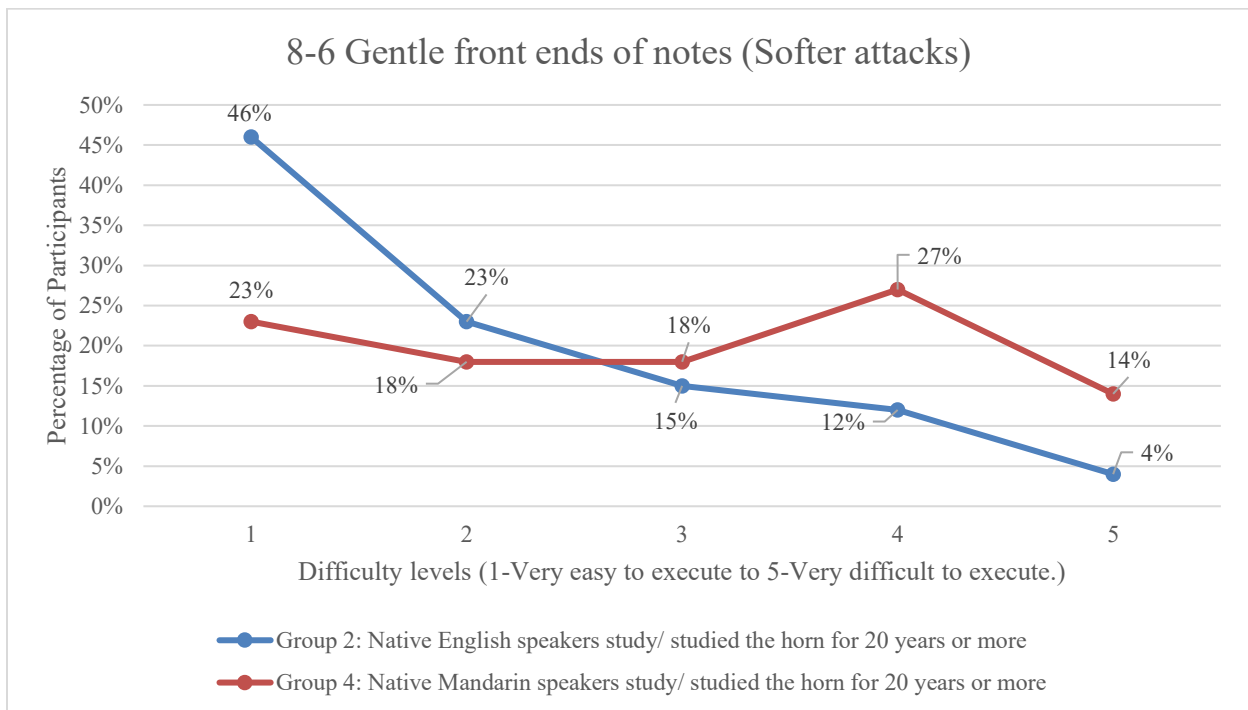
<sup>3</sup> On this subject, there is a statistically significant ( $p$ -value < .05) for the comparison of Group 2 and Group 4.



**Figure 8. Clear front ends of notes (Pure and clear attacks)**

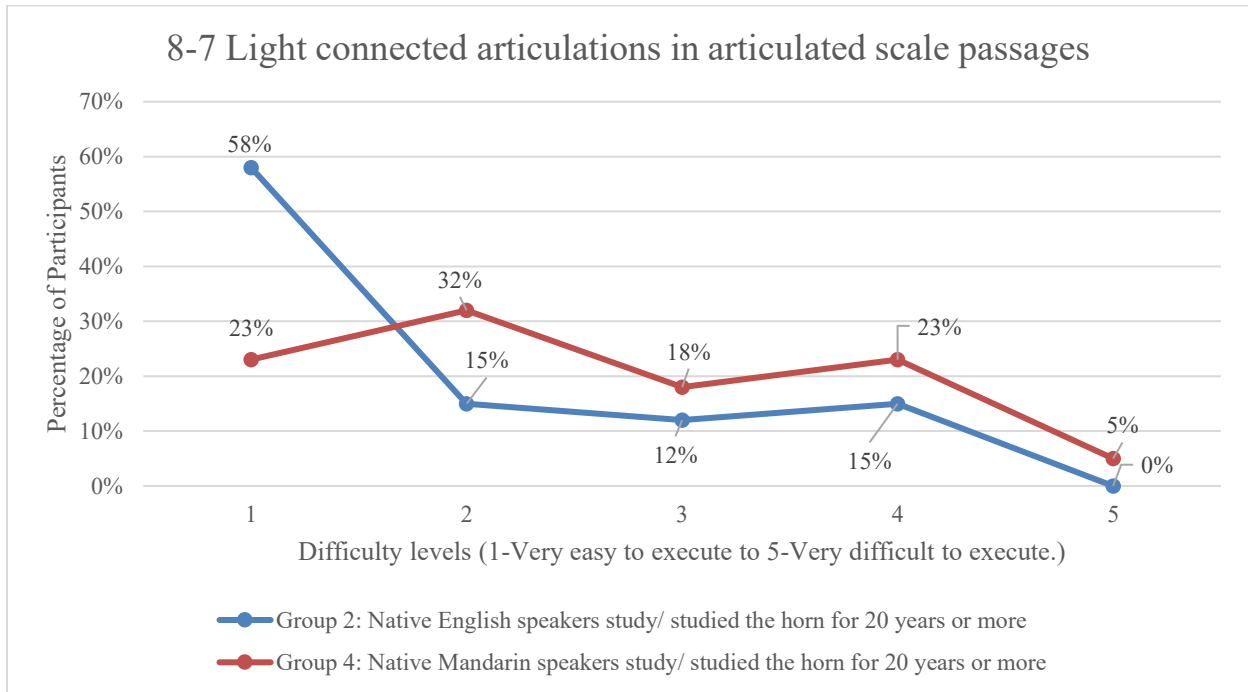


**Figure 9. Gentle front ends of notes (Softer attacks)<sup>4</sup>**

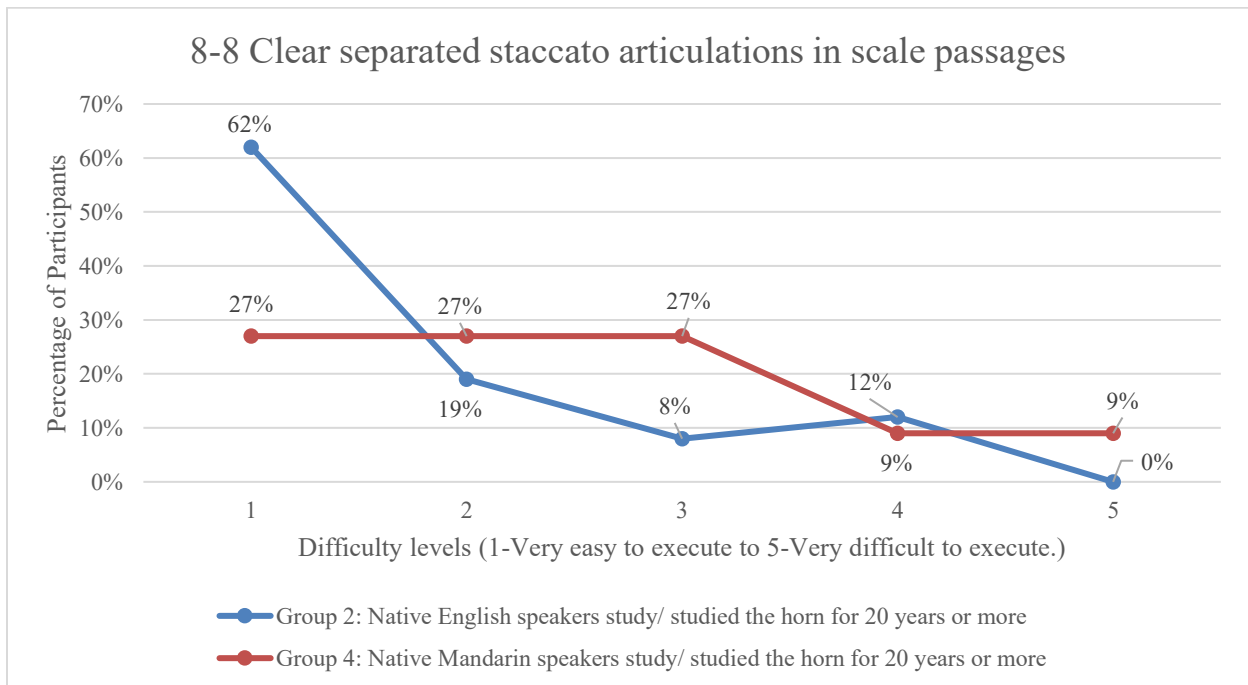


<sup>4</sup> On this subject, there is a statistically significant ( $p$ -value < .05) for the comparison of Group 2 and Group 4.

**Figure 10. Light connected articulations in articulated scale passages<sup>5</sup>**



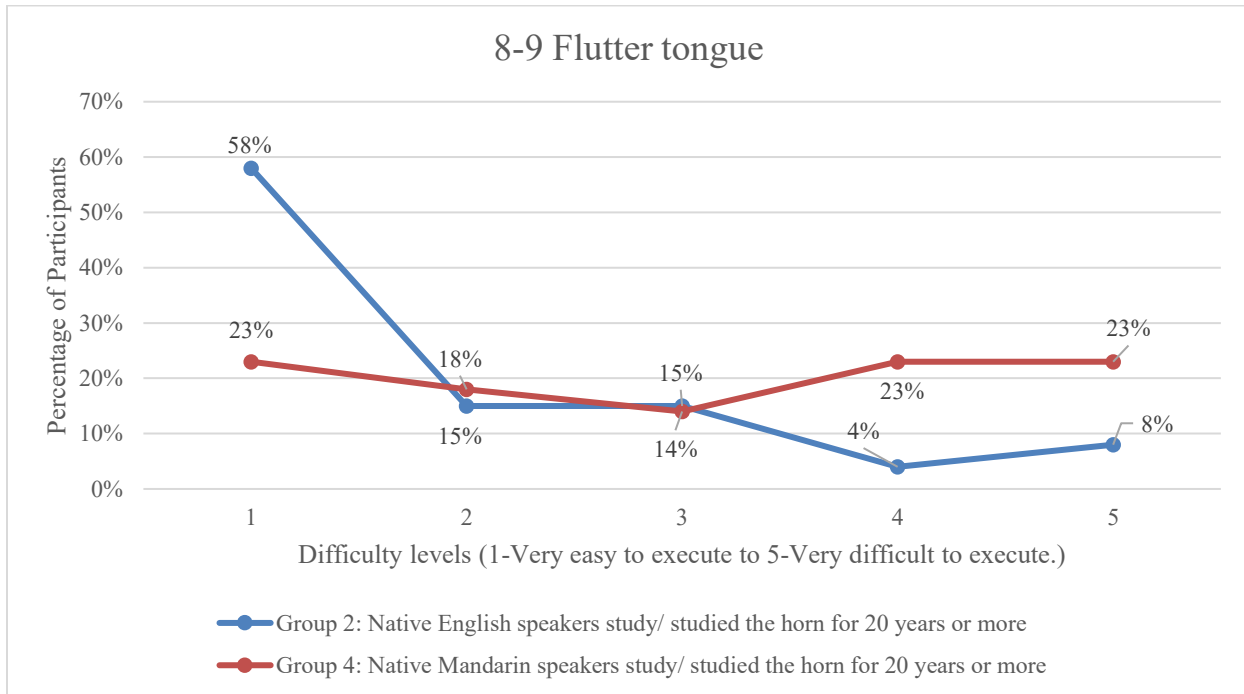
**Figure 11. Clear separated staccato articulations in scale passages<sup>6</sup>**



<sup>5</sup> On this subject, there is a statistically significant ( $p$ -value < .05) for the comparison of Group 2 and Group 4.

<sup>6</sup> On this subject, there is a statistically significant ( $p$ -value < .05) for the comparison of Group 2 and Group 4.

**Figure 12. Flutter tongue<sup>7</sup>**



In Question 9, participants were asked to describe their general tone quality. Participants selected at least three given options among ‘mellow’, ‘warm’, ‘darker voice’, ‘brighter voice’, ‘thinner voice’, ‘smaller voice (woodwind chamber type)’, ‘bigger voice (orchestra type/ brass chamber type)’, ‘lighter voice’, ‘direct’, ‘fuller voice’, and ‘others’. The survey randomized the options for each participant to prevent suggestive answering.

I arranged the options into two categories for analysis: ‘Tone quality’ and ‘general volume/ voice projection’. Within the category of ‘tone quality’, there are four sub-categories: C1: ‘mellow’ and ‘warm’; C2: ‘brighter voice’ and ‘direct’; C3: ‘darker voice’ and ‘more closed voice’; C4: ‘open voice’ and ‘brassy’. Within the category of ‘general volume/ voice projection’, there are two sub-categories: V1: ‘smaller voice’, ‘lighter voice’, and ‘thinner voice’; V2: ‘bigger voice’ and

<sup>7</sup> On this subject, there is a statistically significant ( $p$ -value < .05) for the comparison of Group 2 and Group 4.

‘fuller voice’. Since the answers of participants who chose the option of ‘Others’ did not relate to, or affect the grouping, the ‘others’ option will not be included in the test and categories.

After categorizing the options, I created the frequency based on ‘1’ and ‘0’. If the participants selected either adjective in the sub-category, they would be scored as ‘1’. If the participants did not select any adjectives from that sub-category, they would be scored as ‘0’. For example, if the participants describe their general tone quality as ‘mellow, warm, darker voice, and thinner voice’, then the scoring following with the order of C1, C2, C3, C4, V1, and V2 will be 1, 0, 1, 0, 1, and 0. The scoring for this question will only be either ‘1’ or ‘0’. Even though the participant has selected ‘mellow’ and ‘warm’, they are considered to be in a single category.

Among native English speakers who have studied/ played the horn between 3 and 19 years (Group 1), 74% of participants belong to C1, 33% of participants belong to C2, 38% of participants belong to C3, 28% of participants belong to C4, 33% of participants belong to V1, and 56% of participants belong to V2. (\*The percentage is based on the participants in Group 1.) (See Table 2.)

Among native English speakers who have studied/ played the horn for 20 years or more (Group 2), 77% of participants belong to C1, 31% of participants belong to C2, 27% of participants belong to C3, 35% of participants belong to C4, 27% of participants belong to V1, and 65% of participants belong to V2. (\*The percentage is based on the participants in Group 2.) (See Table 3.)

Among native Mandarin speakers who have studied/ played the horn between 3 and 19 years (Group 3), 79% of participants belong to C1, 29% of participants belong to C2, 21% of participants belong to C3, 25% of participants belong to C4, 39% of participants belong to V1, and

50% of participants belong to V2. (\*The percentage is based on the participants in Group 3.) (See Table 2.)

Among native Mandarin speakers who have studied/ played the horn for 20 years or more (Group 4), 73% of participants belong to C1, 59% of participants belong to C2, 9% of participants belong to C3, 36% of participants belong to C4, 27% of participants belong to V1, and 68% of participants belong to V2. (\*The percentage is based on the participants in Group 4.) (See Table 3.)

**Table 2. Percentages of participants who have studied/ played the horn between 3 and 19 years in 6 categories on question 9 (tone quality)**

	C1	C2	*C3	C4	V1	V2
Group 1 belongs to the category	74%	33%	38%	28%	33%	56%
Group 1 doesn't belong to the category	26%	67%	62%	70%	67%	44%
Group 3 belongs to the category	79%	29%	21%	25%	39%	50%
Group 3 doesn't belong to the category	21%	71%	79%	75%	61%	50%

\*The ratio of percentage between belonging or not belonging to the category among native English speakers and Mandarin speakers is noticeably different.

**Table 3. Percentages of participants who have studied/ played the horn for 20 years or more in 6 categories on question 9 (tone quality)**

	C1	*C2	*C3	C4	V1	V2
Group 2 belongs to the category	77%	31%	27%	35%	27%	65%
Group 2 doesn't belong to the category	23%	69%	73%	65%	73%	35%
Group 4 belongs to the category	73%	59%	9%	36%	27%	68%
Group 4 doesn't belong to the category	27%	41%	91%	64%	73%	32%

\*The ratio of percentage between belonging or not belonging to the category among native English speakers and Mandarin speakers is noticeable different.

For question 9, I used the Chi-square test to compare the groups on their responses. Based on the percentage reports, I focus on C3 among the participants who have studied/ played the horn between 3 and 19 years and C2 and C3 among the participants who have studied/ played the horn for 20 years or more. The test result of C3 among the participants who have studied/ played the horn between 3 and 19 years is  $X^2 = 2.20$ ,  $p > .05$ , which is considered not significantly different.

The test result of C2 among the participants who have studied/ played the horn for 20 years or more is  $X^2 = 3.88, p < .05$ , which is considered statistically significant, and the test result of C3 is  $X^2 = 2.49, p > .05$ . (See Table 4.)

**Table 4. Chi-square test  $p$  values for differences in tone quality reports (question 9)**

	C1	C2	C3	C4	V1	V2
Participants who have studied/ played the horn between 3 and 19 years	0.690	0.679	0.138	0.770	0.616	0.604
Participants who have studied/ played the horn for 20 years or more	0.738	0.049	0.115	0.899	0.978	0.838

\* $p$  value  $< .05$  is considered statistically significant (shown in blue).

As a result, there are no differences between participants from different native languages. Languages seem not to be the factor in determining the tone quality and the volume in the group of people who have studied/ played the horn between 3 and 19 years.

However, in the groups of participants who have studied/ played the horn for 20 years or more, C2 has tested as  $X^2 = 3.88, p < .05$ , which indicates that native English speakers and native Mandarin speakers have a detectable difference in tone quality. Native Mandarin speakers are more likely to report having a brighter and more direct tone quality, according to the data collected.

On Question 10, participants were asked to describe their current articulation in general. Participants were asked to select three options among the following: ‘strong articulation’, ‘soft articulation’, ‘slow articulation’, ‘slow attack’, ‘fast attack’, ‘stiff articulation’, ‘mellow articulation’, ‘smooth articulation’, ‘lighter attack’, ‘heavy attack’, and ‘others’. The survey will randomize the options for each participant to prevent suggestive answering.

To analyze the collected data, I organized the given options into five categories: A1: ‘strong articulation’, ‘heavy attack’, and ‘stiff articulation’; A2: ‘fast attack’; A3: ‘soft articulation’ and ‘lighter attack’; A4: ‘slow attack’ and ‘mellow articulation’; A5: ‘smooth articulation’. Four

participants among the native English speakers who have studied/ played the horn for 20 years or more (Group 2) are excluded, because all of the articulations provided were selected, which are contradictory to each other. With the exclusions, the number of participants for this question adjusted to 39 participants in Group 1 (Native English speakers who have studied/ played the horn between 3 and 19 years), 22 participants in Group 2 (Native English speakers who have studied/ played the horn for 20 years or more), 28 participants in Group 3 (Native Mandarin speakers who have studied/ played the horn between 3 and 19 years), and 22 participants in Group 4 (Native Mandarin speakers who have studied/ played the horn for 20 years or more).

After categorizing the options, I created the frequencies 1 and 0 by using the method described in question 9. In Group 1, 51% of the participants belong to A1, 36% of the participants belong to A2, 59% of the participants belong to A3, 54% of the participants belong to A4, and 46% of the participants belong to A5. (\*The percentage is based on the participants in Group 1.) (See Table 5.)

Among Group 2, 68% of the participants belong to A1, 64% of the participants belong to A2, 45% of the participants belong to A3, 23% of the participants belong to A4, and 50% of the participants belong to A5. (\*The percentage is based on the participants in Group 2.) (See Table 6.)

Among native Mandarin speakers who have studied/ played the horn between 3 and 19 years, 32% of the participants belong to A1, 18% of the participants belong to A2, 75% of the participants belong to A3, 75% of the participants belong to A4, and 29% of participants belong to A5. (\*The percentage is based on the participants in Group 3.) (See Table 5.)

Among native Mandarin speakers who have studied/ played the horn for 20 years or more, 32% of the participants belong to A1, 27% of the participants belong to A2, 95% of the participants

belong to A3, 50% of the participants belong to A4, and 32% of the participants belong to A5.

(\*The percentage is based on the participants in Group 4.) (See Table 6.)

**Table 5. Percentages of participants who have studied/ played the horn between 3 and 19 years in 5 categories on question 10 (articulation styles)**

	A1	A2	A3	A4	A5
Group 1 belongs to the category	51%	36%	59%	54%	46%
Group 1 does not belong to the category	49%	64%	41%	46%	54%
Group 3 belongs to the category	32%	18%	75%	75%	29%
Group 3 does not belong to the category	68%	82%	25%	25%	71%

**Table 6. Percentages of participants who have studied/ played the horn for 20 years or more in 5 categories on question 10 (articulation styles)**

	*A1	*A2	*A3	A4	A5
Group 2 belongs to the category	68%	64%	45%	23%	50%
Group 2 does not belong to the category	32%	36%	55%	77%	50%
Group 4 belongs to the category	32%	27%	95%	50%	32%
Group 4 does not belong to the category	68%	73%	5%	50%	68%

\*The percentage ratio between belonging or not belonging to the category among native English speakers and Mandarin speakers is noticeable different.

**Table 7. Chi-square test  $p$  values for differences in articulation reports (question 10)**

	A1	A2	A3	A4	A5
The $p$ value of participants who have studied/ played the horn between 3 and 19 years	0.119	0.106	0.173	0.077	0.145
The $p$ value of participants who have studied/ played the horn for 20 years or more	0.016	0.015	0.000	0.060	0.220

\* $p$  value < .05 is considered statistically significant (shown in blue).

The same as question 9, responses to question 10 were tested with the Chi-square statistic test. Among participants who have studied/ played the horn between 3 and 19 years, all of the categories showed results of  $p$  value > .05, which indicated that the native language does not seem to affect the articulation style or does not show an impact on the articulation style. Among participants who have studied/ played the horn for 20 years or more, the percentage chart showed that in categories A1, A2, and A3, the percentage of belonging or not belonging was the opposite



between native English speakers and native Mandarin speakers. This highly suggested that native language might have a strong influence on having different articulation styles. As expected, A1 has the  $X^2 = 5.81, p < .05$ , A2 has  $X^2 = 5.87, p < .05$ , and A3 has the  $X^2 = 13.21, p < .01$ . A4 and A5 are  $p > .05$ , which means the articulation of ‘slow attack’, ‘mellow articulation’, and ‘smooth articulation’ might not be affected by different native languages. (See Table 7.)

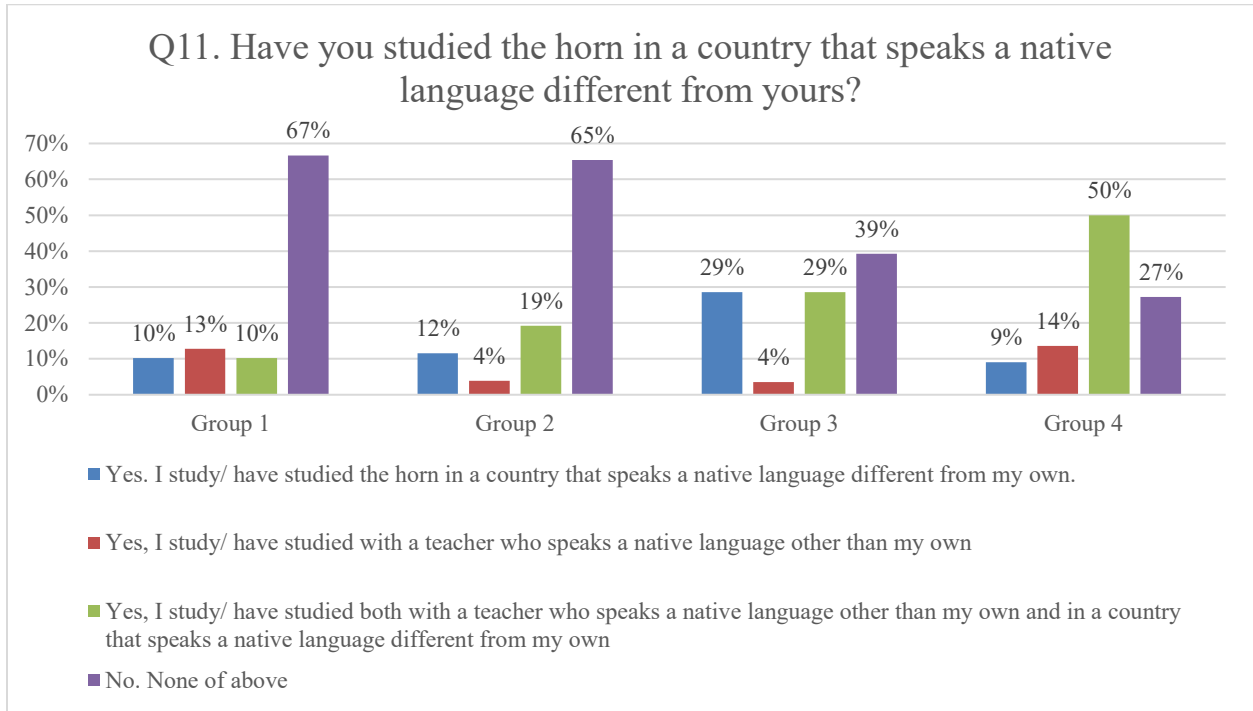
### **Secondary questions- Q11 to Q16:**

Q11, Q13, and Q15 are items that participants responded to using Likert scales. Q12, Q14, and Q16 are open-ended questions, which are used to elaborate their choices/ opinions on Q11, Q13, and Q15. For the study purpose of this paper, Q12, Q14, and Q16 would not be analyzed.

On Q11, participants were asked whether they have studied the horn in a country that speaks a native language different from theirs, and four options are provided: 1. ‘Yes. I study/ have studied the horn in a country that speaks a native language different from my own.’, 2. ‘Yes, I study/ have studied with a teacher who speaks a native language other than my own’, 3. ‘Yes, I study/ have studied both with a teacher who speaks a native language other than my own and in a country that speaks a native language different from my own’, and 4. ‘No. None of the above’.

In Group 1, 4 participants selected option 1, 5 selected option 2, 4 selected option 3, and 26 selected option 4. In Group 2, 3 participants selected option 1, 1 participant selected option 2, 5 selected option 3, and 7 selected option 4. In Group 3, 8 participants selected option 1, 1 participant selected option 2, 8 selected option 3, and 3 selected option 4. In Group 4, 2 participants selected option 1, 3 selected option 2, 11 selected option 3, and 6 selected option 4. (See Figure 13.)

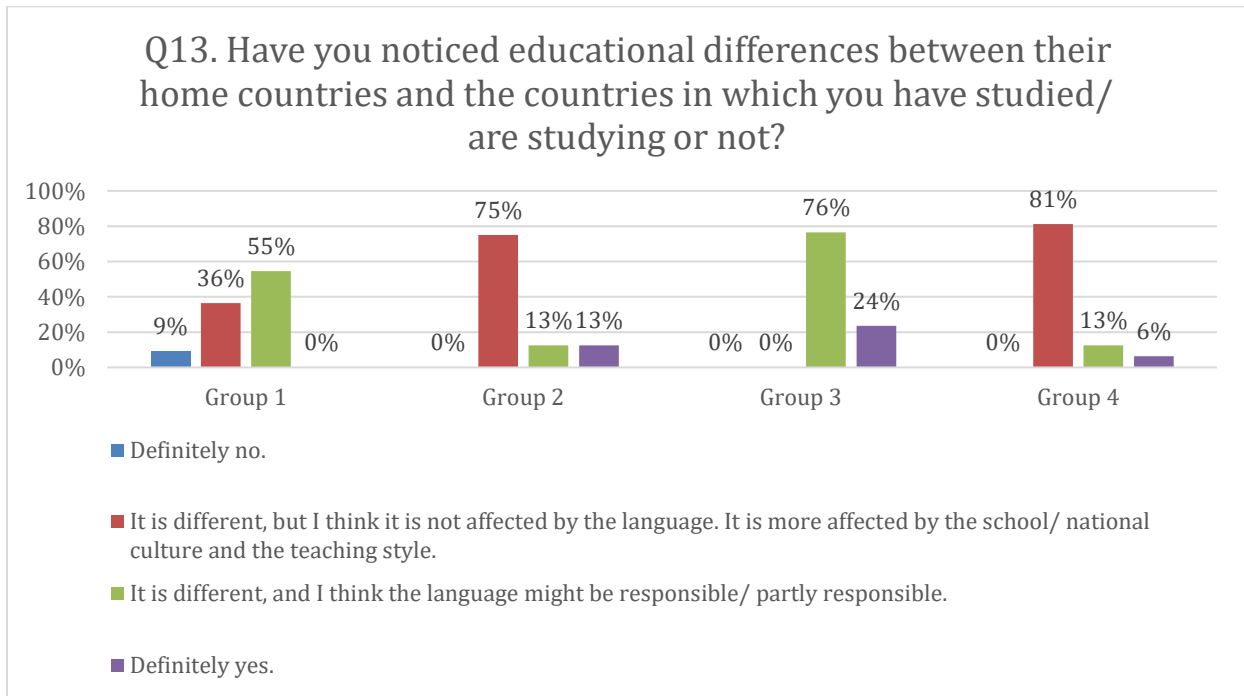
**Figure 13. Have you studied the horn in a country that speaks a native language different from yours?**



Participants who selected option four would not participate in the secondary questions. For the following questions, there are 13 participants in Group 1, 9 in Group 2, 17 in Group 3, and 16 in Group 4.

In Q13, participants were asked whether they have noticed educational differences between their home countries and the countries they have studied/ are studying or not. In addition, they are also asked whether they think native languages impact the differences or not. They have four options: 1. 'Definitely no.', 2. 'It is different, but I think it is not affected by the language. It is more affected by the school/ national culture and the teaching style.', 3. 'It is different, and I think the language might be responsible/ partly responsible.', and 4. 'Definitely yes.'

**Figure 14. Have you noticed educational differences between their home countries and the countries in which you have studied/ are studying or not?**

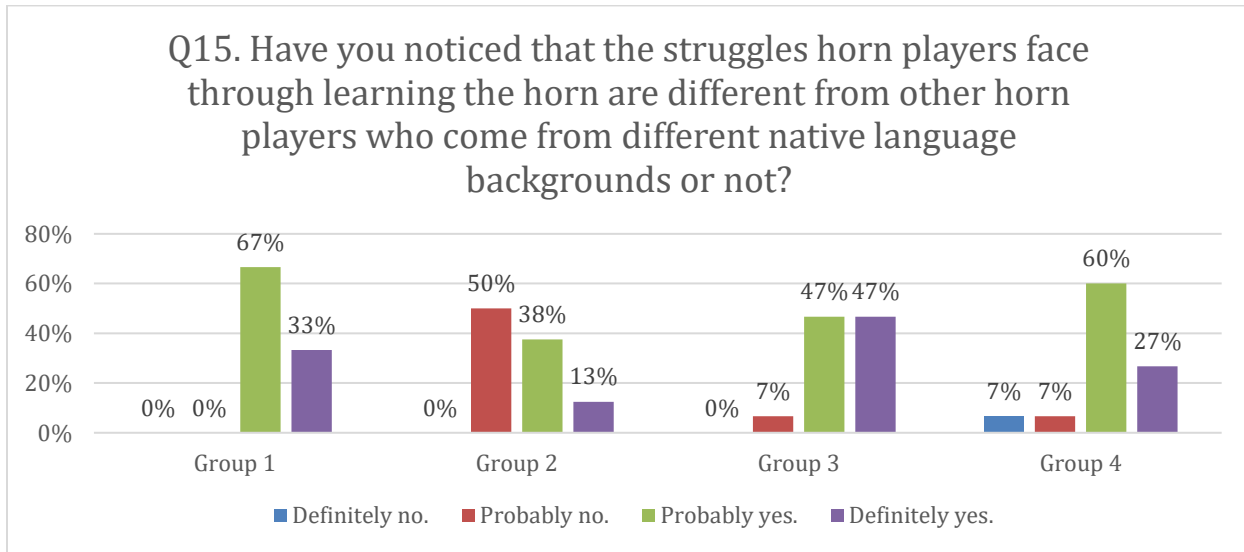


In Group 1, 1 participant selected option 1, 4 selected option 2, 6 selected option 3, and 0 selected option 4. In Group 2, 0 participants selected option 1, 6 selected option 2, 1 selected option 3, and 1 selected option 4. In Group 3, 0 participants selected option 1, 0 selected option 2, 13 selected option 3, and 4 selected option 4. In Group 4, 0 participants selected option 1, 13 selected option 2, 2 selected option 3, and 1 selected option 4. (See Figure 14.)

Interestingly, most participants who have studied/ played the horn between 3 and 19 years noticed differences between different countries and think the native languages influence it. In the groups of participants who have studied/ played the horn for 20 years or more, the majority think there are differences between different countries. However, it might be influenced by the school/ national culture and the teaching style. However, based on questions 8 to 10, it seems like native language affected the groups of participants more who have studied/ played the horn for 20 years or more.

In Q15, participants were asked whether they noticed the struggles they faced through learning the horn were different from other horn players who come from different native language backgrounds or not. They have four options: 1. ‘Definitely no.’, 2. ‘Probably no.’, 3. ‘Probably yes.’, and 4. ‘Definitely yes.’.

**Figure 15. Have you noticed that the struggles horn players face through learning the horn are different from other horn players who come from different native language backgrounds or not?**



In Group 1, 0 participants selected option 1, 0 selected option 2, 6 selected option 3, and 3 selected option 4. In Group 2, 0 participants selected option 1, 4 selected option 2, 3 selected option 3, and 1 selected option 4. In Group 3, 0 participants selected option 1, 1 selected option 2, 7 selected option 3, and 7 selected option 4. In Group 4, 1 participant selected option 1, 1 selected option 2, 9 selected option 3, and 4 selected option 4. (See Figure 15.)

## Chapter 5: Summary and discussion

### 5.1 Results and relationships

The data gathered for this study indicated that there are different perceptions of tone qualities, articulation styles, and challenges among horn players from different native language backgrounds.

#### **1) Is it harder to play consistent tone quality for people whose native language is tonal?**

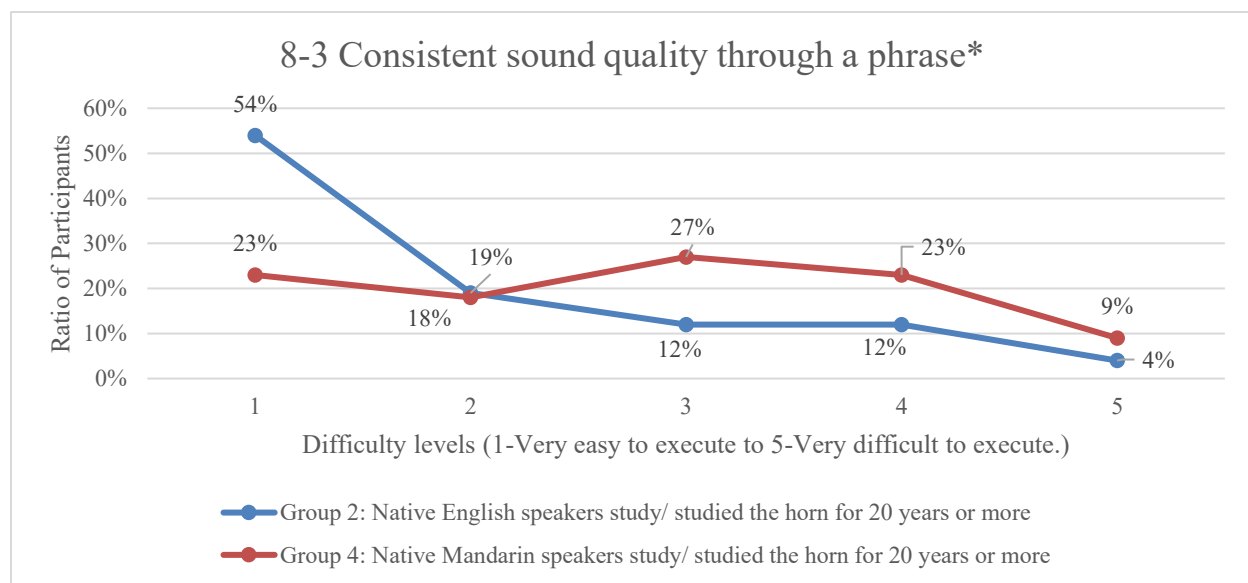
In Chapter 2-2: ‘Stress accent language and tonal language’, I mentioned that my hypothesis is *‘To produce different tones, native Mandarin speakers need to adjust the direction of the airstreams, because they have the habit of speaking with various types of airstreams and placements of vibrations. Most brass instrumental players, whose native language is Mandarin, struggle with unifying and straightening the airstream. The instinct of the native language would easily dominate the inner mouth shape and how to use the air unconsciously.’*

According to the survey questions answered by participants who study/ studied the horn for 20 years or more on questions 8-3, there are more native Mandarin speakers who think it is more challenging to perform music with consistent sound quality than native English speakers. 54% of participants from Group 2 think the difficulty level of playing consistent sound quality through a phrase is the lowest, while only 23% of participants from Group 4 think alike. The information above indicates that it is considerably more challenging to maintain consistent sound quality through a phrase for players whose native language is tonal. (See Figure 16.)

Besides the differences between tonal and accented languages, I think music education enhances the differences between native English speakers and Mandarin speakers. In Asia, most

musicians/ students learned using the Solfege system, while in America, most musicians/ students learned by singing without note names or solfege syllables. The solfege system creates different inner mouth movements than singing without note names. In addition to the different air streams, singing and learning with various inner mouth shapes increases and reveals more inconsistent tone quality. However, this does not eliminate the importance of the solfege system. It helps students and musicians better recognize the notes, positions, and the relationship between notes and scales.

**Figure 16. Consistent sound quality through a phrase**



**2) Is native language a factor that influences the smoothness of playing?**

In the second section of chapter 2, ‘Stress-timed language and syllable-timed language’, I mentioned that *‘The duration of words affects how we interpret the rhythm of the language and influences our musical interpretation. Since words have fixed duration, it is less comfortable for native Mandarin speakers to naturally stretch the words, like sustaining a long note. However, things are often two-sided. Because of the gentle cuts between words, native Mandarin speakers can articulate notes on instruments cleaner and more precisely. In addition, the fixed duration*

*would also create a habit of making short pauses between each note, making it less smooth while playing the music.'*

Unfortunately, the difficulty levels of 'smooth and connected phrases' between Group 2 (native English speakers who have studied/ played the horn for 20 years or more) and Group 4 (native Mandarin speakers who have studied/ played the horn for 20 years or more) were similar. With the Mann-Whitney calculation, the result was tested as  $U = 227, p > .05$ , indicating no differences in the perceptions of the difficulty in playing melodies smoothly by participants in Groups 2 and 4.

However, the difficulty levels of 'smooth and connected phrases' is not the only factor affecting the smoothness of melodies. Consistent tone also plays a vital role in whether players can play through the phrase smoothly or sound smoothly or not. Because with consistent tone quality, phrases would be more likely to be smooth and continuous, making them sound much smoother and more natural in the audience's ears.

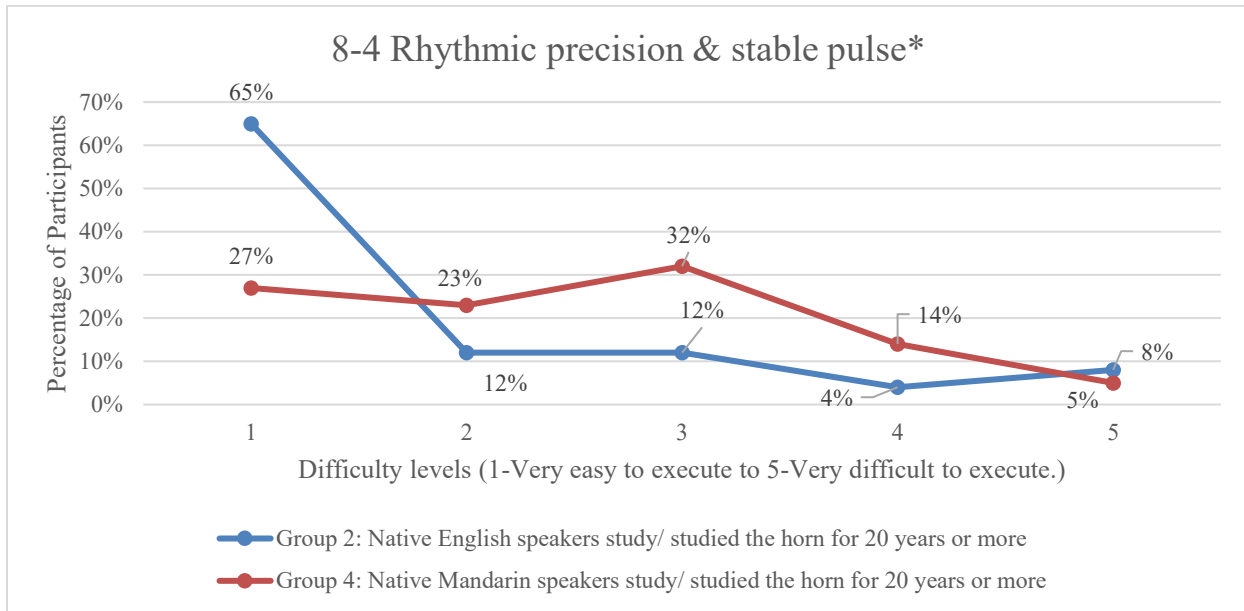
### **3) Do players from different native language backgrounds sense pulse or rhythm differently?**

Based on the nature of languages, I hypothesized that the equal duration language would help for playing steadily with the equal pulses but reduce the comfortable level of naturally stretching the words, like sustaining a long note.

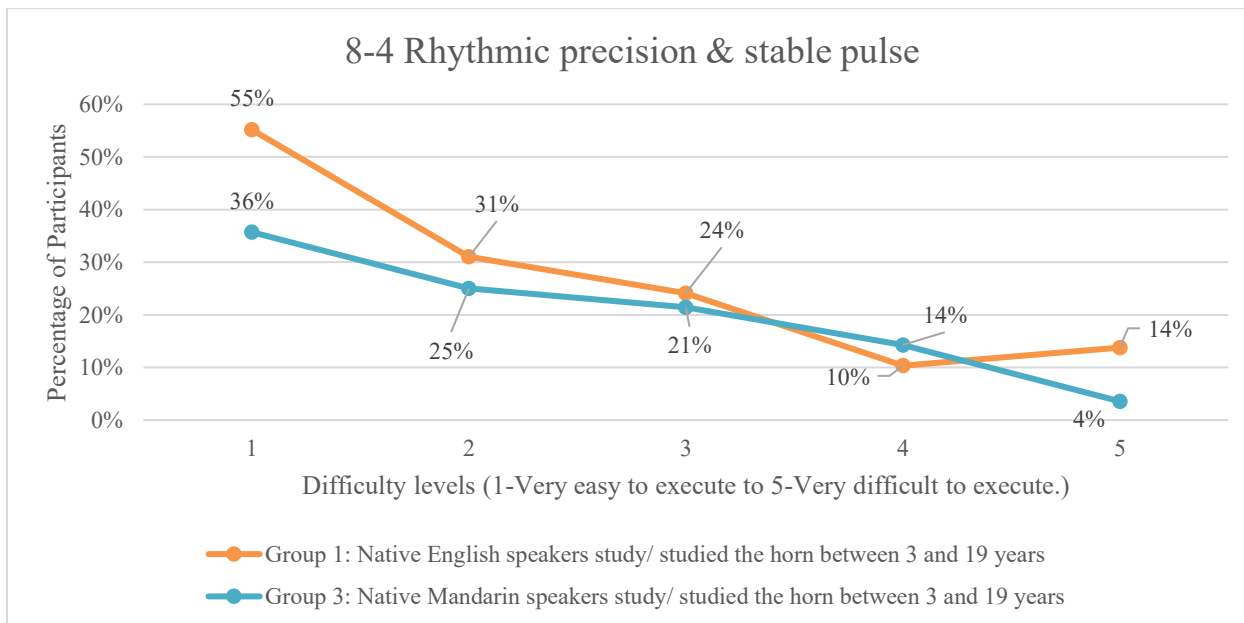
In Question 8, participants were asked to evaluate the difficulty level on the technique of keeping 'Rhythmic precision & stable pulse'. The Mann-Whitney U test suggested that the perceived difficulty of performing with rhythmic precision and stable pulse is significantly different. 65% of Group 2 rated the difficulty levels of playing stably on rhythm as the most effortless technique versus 27% of the participants in Group 4. The chart indicates that playing

music with higher rhythmic precision and stable pulse is perceived to be relatively easier for native English speakers, which is contradicted by my hypothesis. However, to understand the influences brought by the duration of the languages, we would need data on the question, such as the difficulty level of ‘comfortably switching the notes’ length’.

**Figure 17. Rhythmic precision & stable pulse- Group 2 & 4**



**Figure 18. Rhythmic precision & stable pulse- Group 1 & 3**





However, like the other techniques, the impact between native Mandarin speakers and native English speakers only showed in the participants who have studied/ played the horn for 20 years or more. Even though the average difficulty levels are still higher for native Mandarin speakers than for native English speakers among the participants who have studied/ played the horn between 3 and 19 years, with  $p > .05$ , no statistically significant differences were found. (See Figure 17 and 18.)

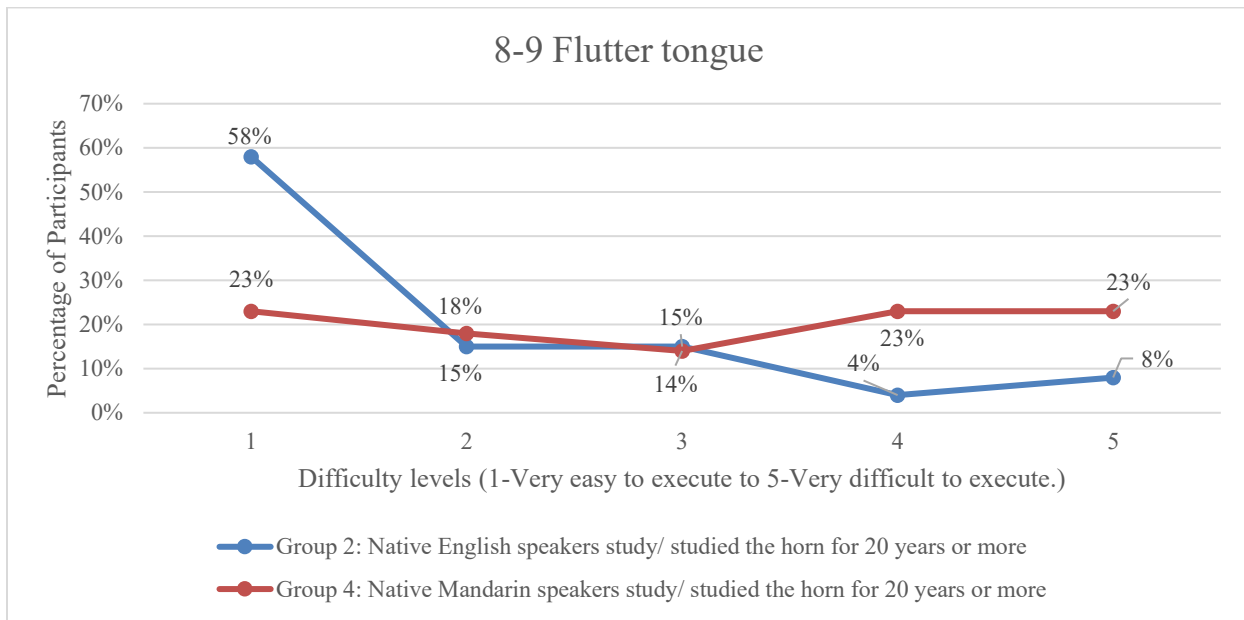
**4) Most of the horn players and educators mentioned that if you know how to pronounce the ‘rolled-R’, you would be able to execute the flutter tongue. Why is it? Is it because the mechanism of the language is the same as playing the horn?**

On question 8, perceived difficulty of flutter tongue technique, the test result comparing native English speakers and native Mandarin speakers who have studied/ played the horn for 20 years or more was  $U = 161, p < .01$ . As figure 19 shown, the perceived difficulty level between participants from Group 2 and 4 are notably different. The percentage of the native English participants thought that the flutter tongue is relatively easy are doubled than the native Mandarin participants. At the difficulty level 5, the percentage of the native mandarin participants are about three times more than the native English participants.

Interestingly, the ‘rolled R’ does not exist in either English or Mandarin. Why are there dramatic differences in the difficulty levels of flutter tongue between these Groups 2 and 4? First, English is closer to European languages, which contain the ‘rolled R’ sound. The pronunciation of European languages is more similar to English than to Mandarin. Second, the ‘rolled R’ did exist in old English. Even though it does not exist in Modern English , the trait has left some impact on English compared to Mandarin, which is not influenced by the ‘rolled R’. Third, my hypothesis is

that most native English speakers have learned European languages as their second language; most native Mandarin speakers have learned English as their second language. Exposure to European languages in early ages increases the probability of being able to roll the ‘R’ and being more familiar with the rolled ‘R’ sound. However, these hypotheses have not been proven and compared in the research paper. It would be interesting information to collect for future studies.

**Figure 19. Flutter tongue**



**5) Is there a unified tone quality among native English horn players and native Mandarin horn players?**

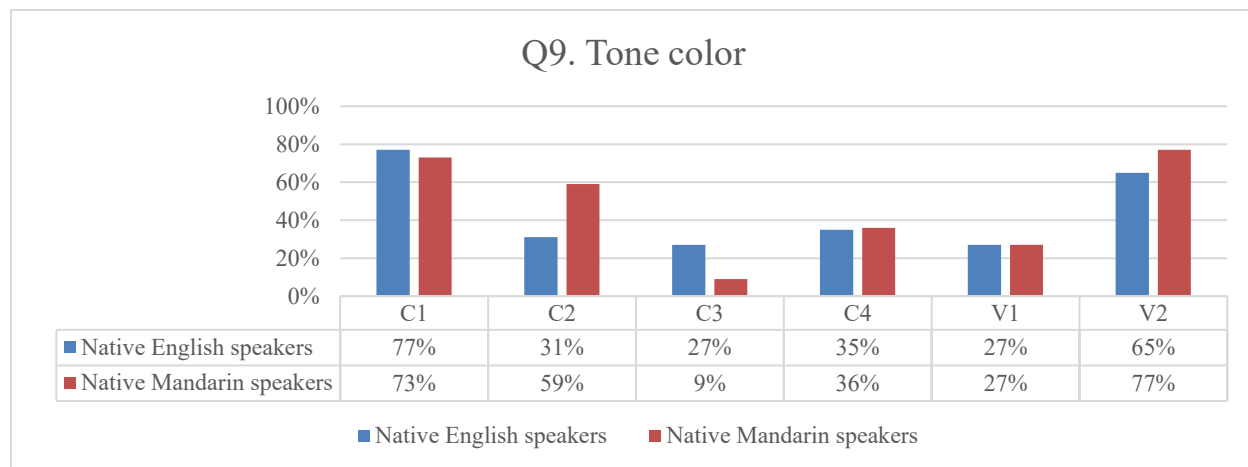
The data collected on question 9 suggested that there is no unified or unique tone quality among players from different native language backgrounds and years of horn studying/ playing experiences.

59% of the native Mandarin speakers who have studied/ played the horn for 20 years or more (Group 4) described their sound as brighter and more direct voice (C2) compared with 31% of the native English speakers who have studied/ played the horn for 20 years or more (Group 2).

The chi-square test result on C2 is  $X^2 = 3.88$ ,  $p < .05$ , which suggests that perceptions of these particular tone quality descriptors differs between native Mandarin speakers and native English speakers.

However, even though the test result and the percentage suggested a difference in this specific tone category, it is hard to distinguish and label the tone quality for either native English speakers or native Mandarin speakers. Because other than C2, all of the categories of tone quality were not statistically different between groups. In addition, the percentages of participants belonging to the specific categories are nearly identical between native English and native Mandarin speakers. The percentage of participants that indicated the categories mellow voice and warm voice (C1), open voice and brassy tone (C4), Smaller voice, lighter voice, and thinner voice (V1), and bigger voice and fuller voice (V2) were similar between Groups 2 and 4. This suggested that native English speakers and native Mandarin speakers perceive their tone qualities similarly. (See Figure 20.)

**Figure 20. Tone color between native English speakers and native Mandarin speakers who have studied/ played the horn for 20 years or more.<sup>89</sup>**



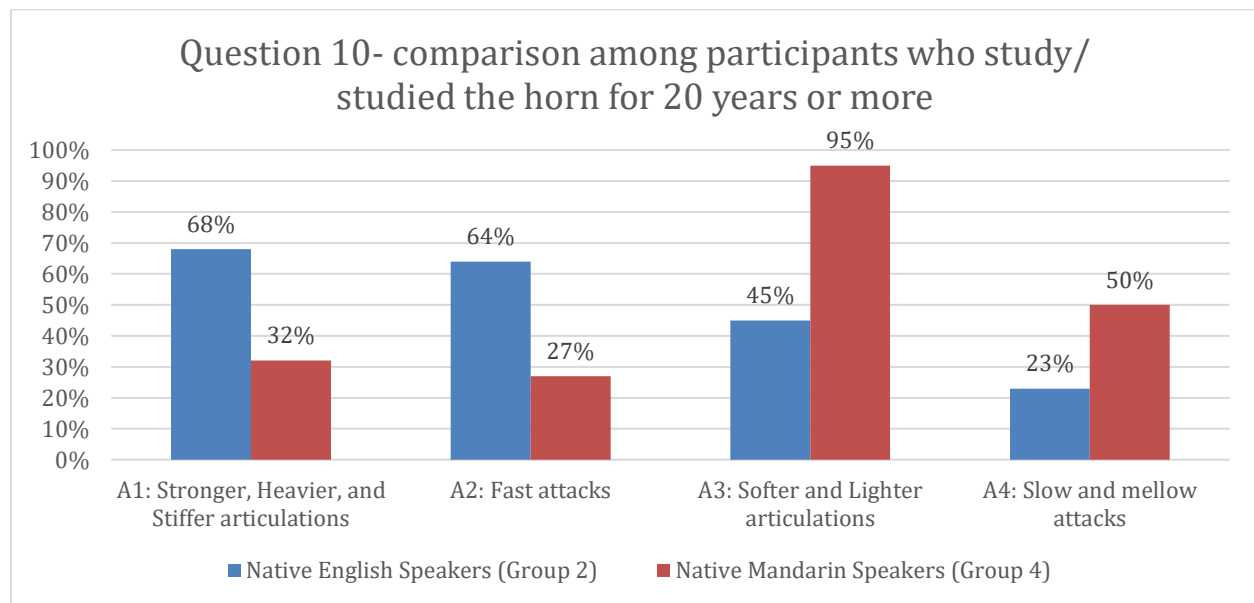
<sup>8</sup> C1: ‘mellow’ and ‘warm’; C2: ‘brighter voice’ and ‘direct’; C3: ‘darker voice’ and ‘more closed voice’; C4: ‘open voice’ and ‘brassy’. V1: ‘smaller voice’, ‘lighter voice’, and ‘thinner voice’; V2: ‘bigger voice’ and ‘fuller voice’.

<sup>9</sup> The  $p$  value on C2 is  $p < .05$ , which is considered statistically significant (shown in blue color).

**6) There are more native Mandarin speakers with stronger, heavier, and stiff articulation than native English speakers. Is this true?**

My educational background allowed me to experience horn educational systems and performance in Taiwan (the official language is Mandarin) and the United States (English) for about seven years in each country. I feel that it is more common to hear a stronger, heavier, and stiffer articulation from native Mandarin speakers than from native English speakers. However, based on the data collected from question 10, I realized my hypothesis was wrong. Between participants who have studied/ played the horn between 3 and 19 years, there were no differences. Nevertheless, interestingly, Group 2 and Group 4 did report different perceptions of their articulation quality, which is opposite from what I hypothesized.

**Figure 21. Comparison among participants who study/ have studied the horn for 20 years or more**



As the figure shows, the number of participants in Group 2 who belong to A1 (stronger, heavier, and stiffer articulations) and A3 (softer and lighter articulations) is about one time more than the number of participants in Group 4. The opposite trend was found for the categories A2

(fast attacks) and A4 (slow and mellow attacks). Based on the data, the majority of native English speakers consider themselves as playing with strong attacks, fast attacks, heavy attacks, and stiff articulation. Most native Mandarin speakers identify themselves as playing with softer and lighter articulations and slow and mellow attacks. However, the Chi-square of category A3,  $X^2 = 3.54$ ,  $p > .05$  was not statistically significant.

Surprisingly, this is the opposite from what I suspected. However, one of my worries and concerns about this survey is that this is self-evaluated. Describing one's articulation styles is subjective, which means participants might have different standards about the adjective provided. However, it is impressive that there is a vast difference between native English speakers and native Mandarin speakers. (See Figure 21.)

### **7) Do players from different native language backgrounds articulate in the same places, with the same speed, or the movements of the tongue?**

On question 8, 'consistent sound quality through a phrase', 'rhythmic precision and stable pulse', 'gentle front ends of notes', 'light-connected articulations in articulated scale passages', 'clear separated staccato articulation in scale passages', and 'flutter tongue' have been tested with the result of  $p < .05$ , which indicated that the difficulty level is statistically different between group 2 and 4. Six of the techniques I mentioned above are proven to be statistically different, and are rated as more challenging to learn and execute by native Mandarin speakers than by native English speakers.

Like the other results, the impact of the native language was only revealed among the participants who have studied/ played the horn for 20 years or more. Four hypotheses might cause this situation and phenomenon. First, it is a self-evaluated survey. As we know, music is subjective.

Everyone has different standards of dark and bright, soft and hard, fast and slow, etc. With different standards, it is hard to judge whether it is accurate. However, it is also essential to note that even though it is a self-evaluated survey, there were statistically significant differences between the two language groups.

Second, players who have studied/ played the horn for 20 years or more are more experienced and know how to express their thoughts about playing better and more precisely. Moreover, they are more likely to be stylistically stable than players with less experience.

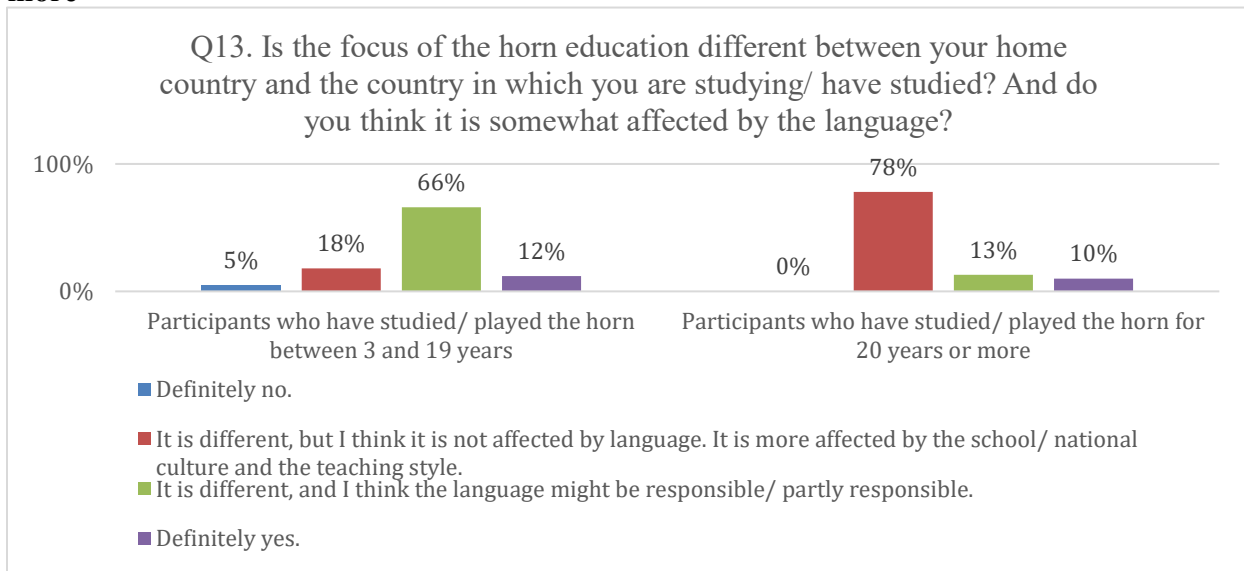
Third, horn education and language education has been globalized for the current generation. About 20 to 30 years ago, the internet was not widely used as a means of disseminating information. Music, arts, knowledge, information, and almost everything were not as easily exchanged and fused into each other. People in different countries could maintain their identity, uniqueness, and characters. With a more regional education system, I believe it is more likely to show the differences between each group. However, people who have studied/ played the horn between 3 and 19 years were educated with globalized information, educational system, and teachers whose playing was globalized or fused. It is harder to detect whether their native language influences them or not.

Fourth, participants who have studied/ played the horn for 20 years or more are more likely to be in the generation where they learn a second language much later. However, participants who have studied/ played the horn between 3 and 19 years are more likely to be in the generation where they were exposed to and started learning a second (or even third) language at an early age. These factors complicated the data and analysis.

**8) How do horn players think about the relationship between native languages and brass playing?**

According to the chart of the responses to Question 13, more participants who have studied/ played the horn between 3 and 19 years believe that native language might be responsible/ partly responsible for differences. However, more participants who have studied/ played the horn for 20 years or more thought the differences are more affected by the school/ national culture and the teaching style. (See Figure 22.)

**Figure 22. Comparison on Q13 between participants who have studied/ played the horn between 3 and 19 years and participants who have studied/ played the horn for 20 years or more**



Interestingly, results of the self-evaluated questions indicate that there are no statistically significant differences between native English and native Mandarin speakers who study/ play the horn between 3 and 19 years. However, in the question of ‘Is the focus of the horn education different between your home country and the country in which you are studying/ have studied? And do you think it is somewhat affected by the language?’, 66% of the players who study/ play the horn between 3 and 19 years think that languages might be responsible/ partly responsible for different horn educational focus from different countries.

To summarize the open-ended responses to Question 14, both native English speakers and native Mandarin speakers think that the teaching focus and educational methods are different. For example, some native English speakers mentioned that “*I’m from US, and in China it’s heavily influenced by German and Russian Traditions*”; “*American teachers are more focused on being very precise and are very methodical in their teaching, whereas German teachers are much more focused on sound quality and musicality.*”; and “*Articulation focus, conservatory history and style, tone color*”. Some native Mandarin speakers mentioned that “台灣教育要求實際音的正確演奏；而香港及德國的大師較重音色及整體的律動，較全貌。*(In Taiwan, horn education focuses more on playing accurately, while horn masters focus more on the tone quality and groove. It is relatively comprehensive.)*”，“主要是環境，語言有影響，但最主要是文化背景及日常生活。*(Mainly because of environment, language impact, but the most important is the cultural background and the daily life.)*”，and “美國注重樂團片段跟基本技巧。台灣重獨奏*(In America, they focus on orchestra excerpts and the basics. In Taiwan, they focus more on solo.)*”

On Question 16, participants were asked to describe the difference between countries and their opinions about the relationship between native languages and brass playing. The responses from one of the native English speakers and one of the native Mandarin speakers raised my interest. The English participant mentioned, “Those that speak romance languages, especially Spanish, can do double and triple tonguing way easier than I can.” The native Mandarin participant said that “像是講西班牙語的同學，他們的點音、滑音都會非常自然、容易*(Like the native Spanish classmates, their articulation and the slurs are very natural and easy.)*” Both participants from different native language backgrounds pointed out the same idea of their opinion on native Spanish-speaking players. It was surprising to have participants from different language backgrounds having the same opinions toward a third language.



## **5.2 Application to horn playing**

### **Singing without note name**

This exercise benefits people who have difficulty playing with consistent sound quality. Solfege is a system that gives a unique name for each note. There are two methods of applying this system: the fixed “Do” method and the movable “Do” method. No matter which method is applied, the main issue of singing with the Solfege system is inconsistent inner mouth shapes. However, singing and playing the horn while changing your inner mouth shape will increase the possibility of having inconsistent sound quality. According to the survey, for native Mandarin speakers, it is harder to play and maintain a consistent sound. In this case, teachers could train students to focus on thinking and singing the music with a fixed note name and avoid dramatic mouth movements. However, the fixed names should not be randomly chosen. The selected consonants and vowels should help players create a natural articulation for the horn and brass playing. Words like ‘*La*’, ‘*Lee*’, ‘*Lo*’, ‘*Da*’, ‘*Dee*’, ‘*Do*’, ‘*Ta*’, ‘*Tee*’, and ‘*To*’ make this exercise more effective.

The consonants determine how horn players place the tongue and how much energy they put into articulations. The consonants ‘*L*’, ‘*D*’, and ‘*T*’ create natural and subtle movements for articulating on the horn. The consonant ‘*L*’ is not too direct. The consonant ‘*D*’ is suitable for articulating the tenuto passages, which gives a strong attack but not a harsh or direct air attack. The consonant ‘*T*’ helps articulate the staccato passages, creating fast and abrupt air attacks.

Interestingly, based on my teaching and personal experience, horn players from different native language backgrounds have different tendencies to use the consonant ‘*L*’, ‘*D*’, and ‘*T*’. I tend to play with more rigid and stronger attacks, therefore it would be more beneficial if I used the consonant ‘*L*’ more frequently. However, for a player whose articulations are generally considerably mellow, I suggest they apply the consonant ‘*D*’ more often. The reason behind the

exercise is that the tongue touches different areas with the different consonants I listed above. The tongue touching a larger area would slow down the speed of air, providing a warmer tone quality. It could make the articulations with ‘L’ less audible and prominent than articulating with ‘D’. The choice of consonants would need to be adjusted based on individuals.

On the other hand, the vowels affect the shape of the internal mouth. This includes how much the lower jaw should be open, how much the hard and soft palates should raise, and whether the inner mouth should be opened vertically or horizontally. According to the International Phonetic Alphabet chart (IPA chart), the mouth shape for pronouncing the vowel ‘a’ ( /a/ ) (ex. Lava<sup>10</sup>) should be open and emphasize placing the air in the center of the mouth. The inner mouth shape for the vowel ‘ee’ is ( /i/ ) (ex. Even<sup>11</sup>). However, it is important not to stretch the lips tightly. The emphasis of ‘ee’ will be in the center of the mouth. For the vowel ‘o’ ( /ɒ/ ) (ex. Cold<sup>12</sup>), the inner mouth shape builds similarly to /a/, but the lower jaw needs to open even more. The emphasis will be on the back of the mouth (around the root of the tongue).

These three vowels are interesting and amazingly useful for horn playing because the open inner mouth shape allows air to flow easily. Additionally, emphasizing the vowels while singing and playing the horn can help create more resonance and ease. However, the three vowels assist players in various ranges. The vowel ‘a’ is better for playing in the middle range. Generally speaking, the vowel ‘a’ is a well-balanced embouchure for horn playing. The vowel ‘ee’ helps to concentrate and accelerate the airstream, which assists players in playing in the higher register. Students have asked me which consonant they should use and the range for each. The range and usage highly depend on the individual and their desired sound quality. As mentioned above, ‘ee’

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<sup>10</sup> The vowel ‘a’ ( /a/ ) sounds like the first ‘a’ pronunciation in the word ‘Lava’.

<sup>11</sup> The vowel ‘ee’ ( /i/ ) sounds like the first ‘e’ pronunciation in the word ‘Even’.

<sup>12</sup> The vowel ‘o’ ( /ɒ/ ) sounds like ‘o’ pronunciation in the word ‘Cold’.

would help while playing in the higher register. However, the sound quality would be relatively thinner and less ringing with the fast airstream and a flatter inner mouth shape. For different preferences and the requirements of the music, players could choose to play in the higher register with the combination of ‘*ee*’ and ‘*a*’. I would not suggest using ‘*o*’ because the inner mouth shape of ‘*o*’ is too wide, and the air stream is too slow and mellow, which would not create an elegant tone quality. Applying the same concept to the lower register, players could either use ‘*o*’ or ‘*a*’, but not suggested to use ‘*ee*’.

However, even though it is better to sing and play the horn without using the solfege system, musicians and horn players must know the relationship between the scales and the pitch. Knowing solfege has its value toward musicianship. To sing without note name is to assist players who found it challenging to maintain a consistent tone quality.

With personal teaching experience and results from the survey, I highly encourage native Mandarin-speaking students to try practicing the horn without singing the note names. Maintaining consistent sound quality was tested and shown to be more challenging for native Mandarin speakers than native English speakers. However, this would also benefit any player who suffers from maintaining consistent sound quality. (See Appendix III and IV.)

### **Flutter Tongue**

Flutter tongue is a tricky technique to teach and learn. As I mentioned before, if a student cannot pronounce the ‘rolled Rs’, they will likely not be able to replicate the flutter tongue. With the traditional way of learning, students would need to think about the movements of ‘rolled Rs’, air stream, tongue movement, tone quality, etc. However, focusing on too many things can make learning the movement more difficult. Simplifying the task could reduce the difficulty and ease

the nerves of learning the flutter tongue technique. Instead of remembering detailed instructions immediately, starting with learning ‘rolled Rs’ without the horn involved would be much more effective and productive. It not only simplifies the tasks but also reduces the stress level for students while learning new techniques.

As a tip for learning the ‘rolled Rs’, students could first try to create the same sounds but shorten them. Instead of trying to hold the ‘rolled Rs’ for long, it is only essential to be able to produce the sound. The length does not matter in the first stage of learning. After learning the movements, they could extend the length gradually. The final goal is to roll the Rs comfortably and steadily.

After rolling Rs steadily, students could try the same technique on the horn and produce the same movements. Like learning the rolled Rs without the horn, the beginning goal of playing the flutter tongue on the horn is to produce the sound, even if it is short and abrupt.

According to the survey results, this method could benefit horn players who struggle with learning flutter tongue and particularly native Mandarin speakers.

### **Adding lyrics from different languages**

Adding lyrics from different languages could help students think deeper about phrasing and the meaning of the music. Also, it is an engaging, interesting, and innovative horn-learning method.

Before adding the lyrics, I highly recommend that students read about the composer and understand the background of the piece. The lyrics should be designed based on the story behind the music. This activity encourages students to learn the story behind the music, giving them a better idea of how to interpret it.

My idea of adding lyrics from different languages is that different languages could help to break down the old habits of playing the horn and refresh the way you use your tongue and phrasing. As the survey results suggested, native English speakers find it easier to produce smoother phrases, so I suggest players who wish to play smoother add English lyrics. However, this learning method is tricky. As we all know, people can speak the same language with different eloquence and accents. It is important to mimic the accents and fluency of native speakers. For instance, if Mandarin native speakers would like to apply English lyrics, I would highly suggest they first try to speak like English native speakers. It does not mean that you should sound like a native speaker completely. However, it is essential to mimic how they speak and reproduce the sound they make, which would help to get the most out of this learning and practicing method. In addition to adding the lyrics and singing the lyrics before playing, I also suggest that horn players could try to mimic the tone and the fluency through videos, movies, and TV shows. It is a highly accessible and relaxing learning method. After building the habits, it could be easily applied to horn playing.

Appendix V includes an example of adding lyrics on the *Lied, No. 1*, composed by Leone Sinigaglia. The composer wanted to create a smooth and melodic atmosphere in this song. I added the lyrics in English and Mandarin with a similar theme and story. Singing in both languages on the same melodies provides different punctuations, feelings, and articulations. While singing in Mandarin, I would need to put more effort into making the music more melodic. However, singing in English is naturally smoother and easier to connect. In other words, depending on the needs of the music, players could try to add lyrics from different languages but settle down with the language that depicts the music the most. (See Appendix V.)

### **New mindset while practicing the horn**

Many researchers have found and proven that multiple teaching approaches benefit learning in general. Applying multiple approaches during lessons or toward individuals is also highly effective for music learning and teaching.

In traditional horn education, horn instructors use various teaching approaches and methods to keep students engaged and active during the lessons and master classes. However, most approaches and methods focus on improving technique, producing a good tone and correct notes, or even interpreting the music. In other words, it is detailed and direct instructions on how to produce the music. These approaches are pleasant and effective but may not be suitable for all students. For example, these detailed instructions may not be suitable for students who tend to overthink their horn playing and performing. With detailed instructions, this type of student might easily stress themselves too much and make the movements of playing/ producing the music too artificial to deliver the notes and music interpretation correctly. Multiple failures would affect the students' confidence level and create a fear and barrier toward playing the horn.

First, playing the horn by thinking about the connections between language could effectively reduce stress levels psychologically. Because they are not focusing on 'producing the notes' but on 'speaking'. Second, it redirects students' focus from thinking about their previous failure to concentrating on simply being able to play the notes and convey the music. Shifting their thoughts and conquering their fears would take a while, but it is doable. Third, speaking is one of the most comfortable and relaxing activities for humans, which allows students and horn players to play the horn more naturally and comfortably. Forth, after a couple of successes, students would feel more confident and less stressed from learning from the perspective of languages. Moreover, the approach of learning from the angle of languages not only helps students who are less confident

with their playing but also prevents and reduces the possibility of experiencing massive breakdowns by facing too many failures.

There are various ways of applying the concept of learning from the angle of languages to horn teaching. Before using the concept to teach, understanding and knowing more about the mechanisms of your and your students' native languages are necessary. It is not required for instructors and students to speak fluently in multiple languages. However, it is required to know the mechanisms, as described in the second section of chapter 2. Comparing English and Mandarin would be a good start to knowing more about the language. The structure of the phrase, accents of the language, and the inner mouth shapes of the language would be useful information.

For example, if my native language is Mandarin and my student's native language is English. According to the survey results, native English speakers have stronger, heavier, and faster attacks than native Mandarin speakers. It is harder for native English speakers to articulate softer and gentler than Mandarin speakers. When native English speakers need to learn how to articulate softer, I would ask students to repeat a set of designed Mandarin phrases. It is more important to mimic the accents and get familiarized with the mouth movements of the other languages.

Again, speaking fluently and interacting like native speakers are not essential to the exercise. Practicing the same/ similar accents and inner mouth movements and shapes is vital to let students feel the familiarity and be able to apply the same movements to different articulation needs. Instead of forcing students to soften the articulations, you could suggest students play with the same feeling while you are producing the sound of Mandarin phrases. After some practice and repetition, it would make the horn playing more natural and easier to understand.

However, it is suggested to apply this teaching approach in the lessons of more advanced horn students or students who know more than two languages because it might confuse students at the beginner levels.

### **5.3 Challenges of the survey and the topic**

Even though some statistical relationships were found between native languages and horn playing, it is still hard to prove the relationships directly. First of all, the results of the survey are based on self-evaluations by the participants. The participants' responses are subjective and could be biased. Second, music is highly subjective. Everyone would rate and evaluate the identical music differently. Third, different wording and answering methods also affect the results of the survey.

Even though I had avoided using negative words, consulted with professionals on better wording, and tried to minimize the risk of getting false positives while designing the survey, it is still possible that the bias and subjectivities have impacted the survey results.

This topic has more potential and could be examined more in-depth with other methods. For example, setting up interviews with experienced horn educators and players from different native languages would be straightforward. However, the disadvantage of this method is that the idea that native languages influence horn playing might be easily planted in the minds of those being interviewed, which could modify the results. Another method is to use technologies to analyze the differences between players from different native language backgrounds. However, this method needs strong and sensitive technologies for recording, data analysis, sensitive microphones, etc. As far as I know, it is still difficult to find compatible technologies to analyze the relationship between native languages and horn playing. The other method is to collect even



more data from players with various native language backgrounds. With more extensive data, it would be even more accurate.

## **5.4 Discussion & Conclusion**

Based on the survey, research results showed that there were significant differences between the native English speakers and the native Mandarin speakers in terms of their general articulation styles and their perceived difficulty levels of some techniques. Specifically, native English speakers found the following techniques to be easier to perform: ‘consistent sound quality through a phrase’, ‘rhythmic precision and stable pulse’, ‘gentle front ends of notes (softer attacks)’, ‘light-connected articulations in articulated scale passages’, ‘clear separated staccato articulation in scale passages’, ‘clear separated staccato articulation in scale passages’, and ‘flutter tongue’. Also, majority of the native Mandarin speakers described that they have a softer and more mellow articulation styles versus to majority of the native English speakers described that they have a brighter and heavier articulation styles.

Interestingly, the differences were only found in the more experienced group of horn players who had studied/ played the horn for 20 years or more. No significant differences were found between the native English speakers and native Mandarin speakers in the less experienced group of horn players who have studied/ played the horn between 3 and 19 years. Beyond this finding, the result of the technique ‘rhythmic precision and stable pulse’ also turned out to be unexpected. Due to the equal duration feature of Mandarin, the technique was hypothesized to be easier to execute by native Mandarin speakers, which showed opposite in the result.

These findings indicate the need for developing teaching methods and exercises to help horn players overcome the barriers created by their native language and leverage the strength brought with their native language. Four teaching methods: ‘Singing without note name’, ‘Flutter

tongue (Simplifying the learning process)', 'Adding lyrics from different languages, and 'New mindset while practicing the horn' are developed and provided with detailed instructions for applying in horn teaching in the project. The purpose of this project was to gather and present a general information guideline on revealing whether there is relationship between native language and brass playing or not. I hope that this study can contribute to the understanding of the possible links between language and brass playing and inspire musicians and educators to integrate this concept in their performance and teaching.

### **5.5 Future Potential of this Topic**

This topic can be verified not only in horn education but also in music education in general, such as 'interpreting the music following with the mechanism of the native language of the composer', 'different focus on giving master class/ lecture based on the native language of the majority audience', 'why the influenced are shown in more experienced players and not in the less experienced players', etc.

With the variety and potential of the topic, I hope the data collecting and analyzing methods could also be improved and collaborated with the developed AI systems, recording technology, and scientific equipment. However, the survey could be a budget-friendly, efficient, and easy-accessed tool to collect general information, which helps to understand relationships and develop potential topics.

Based on my research, it would be helpful to collect more data from various native languages-speaking horn players, develop more comprehensive and organized horn exercises from different linguistic angles, and broaden data collecting methods based on my collected results. In addition to the online survey, a blind test with recording horn playing and speaking would also be useful.

Additionally, interviewing instructors from different native language backgrounds would be adequate to learn more about the relationship between language and horn education.

Anton, Ronald J. 1990. "Combining Singing and Psychology." *Hispania* 73, No. 4: 1166-1170.

Catherine J. Stevens, Peter E. Keller, and Michael D. Tyler. 2011. "Tonal language background and detecting pitch contour in spoken and musical item." *Psychology of Music* 41: 59-74.

Erin McMullen, Jenny R. Saffran. 2004. "Music and Language: A Developmental Comparison." *Music Perception* 21: pp. 289-311

Giuliano, Ryan, Peter Pfordresher, Emily Stanley, Shalini Narayana, and Nicole Y. Wicha. 2011. "Native Experience with a Tone Language Enhances Pitch Discrimination and the Timing of Neural Responses to Pitch Change." *Frontiers in Psychology* 2. <https://doi.org/10.3389/fpsyg.2011.00146>.  
<https://www.frontiersin.org/articles/10.3389/fpsyg.2011.00146>.

Han, Feifei. 2013. "Pronunciation Problems of Chinese Learners of English." *Ortesol Journal* Vol. 030: pp. 26-30.

## **Appendix I: Recruitment letter**

Hello everyone, I'm Yu-Hsuan Cheng, a DM-Horn student at the Indiana University Jacobs School of Music. Professor Richard Seraphinoff, Dr. Peter Miksza, and I are conducting a study examining the relationships between native languages and brass playing. We are looking for participants who have played the horn for over three years. Participation in our study involves a one-time online survey that will take approximately 10 minutes to complete. In this survey, you will be asked to (a) Describe your general background and experiences in horn playing (b) Opinions about the relationships between native languages and brass playing. Please be aware that participation is completely voluntary. Your responses will be completely confidential. If you are interested in participating in the study, please follow the survey link. [https://iu.co1.qualtrics.com/jfe/form/SV\\_0rCN8AYcxUODVtk](https://iu.co1.qualtrics.com/jfe/form/SV_0rCN8AYcxUODVtk)

## Appendix II: Survey

# Language and Brass

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### Start of Block: Basic information

Q1. Have you played horn for more than 3 years?

Yes. (Please enter how many years you have played the horn below)

\_\_\_\_\_

No.

Q1. 請問您演奏/學習法國號吹奏有超過三年嗎?

是。(請註明演奏/學習法國號吹奏多少年)

\_\_\_\_\_

否。

-----

Q2 Are you currently taking private lessons?<br>

Yes. (Please enter how many lessons you take in a typical month)

\_\_\_\_\_

No.

I'm a horn teacher.

I'm a contracted/ freelance horn performer.

Q2 您目前有定期上法國號個別課嗎?

是。(請註明平均一個月裡上幾堂課。)

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否。

我是法國號教師。

我是法國號演奏家。

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Q3 What age are you?

0-18

19-22

23-30

31-40

41-50

Above 50

Q3 您的年齡?

- 0-18
  - 19-22
  - 23-30
  - 31-40
  - 41-50
  - 50 歲以上
- 

Q4 Current career / status?

- Contracted Horn Performer
- Contracted/ Professional Horn Educator (Higher Ed.)
- Contracted/ Professional Horn Educator or Private/ Sectional instructor (All levels, except Higher Ed.)
- Graduate student, majoring in Horn
- Graduate student, not majoring in Horn
- Undergraduate student, majoring in Horn
- Undergraduate student, not majoring in Horn
- Other... \_\_\_\_\_

Q4 目前的職業?

- 約聘法國號演奏家
  - 約聘法國號教授 (大專院校)
  - 法國號個別課/ 室內樂/ 樂團分布課老師 (非大專院校)
  - 碩博士班學生, 主修法國號
  - 碩博士班學生, 非法國號主修
  - 大學生, 主修法國號
  - 大學生, 非法國號主修
  - 其他... \_\_\_\_\_
-



Q5 Your native language is...

- Cantonese
- English
- French
- German
- Japanese
- Korean
- Mandarin
- Spanish
- Vietnamese
- Bilingual (Learn both languages at an early age) (Answer order, "Dominant native languages, Secondary native language")  
\_\_\_\_\_
- Other... \_\_\_\_\_

Q5 您的母語是...

- 粵語
  - 法文
  - 法語
  - 德文
  - 日文
  - 韓文
  - 中文
  - 西班牙文
  - 越南語
  - 雙語 (兩個語言都必須在幼童時期接觸) (請依照 "主要母語, 次要母語" 順序回答)  
\_\_\_\_\_
  - 其他... \_\_\_\_\_
-

Q6 What is the brand of the horn you are using regularly? <br>

- Alexander
- C. G. Conn
- Engelbert Schmid
- Hans Hoyer
- Holton
- Jupiter
- Paxman
- Thein
- Other.... \_\_\_\_\_

Q6 您所用的法國號是...

- Alexander
- C. G. Conn
- Engelbert Schmid
- Hans Hoyer
- Holton
- Jupiter
- Paxman
- Thein
- 其他... \_\_\_\_\_

---

Q7 Material of the horn you are using?

- Yellow brass
- Rose brass
- Nickel Silver
- Other... \_\_\_\_\_

Q7 您所使用的法國號材質是?

- 黃銅
- 紅銅
- 鎳銀
- 其他... \_\_\_\_\_

**End of Block: Basic information**

---

**Start of Block: Block 5**

Q8 Please rate the difficulty of these techniques in your own playing by using the following scale: <br>1-

Very easy to execute to 5-Very difficult to execute<br>

Clean articulations	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
Smooth and connected phrases	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
Consistent sound quality through a phrase	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
Rhythmic precision & stable pulse	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
Clear front ends of notes (Pure and clear attacks)	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
Gentle front ends of notes (Softer attacks)	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
Light connected articulations in articulated scale passages	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
Clear separate staccato articulations in scale passages	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
Flutter tongue	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5

Q8 請依照您對下列吹奏技巧的難易度進行評分: <br /> 1- 執行上非常容易; 5- 執行上較有難度

清晰的點音	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
圓滑線樂句 和連貫性樂句	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
穩定的音質/ 音色	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
精準的節奏 和律動	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
每個音的開 頭都是乾淨 和精準的	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
每個音的開 頭都是溫柔, 卻清楚的	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
輕巧但連貫 不間斷地點 音	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
乾淨精準, 卻 短促的點音	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
花舌	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5

---

Page Break



Q9 How would you describe your general tone quality?<br>(Choose at least three options so that we could better understand your tone quality.)<br>

- Mellow
- Warm
- Darker voice
- Brighter voice
- Thinner voice
- More closed voice
- Open voice
- Brassy
- Smaller voice (Woodwind chamber type)
- Bigger voice (Orchestra type/ Brass chamber type)
- Lighter voice
- Direct
- Fuller voice
- Other adjectives... \_\_\_\_\_

Q9 您會如何形容在一般情況下您的法國號音色呢? <br /> (請至少勾選三個選項, 讓我們更加了解您的音色)

綿密的音色 (比較柔的音色)

溫暖的音色

比較暗的音色

比較亮的音色

比較細的音色

悶悶的音色

開闊的音色

管樂團的音色

偏木管的音色

偏銅管的音色

比較輕的音色

比較直接的音色

結實的音色

其他形容詞... \_\_\_\_\_





Q10 How would you describe your current articulation style in general?<br>(Choose at least three options so that we could better understand your articulation style.)<br>

Strong articulation

Soft articulation

Slow attack

Fast attack

Stiff articulation

Mellow articulation

Smooth articulation

Lighter attack

Heavy attack

Other... \_\_\_\_\_

Q10 您會如何形容在一般情況下您的點音方式呢? <br /> (請至少勾選三個選項, 讓我們更加了解您的點音方式)

偏向力道強大的點音

偏向力道柔軟的點音

點舌的速度偏慢

點舌的速度偏快

直接較無彈性的點音

柔軟的點音

滑順的點音

輕巧的點音

較重的點音

其他形容詞... \_\_\_\_\_

-----

Q11 Do you study, or have you studied the horn in a country that speaks a native language different from your own? Do you study/ have studied with a teacher who speaks a native language other than your own?

- Yes. I study/ have studied the horn in a country that speaks a native language different from my own.
- Yes, I study/ have studied with a teacher who speaks a native language other than my own.
- Yes, I study/ have studied both with a teacher who speaks a native language other than my own and in a country that speaks a native language different from my own.
- No. None of above.

Q11 您有在非母語國家學習過法國號嗎? 您有曾經或現在和不同母語背景的教授學習過嗎?

- 是, 我在非母語國家學習過法國號。
- 是, 我和不同母語背景的教授學習過。
- 是, 我在非母語國家學習過法國號, 也和不同母語背景的教授學習過。
- 否。

**End of Block: Block 5**

---

**Start of Block: Block 2**

Q12 What is the native language of the professors you are studying with/ have studied with? And in which country are you studying/ have studied?<br><br>(Please write the native language of your professors and the duration of your study with each professor in the order from the first to the most recent.)<br>(Ex1. Taiwan, studied 4 years with a native Chinese-speaking professor; America, 4 years

with a native English-speaking professor.)<br>(Ex2. Taiwan, studied 4 years with a native Chinese-speaking professor; Taiwan, 4 years with a native German-speaking professor.)<br>

---

Q12 請問您教授的母語背景是? 請問您在哪個國家學習?<br /> <br /> (請將您教授的母語, 您和教授學習幾年, 和受教育的國家按照學習先後順序寫下)<br /> (舉例 1: 台灣, 學習四年, 教授的母語是中文; 美國, 學習四年, 教授的母語是英文)<br /> (舉例 2: 台灣, 學習四年, 教授的母語是中文; 台灣, 學習五年, 教授的母語是德文)

---

---

Q13 Is the focus of the horn education different between your home country and the country in which you are studying/ have studied? And do you think it is somewhat affected by the language?

- Definitely not different.
- It is different, but I think it is not affected by the language. It is more affected by the school/ national culture and the teaching style.
- It is different, and I think the language might be responsible/ partly responsible.
- Definitely yes.

Q13 您覺得在不同國家,法國號教育上的重點有不一樣嗎? 您覺得這個跟語言有關係嗎?

- 完全沒有。
- 教育重點不一樣,但並不是因為語言所致,而是因為校風和教授的特長不同而導致。
- 教育重點不一樣,我想語言佔據了部份的原因。
- 當然有。

End of Block: Block 2

---

Start of Block: Block 3

Q14 What differences in educational approaches have you noticed between your native country and the country in which you have studied? Please describe below.

---

Q14 請敘述您在教育上感受到的不同?

---

---

Q15 Have you noticed that some of the struggles you faced through learning the horn are different from other horn players who come from different native language backgrounds?

- Definitely not.
- Probably not.
- Probably yes.
- Definitely yes.

Q15 您有沒有曾經感受到您自己和不同母語的法國號演奏家/學生存在不一樣的學習困難點?

- 完全沒有。
- 可能沒有。
- 可能有。
- 當然有。

**End of Block: Block 3**

---

**Start of Block: Block 4**

Q16 What different challenges have you noticed between yourself and players from different native language backgrounds? Please describe below.

---

Q16 請敘述您認為不一樣的學習困難點?

---

## Appendix III: Articulation exercise

### Articulation Exercises

For the articulation exercise, I suggest using La-Lee-Lo, Ta-Tee-To, and Da-Dee-Do tonguing.

'L' is a softer articulation. 'T' creates a sharper attack. 'D' builds a slower but more sound oriented articulation. If you tend to play with a brighter tone color, I suggest that you start the exercise with the consonant 'L'. It could soften your articulation which will make the tone quality softer and warmer.

If you have a mellower tone color, I suggest that you start the exercise with the consonant 'T'. The sharper and stronger attack could help you produce a stronger and brighter tone color. It is also beneficial for staccato passages, which gives you a clear and concentrated tone color.

For the tenuto passages or strongly emphasized phrases, I suggest using the consonant 'D'. The consonant 'D' provides slower but more sound oriented articulations, which could help you create a stronger and more pure sound on the attack.

The vowel sound 'A', the pronunciation of which is described in Chapter 5.2, Page 47-49, is good for the range around middle c (c1) to c2. 'EE' is better for the range above c2; and 'O' is good for the range below c1.

\*The suggestions above are not restricted. Please adjust with your preferences, original tone quality, and the sound you need.

\*The ranges for the vowel 'A', 'EE', and 'O' can be expanded by a Major third or Perfect 5th.

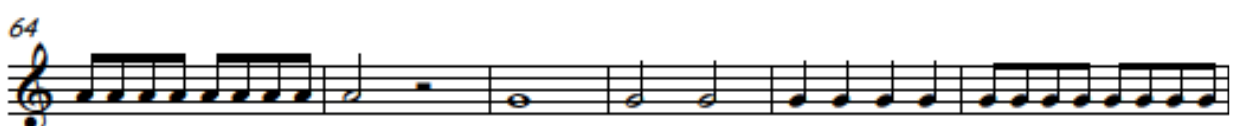
#### Steps for Practicing:

1. Choose a syllable to apply to the exercise. Please stay with the same syllable each time. Then, change to the another syllable next round of practicing.
2. Sing with the syllable you chose before applying it to horn playing.  
(While singing, please pronounce the consonant properly. It would be useless if the consonant is not pronounced properly.) (See Chapter 5.2, Page 47-49 for proper pronunciation)
3. Apply the feeling of singing to horn playing.
4. Practice in different keys and with different syllables.

### Articulation Exercise 1

#### Articulation Exercise 1-1: Basic & Eighteenth notes

2







## Articulation Exercise 2

Articulation Exercise 2 focuses on helping players build a stronger but delicate and clear articulation.

Please follow the practicing steps as described in Exercise 1.

In this exercise, I suggest starting and focusing on using the consonant 'T', which naturally provides a more concentrated and faster air stream.

118 Playing from c1 ascending to c2, then descending from c2 to c1.





## Articulation Exercise 3

Articulation Exercise 3 focuses on practicing the double-tonguing/ triple-tonguing skill.

### Steps for practicing:

1. Sing with double-tonguing before applying to horn playing.
2. Play with single tonguing the first time.
3. Then, play using double tonguing.
  - \*While playing with single tonguing, please try to reproduce the easiness and gentleness created while playing with double tonguing.
  - \*While playing with double tonguing, please try to maintain the same clarity as playing with single tonguing.
  - \*Practice the triple-tonguing skill with the same steps and mindset.

154 **Double-tonguing** Playing from c1 ascending to c2, then descending from c2 to c1.

158 Single Tongue Double Tongue

162 Single Tongue Double Tongue

166 ST DT


170


174


178


182


**Triple-tonguing** Playing from c1 ascending to c2, then descending from c2 to c1.


186 


190 


194 

198 

202 

206 

210 

214 

## Appendix IV: Slurred exercise

### Slurred Exercises

The goal of the slurred exercise is to smooth out and connect the sound, eliminating the gaps between notes.

#### Steps for practicing:

1. Sing with either syllable: 'La', 'Lee', or 'Lo'  
(Focusing on the vowel: Ex. Sing La-a-a, instead of singing La-La-La)
2. Applying the same feeling from singing to horn playing
  - \*Keep the airstream consistent, steady, and straight
  - \*It is important to practice with the metronome. It helps to make the notes more even and steady.
  - \*After familiarizing yourself with playing in C major, it is highly encouraged to play it in different keys.

#### Exercise 1: Playing upward scalewise notes from the tonic

5

9

12

16

20

2

23

6

6

6

24

6

6

6

**Exercise 2: Playing downward scalewise notes from the tonic**

26

26

30

3

3

3

3

3

3

34

5

5

5

5

5

5

3

3

3

3

37

3

3

3

3

3

3

3

3

7

7

41

7

7

7

7

7

7

44

7

7

7

7

7

7

47

Musical staff 47: Treble clef, starting with a whole rest, followed by sixteenth-note runs with fingerings 6, 6, 6.

49

Musical staff 49: Treble clef, sixteenth-note runs with fingerings 6, 6, 6.

**Exercise 3: Playing upward and downward scalewise notes from the tonic**

51

Musical staff 51: Treble clef, eighth-note scale runs.

55

Musical staff 55: Treble clef, eighth-note triplets with fingering 3.

59

Musical staff 59: Treble clef, eighth-note runs.

61

Musical staff 61: Treble clef, eighth-note runs with fingerings 5, 5, 5, 5.

64

Musical staff 64: Treble clef, eighth-note runs with fingerings 5, 5, 5, 5.

67

Musical staff 67: Treble clef, eighth-note runs with fingerings 6, 6, 6, 6.



4

68

Musical staff 68: Treble clef, sixteenth-note runs with sixths. The staff contains four measures of music, each starting with a sixteenth-note run followed by a sixteenth-note rest, then a sixteenth-note run. The number '6' is written above the first sixteenth-note run in each measure.

69

Musical staff 69: Treble clef, sixteenth-note runs with sixths and sevenths. The staff contains four measures of music. The first two measures have sixteenth-note runs with sixths, and the last two measures have sixteenth-note runs with sevenths. The number '6' is written above the first two measures, and '7' is written above the last two measures.

72

Musical staff 72: Treble clef, sixteenth-note runs with sevenths. The staff contains four measures of music, each starting with a sixteenth-note run followed by a sixteenth-note rest, then a sixteenth-note run. The number '7' is written above the first sixteenth-note run in each measure.

75

Musical staff 75: Treble clef, sixteenth-note runs with sevenths. The staff contains four measures of music, each starting with a sixteenth-note run followed by a sixteenth-note rest, then a sixteenth-note run. The number '7' is written above the first sixteenth-note run in each measure.

## Appendix V: Example of adding lyrics to the music

Melodies from *Leone Sinigaglia: Lied, Op. 28, No. 1, mm. 1-33*



Blue birds dance a - round the - gar - den. — They are cheer - ing, ha - ppy, sing - ing to me. —  
藍 鶺 在 空 中 自 由 翱 翔 著 — 他 — 旋 轉 跳 舞 圍 繞 著 我



9 — Look at them, as they fo - llow the - breeze in the sky. Full of joy, full of cheer, without fear. — I —  
— 看 著 他 — —, 自 由 翱 翔 在 藍 天 中, 開 心 地, 雀 躍 地, 無 — 畏 地 我 也



18 want to dance, with - out fear just like the blue bird dan - cing up high in the sky. —  
想 跳 舞 像 藍 鶺 一 樣 享 受 著 跳 舞, 和 藍 天, 和 我



25 — Fly with me, set me free, through the do - or of my heart, I will fly, I will sing, I will dance with you. —  
— 跟 著 他, 張 開 手, 打 開 心 靈 那 扇 窗, 展 開 翅, 和 — 我 — 一 起 高 — 歌

## Bibliography

- Anton, Ronald J. Dec. 1990. "Combining Singing and Psychology." *Hispania* Vol. 73, No. 4: pp. 1166-1170.
- Deutsch, Diana. 2016. "The Puzzle of Absolute Pitch." *Current Direction in Psychological Science* Vol. 11
- Erin McMullen, Jenny R. Saffran. 2004. "Music and Language: A Developmental Comparison." *Music Perception* 21: pp. 289-311
- Giuliano, Ryan, Peter Pfordresher, Emily Stanley, Shalini Narayana, and Nicole Y. Wicha. 2011. "Native Experience with a Tone Language Enhances Pitch Discrimination and the Timing of Neural Responses to Pitch Change." *Frontiers in Psychology* 2 (146).  
<https://doi.org/10.3389/fpsyg.2011.00146>.  
<https://www.frontiersin.org/article/10.3389/fpsyg.2011.00146>.
- Gordon, Reyna, Cyrille Magne, and Edward Large. 2011. "EEG Correlates of Song Prosody: A New Look at the Relationship between Linguistic and Musical Rhythm." *Frontiers in Psychology* 2 (352). <https://doi.org/10.3389/fpsyg.2011.00352>.  
<https://www.frontiersin.org/article/10.3389/fpsyg.2011.00352>.
- Han, Feifei. 2013. "Pronunciation Problems of Chinese Learners of English." *Ortesol Journal* Vol. 030: pp. 26-30.
- Ludke, Karen M., Fernanda Ferreira, and Katie Overy. 2014. "Singing can facilitate foreign language learning." *Memory & Cognition* 42 (1): 41-52. <https://doi.org/10.3758/s13421-013-0342-5>. <https://doi.org/10.3758/s13421-013-0342-5>.
- Peretz, Isabelle, Sebastien Nguyen, and Stephanie Cummings. 2011. "Tone Language Fluency Impairs Pitch Discrimination." *Frontiers in Psychology* 2 (145).  
<https://doi.org/10.3389/fpsyg.2011.00145>.  
<https://www.frontiersin.org/article/10.3389/fpsyg.2011.00145>.
- Tillmann, Barbara, Denis Burnham, Sebastien Nguyen, Nicolas Grimault, Nathalie Gosselin, and Isabelle Peretz. 2011. "Congenital Amusia (or Tone-Deafness) Interferes with Pitch Processing in Tone Languages." *Frontiers in Psychology* 2 (120).  
<https://doi.org/10.3389/fpsyg.2011.00120>.  
<https://www.frontiersin.org/article/10.3389/fpsyg.2011.00120>.