VẤN ĐỀ PHÁT ÂM THANH ĐIỆU TIẾNG THÁI
CỦA NGƯỜI HỌC MIỀN TRUNG VIỆT NAM

Patthida Bunchavalit*

Mục đích nghiên cứu này là khảo sát vấn đề phát âm của người học miền Trung Việt Nam khi học tiếng Thái như một ngoại ngữ. Sáu người Việt Nam được yêu cầu phát âm 203 từ tiếng Thái được tạo ra từ bốn loại âm tiết tiếng Thái. Chương trình Praat được sử dụng để tiến hành phân tích âm thanh về các đặc điểm ngữ âm học. Kết quả nghiên cứu cho thấy sự giao thoa tiêu cực ảnh hưởng đến việc phát âm của người học với thanh cao [4]. Mặt khác, sự giao thoa tích cực ảnh hưởng đến cách phát âm của người học với các thanh trung [1], thanh thấp [2], thanh cao-xuống [3] và thanh thấp-lên [5] vì đặc điểm của chúng tương tự với thanh ngang, huyền, hỏi/nặng, và sắc trong tiếng miền Trung Việt Nam. Ngoài ra, sự khác biệt về đường nét thanh điệu giữa hai ngôn ngữ và sự khác biệt trong cách phân bổ thanh điệu có liên quan đến cấu trúc âm tiết tiếng Thái và tiếng Việt cũng ảnh hưởng đến khả năng phát âm của người học. Đối với việc phát âm âm tiết khép kết hợp với nguyên âm ngắn, người học đã thay thế thanh cao [4] bằng thanh sắc do hiện tượng giao thoa. Tuy nhiên, đặc điểm của thanh sắc tương tự với thanh thấp-lên [5] trong tiếng Thái. Kết quả cho thấy người học không nhận ra được sự khác biệt giữa thanh cao [4] và thanh thấp-lên [5]. Đối với các thanh điệu khác, người học không gặp khó khăn khi phát âm dựa trên đặc điểm ngữ âm học của chúng tương tự với nhau.

Từ khóa: *So sánh đối chiếu, Vấn đề phát âm, Thanh điệu, Tiếng Thái, Tiếng Việt.*

The purpose of this study was to investigate the pronunciation problems of Central Vietnamese learners who study Thai as a foreign language. Six Vietnamese people were asked to pronounce a list of 203 Thai words, which are made up of four types of Thai syllables. The Praat program was used to conduct an acoustic analysis of the phonetic characteristics. The results showed that the negative transfer affected the learners' pronunciation of the high tone [4]. On the other hand, the positive transfer affected the learners' pronunciation of the middle [1], the low [2], the high-falling [3], and the low-rising tones [5] because these characteristics are similar to those of ngang, huyền, hỏi/nặng, and sắc in Central Vietnamese. In addition, the differences in tonal contour and in the distribution of tones related to syllable structures between the two languages have also affected the learners' pronunciation. For the pronunciation of closed syllables with a short vowel, the learners replaced the high tone [4] with sắc by the interference phenomenon. Nevertheless, the characteristics of sắc are more similar to those of the low-rising tone [5] in Thai. The results revealed learners' inability to distinguish between the high [4] and the low-rising tones [5]. For other tones, the learners did not have difficulty pronouncing them based on their similar phonological characteristics.

Keywords: *contrastive analysis, Pronunciation problems, Tones, Thai, Vietnamese.*

* **PGS.TS.**, **Khoa Nhân văn, Đại học Ramkhamhaeng (Thái Lan)**
Email: patthida.b@rumail.ru.ac.th

PRONUNCIATION PROBLEMS IN THAI TONES OF CENTRAL VIETNAMESE LEARNERS

1. Introduction

1.1. Background of Thai tones

Thai belongs to the Tai-Kadai language family, which is the biggest language family in Asia, and most of the users are in Southeast Asia. The Tai-Kadai language family is used in eight countries: China, Myanmar, India, Vietnam, Cambodia, Laos, Thailand, and Malaysia. The five Thai tones are as follows: mid tone [1] (สามัญ); low tone [2] (เอก); high-falling tone [3] (โท); high tone [4] (ตรี); low-rising tone [5] (จัตวา). In the analysis by Arthur (1997) about the acoustic phonetics of Thai tones in 88 monosyllables (not identified syllable type) collected from Thai people, their results on how to distinguish the various tones are shown in Figure 1.
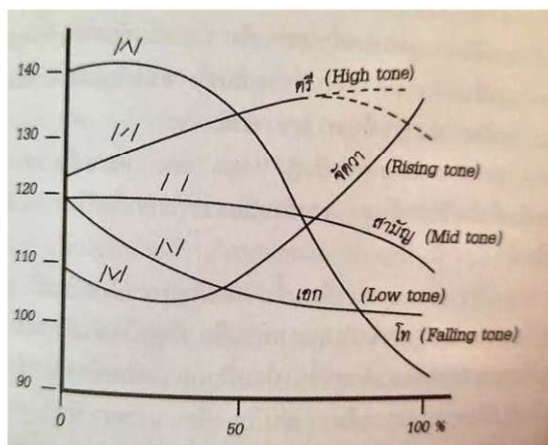

Figure 1. Fundamental frequency (F_0) shapes of Standard Thai tones in the second period (Abramson, 1962, p.126 as cited in Naksakul, 1981, p.99)

They indicated that there are 3 categories of Thai tones, namely: level tone, contour tone, and intensifying tone.

a. Level tone: These are the tones that have a flat frequency covering the whole syllable. There are three Thai tones in this category: mid tone [1], low tone [2], and high tone [4].

b. Contour tone: These are the tones that have variant frequencies through the pronunciation of the syllable. There are two Thai tones in this category: high-falling tone [3], low-rising tone [5].

c. Intensifying tone: This is a type of contour tone that goes up and slopes down in one syllable, which usually occurs in reduplicated words. This specific tone absolutely differs from the other five tones above, which are not diacritic.

1.2. Background of Vietnamese tones

Vietnamese belongs to the Austro-Asiatic language family, the Mon-Khmer language group, and the Viet-Muong branch. Some current languages that belong to this family include Mon, Khmer, and Vietnamese. The 6 Vietnamese tones are as follows: level tone (ngang-[1]); mid-falling tone (huyền-[2]); broken tone (ngã-[5]); low-falling tone (hỏi-[4]); rising tone (sắc-[3]); low-dropping tone (nặng-[6]). The fundamental frequency (F_0) and tonal contour of Vietnamese tones are shown in Figure 2.
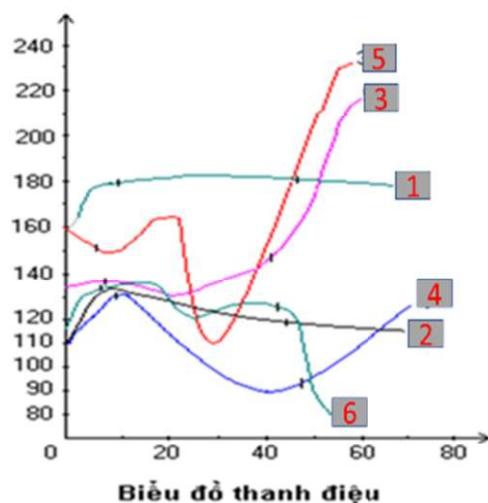
Figure 2. Fundamental frequency (F_0) and tonal contour of Vietnamese tones (Đoàn Thiện Thuật, 1976, p.111)

In summary, there are 3 categories to be distinguished in Vietnamese tones, namely:

1) Pitch (âm vực): There are 3 tones that belong to high pitch, namely ngang, ngã, and sắc, and. There are 3 tones that belong to low pitch, namely huyền, hỏi, and nặng.

2) Even/Uneven (bằng/trắc) tones: There are 2 tones that have even contours, they are ngang and huyền; and. There are 4 tones that have uneven contours, and they are ngã, sắc, hỏi, and nặng.

3) Broken/Unbroken (gãy/không gãy) tones: There are 2 broken tones: which are

ngã and hỏi. There are 2 unbroken tones: which are sắc and nặng.

In reality, there are no even tones that have the broken tone characteristic. Therefore, those features were left empty and remain in only six tones. Those three criteria are distinguished in six Vietnamese tones, and each of those tones is identified in Figure 3.
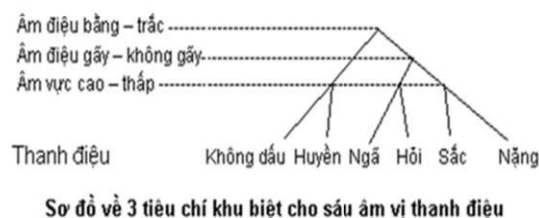

Figure 3. A tree diagram of three categories to distinguish Vietnamese tones (Đoàn Thiện Thuật, 1976, p.103)

Referring to the Vietnamese tonal systems, Hoàng Thị Châu (2009) described and classified the systems into three sub-systems: dialects, which had differences in in certain aspects of some consonants, vowels, and tones. The differences in the tonal systems of each Vietnamese dialect concerned the phonological characteristics and the number of characteristics. There were six tones in the Northern Vietnamese dialect and five tones in the Central and Southern Vietnamese dialects.
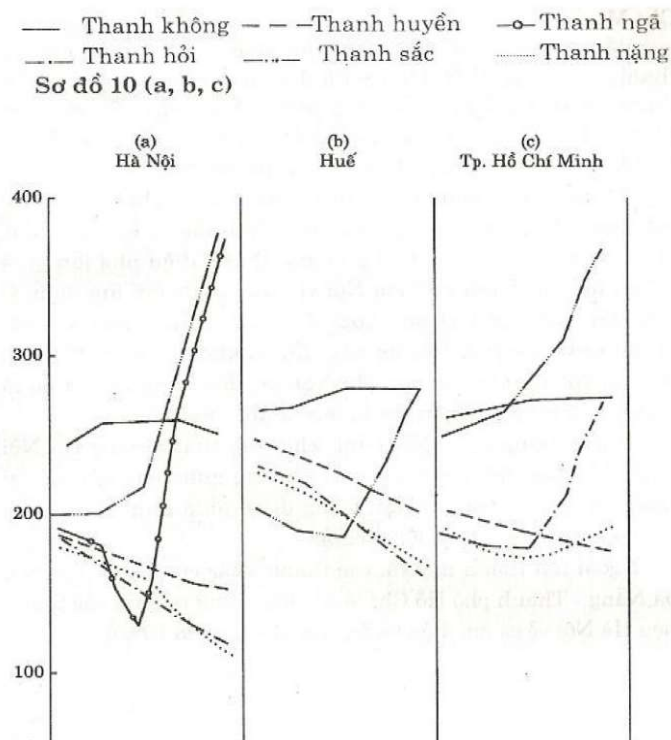
— Thanh không   – – –Thanh huyền   –o–Thanh ngã
_._ Thanh hỏi   _.._ Thanh sắc   .... Thanh nặng
Sơ đồ 10 (a, b, c)

Figure 4. Fundamental frequency (F_0) and tonal contour of three Vietnamese dialects: Northern, Central, and Southern (Hoàng Thị Châu, 2009, p.214)

Table 1. Tonal phonological characteristics of three Vietnamese dialects (Hoàng Thị Châu, 2009)

Tones	Northern	Central	Southern
ngang	mid tone	high tone	high tone
huyền	low tone	low tone	low tone
sắc	high rising	low-rising glottalization	high rising
hỏi	low falling	low-falling creaky voice	low rising
ngã	high rising low	-	-
nặng	dropping glottalization	low-falling glottalization	low falling rising

1.3. The Previous Research

There was some research about the pronunciation of Thai tones by Vietnamese learners. Nguyễn and Jerold (1997), analyzed the voice quality of Northern Vietnamese tones using Wincecil 2.1 and a six-word list representing six Vietnamese tones: ta [ta^1], tà [ta^2], tá [ta^5], tả [ta^3], tã [ta^4], and tạ [ta^6]. Vietnamese words in the Northern Vietnamese tonal system have

different pitch levels: ngang has a pitch level [33]; huyền has a pitch level [21]; and sắc has the highest level [35]. The findings also revealed that nặng has the shortest length and pitch level [32], while ngã has a unique characteristic in which it is stopped in the middle of the syllable and has a pitch level [36].

Huỳnh (2003) studied the contrastive analysis of the phonological systems between Southern Vietnamese and Thai using Wincecil 2.1. The result showed that there were differences between the two systems in terms of syllable structures, consonants, vowels, and tones. However, these two languages also share some similar characteristics. The tones ngang, huyền, sắc, and hỏi in Southern Vietnamese are similar to the mid, the low, the high, and the rising tones in Thai, respectively. But when the tone nặng occurs in a half-closed syllable, it is not like any tones in Thai. This tone is similar to the low tone in Thai when it occurs in the closed syllable. Unlike the standard Thai tones, the falling tone does not occur in the Southern Vietnamese tone system.

The research result of Nguyễn Thị Vân Chi (2006) on a comparative study of acoustic characteristics of Thai tones spoken by Vietnamese using Praat (version 4.3.17) showed that Vietnamese students, who had less experience in the use of Thai language, had problems pronouncing the low tone in closed syllables with a short vowel, the falling tone in closed syllables with a long vowel, and the high tone and

the rising tone. On the other hand, experienced students have problems pronouncing the low tone in the closed syllable with a short vowel and the high tone in the closed syllable.

Buarapha (2006) showed the result of error analysis of Vietnamese tones (Hanoi accent) pronounced by Thai students of Vietnamese using Wincecil, ASAP, and Praat programs to analyze a six-word list including ta [ta^1], tà [ta^2], tả [ta^3], tã [ta^4], tá [ta^5] tạ [ta^6] and a five-Thai word list including คา [kha^1], ข่า [kha^2], ค้า [kha^3], ค้า [kha^4], ขา [kha^5]. It revealed that the tonal phonological systems of Vietnamese and Thai have some differences regarding the fundamental frequency, voice quality, length, pitch, pitch contour, pitch range, and intonation. Vietnamese tones that caused some problems for Thai students who studied Vietnamese were huyền, hỏi and ngã.

On the other hand, the study of Bunchavalit (2010) analyzed flaws in the pronouncing standard Thai sound pitches of Central Vietnamese learners with a 6-word list. Acoustic phonological features were analyzed using the Praat program. The contrastive analysis results revealed that the pitch phonology of Thai and Vietnamese showed similarities and differences in sound cavities, pitches, and tight-tensed sound quality. Although the standard Thai and central Vietnamese pitch phonology each have equally 5 phonemes, it indicates that there are 3 close minimal pairs of pitch phonemes with close sound

cavities. They are: falling (โท): falling (huyền), high (ตรี): high (sắc), and rising (จัตวา): rising (ngã). Moreover, the results revealed that the pitch that generates flaws for learners the most was the rising tone (จัตวา). The second was the midtone (สามัญ). Third were the low tone (เอก) and high tone (ตรี). Finally, the least, was the falling tone (โท) of learners, which was generated from conditions of linguistic interference in four types. They were under differentiation, over-differentiation, reinterpretation, and phone substitution.

The contrastive analysis of the phonetic characteristics of Thai and Vietnamese tones by Bunchavalit (2019), which uses the phonetic characteristics based on the methodologies from the analyses of Arthur (1997), Hoàng Thị Châu (2009), and Đoàn Thiện Thuật (1976). This analysis found that, aside from the difference in quantity of toneme, there are additional differences, including fundamental frequency, length, tone shape, pitch, and voice quality. The high-falling tone [3] (โท) in the Thai tonal system does not occur in the Vietnamese tonal system. Conversely, hỏi, ngã, and nặng in the Vietnamese tonal system do not occur in the Thai tonal system.

2. Purpose

This paper aims to investigate the pronunciation problems of Central Vietnamese learners who study Thai as a foreign language. The assumption was that the causes of the errors were the differences between the tonal characteristics and the influences of the distribution of tones and the syllable structure of Thai and Vietnamese.

3. Research Methodology

3.1. Word list

The research conducted an analysis of the 203 Thai word lists made up of four types of Thai syllable structures. These words were representatives of Thai tones which occur in four types of Thai syllables, as shown in Table 2.

3.2. Informants and area

To obtain the needed information, six Central Vietnamese students aged between 18 to 30 years old participated in the study. There are 3 male and 3 female of second-year students studying at Mahasarakham University, in the Mahasarakham province of Thailand. All of them had studied Thai in Thailand for two years.

3.3. Equipment

The data was collected through semi-structured interviews. In order to get natural sounds, the informants pronounced them using the connected speech with the picture and Vietnamese sentences listed. Through these methods, the informants did not know what words were in the word list, and they, hence, would sound natural, like when they spoke in typical natural settings. After that, the results from this part would be compared with the tones and phonological characteristics of Arthur S. Abramson (1997).

Vietnamese informants pronounced 203 words of simple Thai vocabulary. The

words were divided into two groups: the picture group and the Vietnamese word group. Vietnamese informants pronounced the connected speech. In the picture group, the researcher prepared the pictures and showed them on the laptop. For the vocabulary group, the researcher spoke Vietnamese, and the informants had to translate the researcher's utterances into Thai. The informants had to speak from the pictures and sentences without any preparation. The informants paused for 10 seconds after pronouncing each word, and at the same time, the researcher recorded the voice into Pratt.

3.4. Recording

Before the interviews were recorded, the researcher arranged the interview time with the informants. Each interview lasted 45 minutes. The most suitable place for an interview was the library, as it was the most peaceful place on campus. The data was recorded by the Praat program at 22050 Hz, which was enough for recording speech, and the researcher used a laptop and an Ovann OV-Y690MV microphone as recording equipment.

3.5. Measurement (Fundamental frequency: F_0)

After obtaining the needed data, the researcher edited the word list using Cool Edit Pro and the auditory and noticed wave form in this program. After that, the researcher identified the F_0 of each word and recalculated it in order to assign 11 points. The starting point was 0%, and the ending point was 100%. There was a 10-millisecond (ms) pause between each point, or 10% if using the formula below this.

New duration = F_0 of starting point + (F_0 of end point) divided by 10

After that, the researcher took the value from the new duration calculated the F_0 and then calculated for the average F_0s of six informants. The information was presented in the form of a histogram. While axis X represents the time duration, axis Y represents the fundamental frequency (F_0)

4. Results

The results of average F_0s in pronouncing Thai tones by Central Vietnamese learners in connected speech that occur in Thai syllables are as shown below.
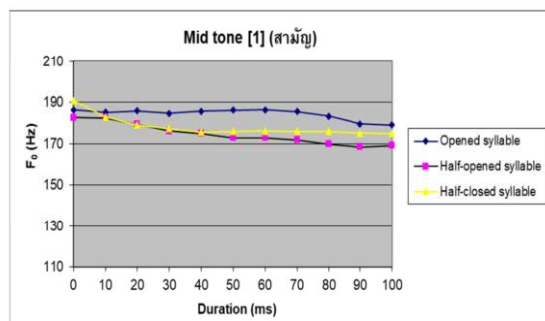
4.1. The mid tone [1]

Figure 5. Average F_0 of the mid tone [1]

The results show that the phonological characteristics of the mid tone [1] in three types of Thai syllables by Vietnamese learners' pronunciation are similar to the tonal contour, which is a mid-flat tone; the starting point and the ending point are in the middle tone, but those are different in pitch level that are higher than the Thai tonal system.
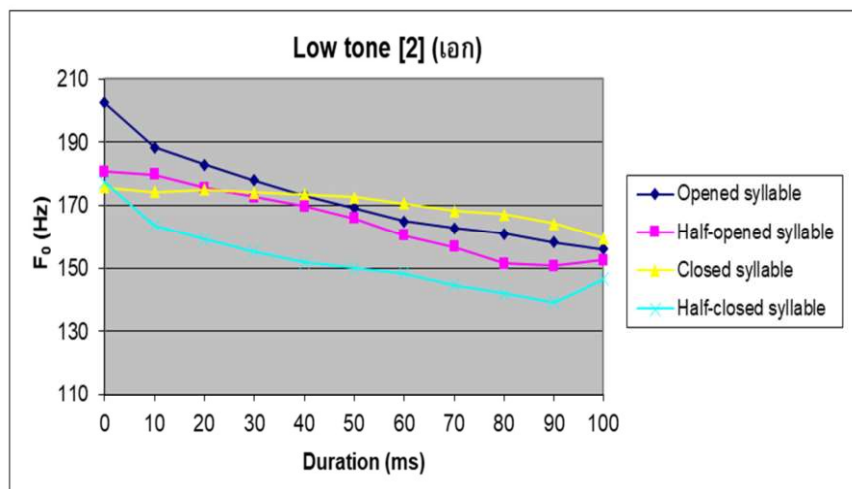
4.2. The low tone [2]

Figure 6. Average F_0 of the low tone [2]

The results show that the phonological characteristics of the low tone [2] in four types of Thai syllables by Vietnamese learners' pronunciation are similar to the tonal contour, which is low tone. The starting point is at a higher pitch than the ending point and gradually lower, but those are different in pitch level, which is higher than the Thai tonal system.

4.3. The high-falling tone [3]

Figure 7. Average F_0 of the high-falling tone [3]

The results show that the phonological characteristics of the high-falling tone [3] in four types of Thai syllables by Vietnamese learners' pronunciation are similar to the tonal contour, which is a high-falling tone. The starting point is at a high pitch level and falls to a low pitch at the ending point, but those are different in pitch level, which is higher than the Thai tonal system.
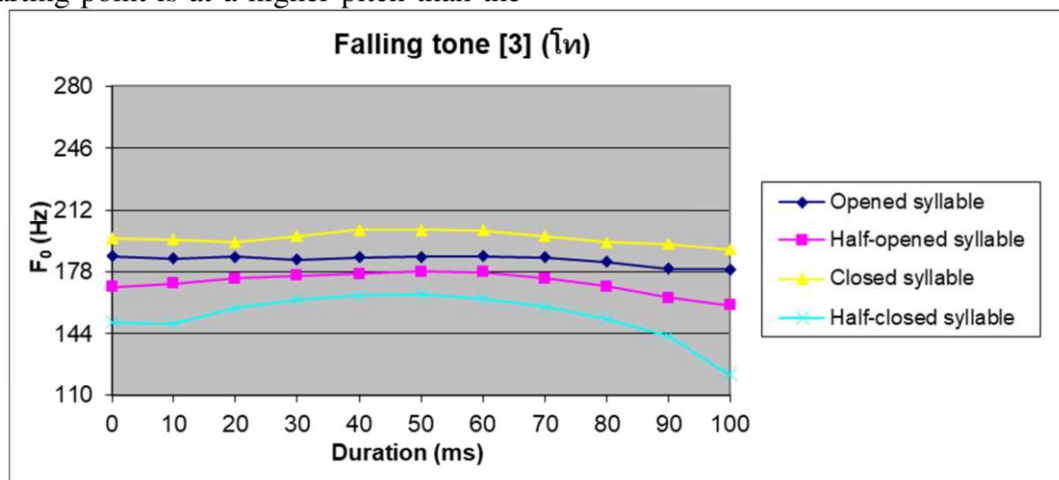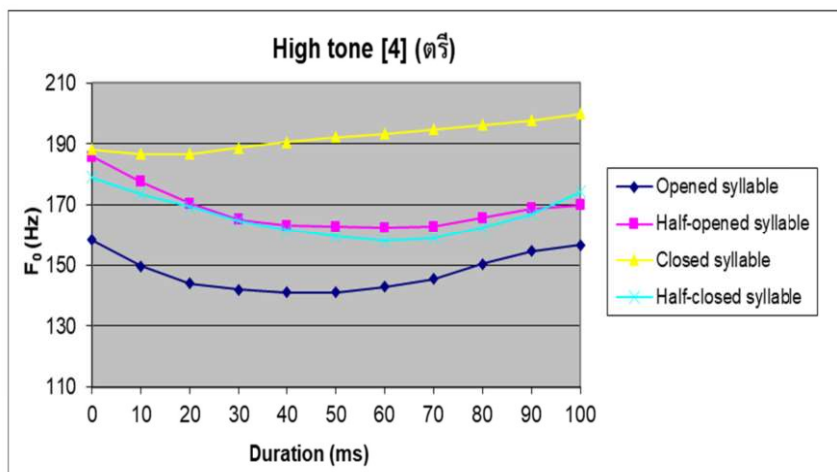
4.4. The high tone [4]

Figure 8. Average F_0 of the high tone [4]

The results show that the phonological characteristics of the high tone in four types of Thai syllables by Vietnamese learners' pronunciation are different from the Thai tones system. In closed syllables, the pitch is slowly higher in the first section and reaches its highest at the end point. In other syllables, the contour gradually falls down in the first section until the middle section and suddenly rises up in the end section, which is similar to the tonal contour of the rising tone. Therefore, there are differences in both the tonal contour and pitch level between Vietnamese learners' pronunciation and the Thai tonal system.

4.5. The low-rising tone [5]

Figure 9. Average F_0 of the low-rising tone [5]
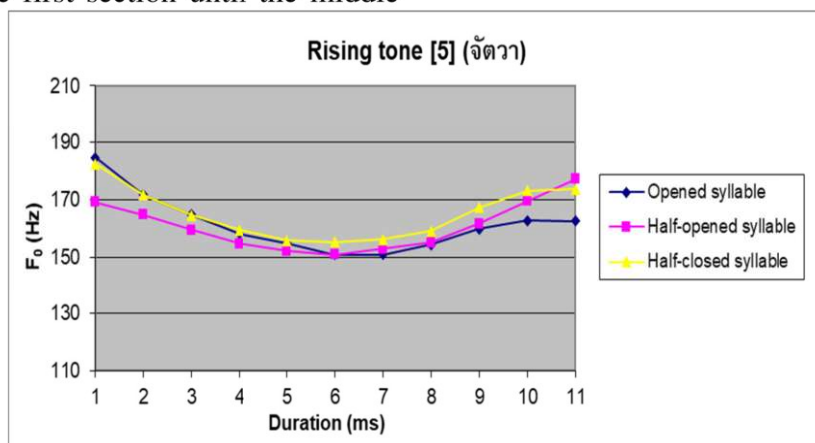
The results show that the phonological characteristics of the low-rising tone [5] in four types of Thai syllables by Vietnamese learners' pronunciation were similar to the tonal contour, which is the falling tone. The contour is gradually falling at the first section and rising up, but that is different in the pitch level; the ending point is lower than in the Thai tonal system.

5. Discussion and Conclusion

In this part, the researcher identified the differences in phonological characteristics between Vietnamese tones and Thai tones from the study of Arthur S. Abramson (1997) and showed the results of Hoàng Thị Châu (2009) on the phonological characteristics of Central Vietnamese tones.

Table 2. Phonological characteristics of Thai and Central Vietnamese tones

Thai tones (Arthur S. Abramson, 1997)	Central Vietnamese tones (Hoàng Thị Châu, 2009)
mid tone [1], สามัญ	high tone, ngang
low tone [2], เอก	low tone, huyền
high-falling tone [3], โท	low rising-glottalization, sắc
high tone [4], ตรี	low falling-creaky voice, hỏi
low-rising tone [5], จัตวา	low falling-glottalization, nặng

Thai and Vietnamese are both tonal languages as well as monosyllabic languages. Learning Thai and Vietnamese can be challenging, though, because of variances in the quantity of tones and phonetic features. In addition, the Vietnamese tonal system uses specific voice qualities to distinguish between each tone, in contrast to the Thai tonal system, which uses low and high pitch, tone shape, and effects from the initial consonant to change tone shape.

The distribution of Thai tones in each type of syllable in the Thai language is not only very closely related to the three groups of initial consonant types: high, mid and low, but also depends of vowels and final consonants. At the same time, the distribution of Vietnamese tones is rarely related to initial consonants and prevocalic which rarely affected to distribution of Thai tones but Thai tones significant related to final consonant and vowel because they usually combine to create basic sonority of syllable. The Thai tonal system is absolutely complicated between the diacritics and some of them are not similar, for example: ขา /kha:⁵/ is none diacritic but the tone is low-rising [5] (จัตวา).

The problems found in Vietnamese learners' pronunciation are the results of the differences in both tonal contour and pitch level, the negative transfer, and the differences in the distribution of tones in correlation with the syllable structure between the two languages. Similarities in the opened, half-opened, half-closed, and closed syllables that occur in "the Thai high tone [4]" and "the Vietnamese sắc tone" affected the way Vietnamese learners pronounce the high tone. These learners tended to transfer the Vietnamese sắc tone into the Thai high tone, which is similar to

the study of Nguyễn Thị Vân Chi (2006). Besides the influence of the distribution of tones and the syllable structure, interference in studying Thai by Vietnamese learners caused by negative transfer is another reason that can be used to explain the errors in their speech. A clear example of this was shown in the Vietnamese closed syllables "sắc" and "nặng" which were found to share the same phonological characteristics in high tone as the sắc tone. Comparing the results of this research with the study of Bunchavalit Patthida (2010) shows that they are completely different. Even Though both researchers collected the data from Central Vietnamese learners, the research methods were completely different. An analysis of a 6-word list: คา [kha^1], ข่า [kha^2], ข้า [kha^3], ค้า [kha^4], ขา [kha^5] found the low-rising tone [5] was the most error in pronouncing Thai tones. The findings revealed that it was almost impossible to find errors in Vietnamese learners' pronunciation in the Thai mono-opened syllable. The analysis of both acoustic phonetics and auditory phonetics yielded similar results. The research method and instrument in this study were collected through semi-structured interviews in order to get natural sounds in connected speech. The learners would not pay attention to the word list when pronouncing each word because they tended not to produce any errors. Therefore, the results from the analysis of pronouncing Thai tones in connected speech in four types of Thai syllables yielded some differences.

On the other hand, positive transfer affected Vietnamese learners' pronunciation of the mid [1], low [2], high-falling [3], and low-rising [5] tones in Thai. These learners could pronounce these tones because they are similar to the ngang, huyền, nặng/hỏi, and sắc tones in Vietnamese, respectively. These Thai and Vietnamese tones have similar tonal contours. However, there were some differences between the two languages in terms of level tone, as Vietnamese tones had a low pitch range while Thai tones had a high pitch range. Although the F_0 of Vietnamese learners' pronunciation was higher than Thai when pronouncing the rising tone, listeners still recognized that it was a rising tone. In line with this view, in acoustic phonetics analysis, if the listeners recognized the tones from the pitch level, they considered the pitch contour characteristics and considered the relative pitch rather than the absolute pitch (Luengthongkhum, 2002). The pitch in Thai tones is the same as in Vietnamese tones or other monosyllabic languages, where the pitch is indicated in each syllable. Incorrect pronunciation results in incorrect pitch and changed meaning of the words (Panthumetha, 1976), and Kanchana Naksakul (1981) gives a description of toneme that distinguishes the meaning of two words that have the same initial consonant, vowel, and final consonant. If it must be considered that pitch in speech words is toneme or not, it must focus on the ability to distinguish meaning.

Although the two languages are tonal languages, the phonological characteristics of Thai and Vietnamese affect the way Vietnamese learners study Thai. The pronunciation problem in the Thai tones of Central Vietnamese learners was the high tone [4] in the closed syllable; the learners replaced the high tone with sắc by the interference phenomenon. Moreover, the learners replaced the high tone [4] with the low-rising tone [5] in the opened, half-opened, and half-closed syllables. These results showed the learners did not recognize the differences between the high tone [4] and the low-rising tones [5]. Another problem was the pitch level of learners who had a higher pitch level than the Thai tones system. Therefore, the result of this research was not only beneficial for teachers who teach Thai language to Vietnamese learners but also helped the learners improve their accuracy in pronouncing Thai tones.

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Appendix:

Word List from the Thai Syllable Structure in Connected Speech

Thai Tones / Structure syllable	mid tone	low tone	falling tone	high tone	rising tone
1. Opened syllable					
1.1 $C_{SV}VV$ $^{T1-5}$	บา/ba:^{1}/	บ่า/ba:^{2}/	บ้า/ba:^{3}/	บ๊า/ba:^{4}/	บ๋า/ba:^{5}/
1.2 $C_{SVL}VV$ $^{T1-5}$	คา/kha:^{1}/	ข่า/kha:$^{/2}$/	ค่า/kha:^{3}/	ค้า/kha:^{4}/	ขา/kh:^{5}/
1.3 $C_{N}VV$ $^{T1-5}$	มา/ma:^{1}/	หม่า/ma:^{2}/	ม่า/ma:^{3}/	ม้า/ma:^{4}/	หมา/ma:^{5}/
1.4 $C_{F}VV$ $^{T1-5}$	ฟา/fa:^{1}/	ฝ่า/fa:^{2}/	ฟ้า/fa:^{3}/	ฟ้า/fa:^{4}/	ฝา/fa:^{5}/
1.5 $C_{W}VV$ $^{T1-5}$	ยา/ja:^{1}/	อย่า/ja:^{2}/	ย่า/ja:^{3}/	ย้า/ja:^{4}/	หยา/ja:^{5}/
1.6 $C_{R}VV$ $^{T1-5}$	รู/ruu^1/	หรู/ruu^2/	รู่/ruu^3/	รู้/ruu:^{4}/	หรู/ruu:^{5}/
1.7 $C_{L}VV$ $^{T1-5}$	โล/loo ^{1}/	โหล่/loo^2/	โล่/loo^3/	โล้/loo ^{4}/	โหล/loo ^{5}/
2. Half-opened syllable					
2.1 $C_{sv}VC_W$ $^{T1-5}$	ใบ/baj^1/	ไบ่/baj^2/	ใบ้/baj^3/	ไบ๊/baj^4/	ไบ๋/baj^5/
2.2 $C_{sv}VVC_W$ $^{T1-5}$	ดาย/daj^1/	ด่าย/daj^2/	ด้าย/daj^3/	ด๊าย/daj^4/	ด๋าย/daj^5/
2.3 $C_{SVL}VC_W$ $^{T1-5}$	ไก/kaj^1/	ไก่/kaj^2/	ไก้/kaj^3/	ไก๊/kaj^4/	ไก๋/kaj^5/
2.4 $C_{SVL}VVC_W$ $^{T1-5}$	ตาย/taaj^1/	ต่าย/taaj^2/	ต้าย/taaj^3/	ต๊าย/taaj^4/	ต๋าย/taaj^5/
2.5 $C_{N}VC_W$ $^{T1-5}$	ใม/maj^1/	ไหม่/maj^2/	ไหม้/maj^3/	ไม้/maj^4/	ไหม/maj^5/
2.6 $C_{N}VVC_W$ $^{T1-5}$	นาย/naaj^1/	หน่าย/naaj^2/	น่าย/naaj^3/	น้าย/naaj^4/	หนาย/naaj^5/
2.7 $C_{F}VC_W$ $^{T1-5}$	ไซ/saj^1/	ใส่/saj^2/	ไส้/saj^3/	ไซร้/saj^4/	ใส/saj^5/
2.8 $C_{F}VVC_W$ $^{T1-5}$	ทราย/saaj^1/	ส่าย/saaj^2/	ส้าย/saaj^3/	ซ้าย/saaj^4/	สาย/saaj^5/
2.9 $C_{W}VC_W$ $^{T1-5}$	ไว/waj^1/	ไหว่/waj^2/	ไหว้/waj^3/	ไว้/waj^4/	ไหว/waj^5/
2.10 $C_{W}VVC_W$ $^{T1-5}$	ยาย/jaaj^1/	หย่าย/jaaj^2/	หย้าย/jaaj^3/	ย้าย/ jaaj^4/	หยาย/ jaaj^5/
2.11 $C_{R}VC_W$ $^{T1-5}$	ไร/raj^1/	ไหร่/ raj^2/	ไร่/ raj^3/	ไร้/raj^4/	ไหร/raj^5/
2.12 $C_{R}VVC_W$ $^{T1-5}$	ราย/raaj^1/	หร่าย/raaj^2/	ร่าย/raaj^3/	ร้าย/raaj^4/	หราย/raaj^5/
2.13 $C_{L}VC_W$ $^{T1-5}$	เลา/law^1/	เหล่า/law^2/	เหล้า/law^3/	เล้า/law^4/	เหลา/law^5/
2.14 $C_{L}VVC_W$ $^{T1-5}$	ลาย/laaj^1/	หล่าย/laay^2/	ล่าย/laay^5/	ล้าย/laay^4/	หลาย/laay^5/
3. Closed syllable					
3.1 $C_{sv}VC_{SVL}$ ^{T2,4}	0	เด็ก/dek^2/	0	เด็ก/dek^4/	0
3.2 $C_{sv}VVC_{SVL}$ ^{T2,3}	0	แดด/ded^2/	แด้ด/ded^3/	0	0
3.3 $C_{SVL}VC_{SVL}$ ^{T2,4}	0	กัด/kat^2/	0	กั๊ด/kat^4/	0
3.4 $C_{SVL}VVC_{SVL}$ ^{T2,3}	0	ขาด/khaad^2/	คาด/khaad^3/	0	0
3.5 $C_{N}VC_{SVL}$ ^{T2,4}	0	หมัก/mak^2/	0	มัก/mak^3/	0
3.6 $C_{N}VVC_{SVL}$ ^{T2,3}	0	หมาก/maak^2/	มาก/maak^3/	0	0
3.7 $C_{F}VC_{SVL}$ ^{T2,4}	0	ผัก/phak^2/	0	พัก/phak^4/	0
3.8 $C_{F}VVC_{SVL}$ ^{T2,3}	0	ฝาก/phaak^2/	0	ฟาก/phaak^4/	0
3.9 $C_{W}VC_{SVL}$ ^{T2,4}	0	หวัด/wat^2/	0	วัด/wat^4/	0
3.10 $C_{W}VVC_{SVL}$ ^{T2,3}	0	อยาก/jaak^2/	ยาก/jaak^3/	0	0
3.11 $C_{R}VC_{SVL}$ ^{T2,4}	0	หรด/rood^2/	0	รถ/rood^4/	0
3.12 $C_{R}VVC_{SVL}$ ^{T2,3}	0	หรีด/riid^2/	รีด/riid^3/	0	0
3.13 $C_{L}VC_{SVL}$ ^{T2,4}	0	หลับ/lab^2/	0	ลับ/lab^4/	0

Structure syllable \ Thai Tones	mid tone	low tone	falling tone	high tone	rising tone
3.14 C_LVVC_{SVL} [T2,3]	0	หลาก/laak[2]/	ลาก/laak[3]/	0	0
4. Half-closed syllable					
4.1 $C_{SV}VC_N$ [T1-5]	ดิน/din[1]/	ดิ่น/din[2]/	ดิ้น/din[3]/	ดิ๊น/din[4]/	ดิ๋น/din[5]/
4.2 $C_{SV}VVC_N$ [T1-5]	บาน/baan[1]/	บ่าน/baan[2]/	บ้าน/baan[3]/	บ๊าน/baan[4]/	บ๋าน/baan[5]/
4.3 $C_{SVL}VC_N$ [T1-5]	ปัน/pan[1]/	ปั่น/pan[2]/	ปั้น/pan[3]/	ปั๊น/pan[4]/	ปั๋น/pan[5]/
4.4 $C_{SVL}VVC_N$ [T1-5]	อวน/ʔuan[1]/	อ่วน/ʔuan[2]/	อ้วน/ʔuan[3]/	อ๊วน/ʔuan[4]/	อ๋วน/ʔuan[5]/
4.5 C_NVC_N [T1-5]	มัน/man[1]/	หมั่น/man[2]/	หมั้น/man[3]/	มั๊น/man[4]/	หมัน/man[5]/
4.6 C_NVVC_N [T1-5]	โมง/mooŋ[1]/	โหม่ง/mooŋ[2]/	โม่ง/mooŋ[3]/	โม้ง/mooŋ[4]/	โหมง/mooŋ[5]/
4.7 C_FVC_N [T1-5]	ฟัง/phaŋ[1]/	ฝั่ง/phaŋ[2]/	ฟั่ง/phaŋ[3]/	ฟั้ง/phaŋ[4]/	ฝัง/phaŋ[5]/
4.8 C_FVVC_N [T1-5]	เซียง/siaŋ[1]/	เสี่ยง/siaŋ[2]/	เซี่ยง/siaŋ[3]/	เซี้ยง/siaŋ[4]/	เสียง/siaŋ[5]/
4.9 C_WVC_N [T1-5]	วัน/wan[1]/	หวั่น/wan[2]/	วั่น/wan[3]/	วั้น/wan[4]/	หวัน/wan[5]/
4.10 C_WVVC_N [T1-5]	วาน/waan[1]/	หว่าน/waan[2]/	ว่าน/waan[3]/	ว้าน/waan[4]/	หวาน/waan[5]/
4.11 C_RVC_N [T1-5]	รัง/raŋ[1]/	หรั่ง/raŋ[2]/	รั่ง/raŋ[3]/	รั้ง/raŋ[4]/	หรัง/raŋ[5]/
4.12 C_RVVC_N [T1-5]	ราง/raaŋ[1]/	หร่าง/raaŋ[2]/	ร่าง/raaŋ[3]/	ร้าง/raaŋ[4]/	หราง/raaŋ[5]/
4.13 C_LVC_N [T1-5]	ลัง/laŋ[1]/	หลั่ง/laŋ[2]/	ลั่ง/laŋ[3]/	ลั้ง/laŋ[4]/	หลัง/laŋ[5]/
4.14 C_LVVC_N [T1-5]	ลาม/laam[1]/	หล่าม/laam[2]/	ล่าม/laam[3]/	ล้าม/laam[4]/	หลาม/laam[5]/

Note: Symbols and their meanings are listed below.

0	This tone does not occur in this structure
gap	no mono-syllable word that has a meaning
C	consonants
C_{SV}	stop and voiced consonants
C_{SVL}	stop and voiceless consonants
C_N	nasal consonants
C_F	fricatives consonant
C_W	semi-vowel consonants
C_R	rolled consonants
C_L	lateral consonants
V	short vowels
VV	long vowels
T	tones
1	mid tone
2	low tone
3	high-falling tone
4	high tone
5	low-rising tone