Tones in Taiwanese South Min:
Tone Sandhi in Northern and Southern Dialect

Wen-Tseng Chang
University of Stuttgart
st164021

[ ]

Abstract

This report presents an experimental phonetic research on tone sandhi phenomena in Taiwanese South Min with south and north accent. There are two experiments are conducted, one is general tone sandhi observation, the other one is different tone sandhi performance in the south and north dialect. The experiment results show a contemporary tone sandhi situation compares to the previous literature.

1 Introduction

Taiwanese South Min, also called "Hokkian", "Minnan", "Hoklo", is linguistically a branch of Min Chinese in Sino-Tibetan language family. South Min is originated from south eastern China especially in Fujin province area with main two kinds of dialects: Quanzhou (northern South Min) and Zhangzhou (southern South Min). For hundreds of years, because of the active immigration from these area, South Min is widely spread to south-easrtern Asia and develop unique dialects and accents in such as Taiwan, Singapore, Malaysia or Philippine.

In the case of Taiwan, during 16th, 17th century there were many immigrants from China settle down in western Taiwan. People from Quanzhou lived in the north, while people from Zhangzhou lived in the south. This become the different accent between *Taipei* (north city) and *Kaohsiung* (south city). Besides, there are some special accents such as *Lukang*, an ancient town in the middle, or *Yilan*, a town in the northeast which is separated from Taipei by a mountain range. Although there are many accents everywhere, South Min is more widely used in southern area. Kaohsiung accent is the mainstream accent and seen as the standard pronunciation collected officially in *Taiwanese South Min Common Words Dictionary*.

1.1 Pitch Research

Tone is defined by pitch, and pitch is a subcategory under the prosody research. In general, prosody refers to suprasegmentals, i.e. not individual phonetic segments such as vowels or consonants, including intonation, tone, stress, and rhythm.

In tonal language, tones provide semantic information and distinguish words. They have same function as vowels or consonants. However, prosody is not easy to distinguish like phonemes or segments and it might contain various features from different speakers or utterances. Take tone as an example, most of the time, tones in tonal language has specific pitch. However, this pitch might various due to different speakers' utterances, emotions, focuses, or even dialog speed.

According to (Xu and Wang, 2001)'s research, pitch targets are the smallest articulatorially operable units associated with linguistically functional pitch units such as tone and pitch accents. They provide a target approximation model to illustrate basic articulatory particularly focus on describing tone and prosody.

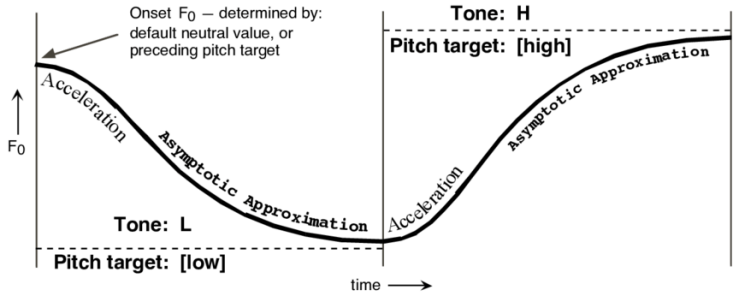

Figure 1: Target Approximation model. (Xu and Wang, 2001)

In Figure1. The vertical lines represent syllable boundaries. The dashed lines represent underlying pitch targets. The thick curve represents the F0 contour that results from articulatory implementation of the pitch targets.

This model tries to generate the fixed features in tone, especially in the continuous sentences. The Figure2 shows how the pitch targets, pitch range, strength, and duration affect to F0 curve.

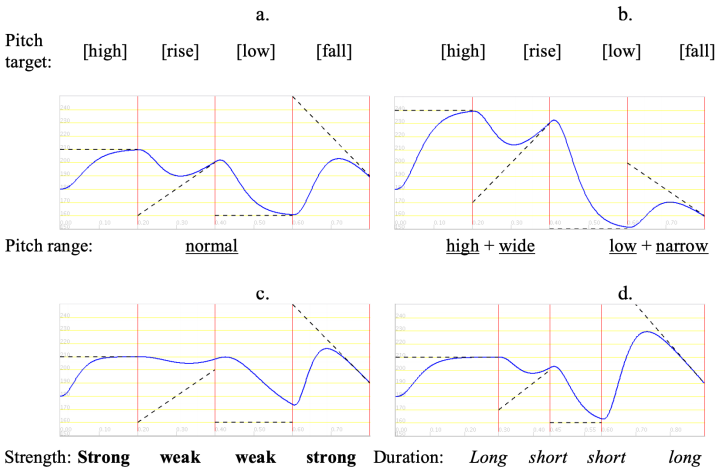

Figure 2: The effect of pitch targets, pitch range, strength, and duration on F0 curve. (Xu and Wang, 2001)

This model contains basic four tones feature in the Mandarin. In South Min language the tone categories and changing are much more complicated. However, by using this model, it helps us to visualize the tone feature and analyze the pitch features in Praat.

1.2 Tone System

South Min uses Chinese characters or Latin alphabets as its writing system. It is a tonal language and the unit of each tone is categorized by characters, which means a word may contain one or more tones and tone sandhi may occur in a word but not in a character. Following by the Middle Chinese phonology, tones are categorized into four tones: even (*ping*), rising (*shang*), leaving/falling (*qu*) and entering (*ru*) and two registers: upper and lower, i.e. *yin and yang*. This is eight-tone system in traditional Chinese

phonology. In the theory of (Yip, 1980) and (Bao, 1999), they point out that tone is described by rigister and contour. The former one shows the higer/low pitch of the tone, the latter one describe the trend or movement of a the F0 curve during a time snippet. According to the *Mandarin-Taiwanese Comparative Living Dictionary* edited by Wu (2000). In Taiwanese South Min, *yinshang* (upper-falling) tone is merged with *yangshang* (lower falling) tone. Therefore, there are only seven tones remain. In Table 1, the citation and sandhi tone are expressed in five level tone mark recorded from (Chen, 2018) in Taipei accent.

Tone Number	Category	Description	Citation Pitch	Sandhi Pitch
1	yinping	high	55	33
2	yinshang	falling	51	55
3	yinqu	low-falling	21	51
4	yinru	mid-checked	21	53
5	yangping	rising	24	33
6	yangshang	-	-	-
7	yangqu	mid	33	21
8	yangru	high-checked	53	21

Table 1: Eight-tone System in Taiwanese South Min.

The five level tone mark is created by Chao in 1930 and adopted into International Phonetic Alphabet (IPA) system for description of tone contours in the tonal languages. From Pitch range 1 to 5 (corresponding to 100-500Hz), the pitch is rising from low to high. For example, *yinping* (5 to 5) sounds flat while *yinshang* (5 to 1) starts from high to low pitch, which sounds like a falling prosody. Figure3 shows the flow of sound in visual expression.

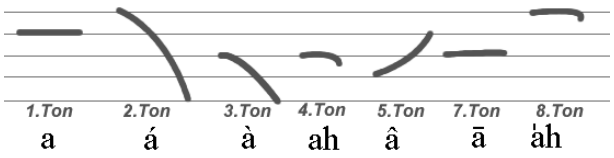

Figure 3: Schematic of Taiwanese tones. The figure is originated from Wikipedia.

Besides, if two tones share same register, the contour will decide the time duration (Ohala, 1978). The raising tone has the longest duration, the second one is flat tone, and the falling tone is the shortest. This results are also shown in the following experiments.

1.3 Tone Sandhi and Previous Studies

Tone sandhi is phenomenon of phonological change. It refers to the tonal alternation between variants of a word or morpheme that in most cases only differ in tones, and this tonal change is conditioned by adjacent tones or by where the word or morpheme is located prosodically or morphosyntactically in an utterance. (Chen, 2018) Tone sandhi can be also seen as a method to create words and provide semantic meaning. (Hsu, 2006)

Tones in Taiwanese South Min can be separate into *citation tone* and *sandihi tone*. Each lexicon has these

two tones. Citation tone is the original/base tone of a word; while sandhi tone is the actual pronunciation tone. If the lexicon does not need to perform sandhi, then the citation tone is the pronunciation tone. A sandhi tone may changed in word, phrase or even in sentence level according to the different position or syntax structure. The general rules of sandhi is introduced in Section 1.4.

1.4 Tone Sandhi Behavior in Taiwanese South Min

Tone Sandhi is an important phonology feature in South Min. Only people apply correct sandhi rules can they express fluent and accurate meaning in South Min. Using wrong sandhi pronunciation sometimes makes listeners confused or even leads to misunderstanding. Because citation tone and sandhi tone may express different semantics meaning in some words.

Sandhi rules of South Min are rather more complicated than other northern Chinese dialects like Mandarin. The general sandhi rules are shown in Table 2, including the different accent between south and north. This rules, however, are also called *double sandhi* because they are only applied into double syllables lexica. Besides, in these words only former syllable (first position) needs to change its tone. For example, the citation tone in the word "sim-kuann" (sweat heart) is tone number *11* with pitch value (Hz in five level tone mark) *55-55*. After applying sandhi, it should be pronounced in tone number *71* as "sīm-kuann" with actual pitch value (Hz) *21-55*. The number in the table all represent "Tone Number".

Tone Number	Category	Sandhi Rule		Meaning	Citation Tone	Sandhi Tone
1	yinping	$1 \rightarrow 7$		sweat heart	sim-kuann (11)	sīm-kuann (71)
2	yinshang	Kaohsiung	$2 \rightarrow 1$	little brother	sió-tī (27)	sio-tī (17)
		Taipei	$2 \rightarrow 5$			siô-tī (57)
3	yinqu	$3 \rightarrow 2$		world	sè-kan (31)	sé-kan (21)
4	yinru	-p, -t, -k	$4 \rightarrow 8$	famous	tshut-miâ (45)	tshu't-miâ (85)
		-h	$4 \rightarrow 2$	bicycle	thih-bé (42)	thí-bé (22)
5	yangping	Kaohsiung	$5 \rightarrow 7$	back and forth	lâi-óng (52)	lāi-óng (72)
		Taipei	$5 \rightarrow 3$			lài-óng (32)
6	yangshang	-		-	-	-
7	yangqu	$7 \rightarrow 3$		outside	guā-kháu (72)	guà-kháu (32)
8	yangru	-p, -t, -k	$8 \rightarrow 4$	papaya	bo'k-kue (81)	bok-kue (41)
		-h	$8 \rightarrow 3$	moon	gue'h-niû (85)	guè-niû (35)

Table 2: General Sandhi Rules and Examples. Lexica are collected from (TSM-Dictionary, 2011)

Figure 4 shows a graphic description. Black arrows represent common rules, blue arrows represent south (Kaohsiung) accent, and yellow arrows represent north (Taipei) accent.

In the research of (Iun et al., 2005), they tried to build a Taiwanese South Min Text-to-Speech (TTS) system for Latin written texts in order to preserve and re-represent the historical document in speech. However, since there were only few data in Latin texts, applied sandhi rules to the system become necessary. According to their research, the list of seven rules are shown as following:

1. **Normal Sandhi**: Example has shown in Table 1 above.

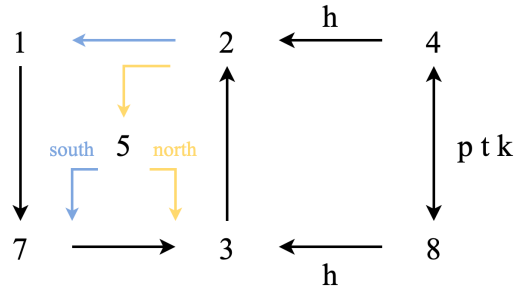

Figure 4: Normal & Double Sandhi with Southern & Northern Accent.

2. **Following sandhi**: This pattern generally occurs on pronouns or the suffix of names. The tone pitch depends on that of the immediately preceding syllable and is either tone 1, 3, or 7. For example, *ho-lí (means "give you")*, tone 72 $\rightarrow$ 77.

3. **Neutral sandhi**: The previous syllable is read as base tone, and the tones of the neutral sandhi are read softly as if they were tone 3 or tone 4. For example, *kiâ chhut lâi (means "walk out")*, tone 585 $\rightarrow$ 543.

4. **Double sandhi**: This pattern mostly appears in syllables ending in the glottal stop (-h) and having tone 4. The normal sandhi rules are applied twice in sequence (i.e. $tone4 \rightarrow tone2 \rightarrow tone1$). For example, *beh tha'k-chu (means "be going to study")*, tone 441 $\rightarrow$ 141.

5. **Pre-á sandhi**: The syllables before á are different from the normal sandhi unless they are tone 1 or tone 2. For example, *sun-á (means "nephew")*, tone 12 $\rightarrow$ 72.

6. **Triplicated sandhi**: The first syllable of triplicated words does not follow normal sandhi rules unless it is of tone 2, 3, or 4. For example, *bah-bah-bah (means "more fatter" or "fatty")*, tone 444 $\rightarrow$ 224.

7. **Rising sandhi**: This pattern usually occurs in loanwords from Japanese; the sandhi tone is similar to tone 5. For example, *hăn-to-lù (means "steering wheel")*, tone 513.

However, none of the rules can cover the whole sandhi phenomena in South Min and there are always some exceptions exist.

1.5 Research Question

This paper aiming at conducting the phonological experiment in the tone sandhi phenomena in Taiwanese South Min and analysing in accent from different area. The following are the research questions:

- Comparing to the sandhi rules research conducted decades ago, is the sandhi phenomena still the same in these day?
- How is the tone sandhi performs in south and north accent?

For the first question. Nowadays in Taiwan many people are not speak South Min as native language. Will this situation affect the sandhi rules? Is there any language tone shifting or exchange in Taiwanese South Min?

Two experiments are conducted: First, analysis of general sandhi rules. According to the previous research, there are seven sandhi rules, including the special entering tone in four ending: -p, -t, -k, -h in *Tone4* and *Tone8*. Therefore, there are 13 sentences prepared in the experiment.

Second experiment is a further experiment of south and north accent. According to the sandhi rules, people from south and north perform different tone sandhi in *Tone2* and *Tone5*. We want to observe if it is very significantly different.

2 Methods

The goal of the experiment aims at measuring tone sandhi in north and the south of Taiwanese South Min.

Script Design: First, participants are asked to read a list of sentences, each sentence has a word with sandhi tone. An example of the sentence looks like this: *"kóng phang-phang tsi't pái" (means: Say phang-phang again)*. There are 13 sentences in total containing all the general sandhi rules in Table 3.

All the lexica are reduplication, a kind of word with the repeated double syllable. Using reduplication words helps to record one syllable with both citation tone and sandhi tone. Besides, it can avoid the same lexicon with with different pronunciation, e.g. vowel changing, in dialects.

Number	Testing Sentence	English Translation	Relation w/ Rules
1	kóng "phang-phang" tsi't pái.	Say "phang-phang" again.	Tone 1
2	kóng "hó-hó" tsi't pái".	Say "hó-hó" again.	Tone 2
3	kóng "phànn-phànn" tsi't pái.	Say "phànn-phànn" again.	Tone 3
4	kóng "siap-siap" tsi't pái.	Say "siap-siap" again.	Tone 4 w/ -p
5	kóng "pit-pit" tsi't pái.	Say "pit-pit" again.	Tone 4 w/ -t
6	kóng "phak-phak" tsi't pái.	Say "phak-phak" again.	Tone 4 w/ -k
7	kóng "bah-bah" tsi't pái.	Say "bah-bah" again.	Tone 4 w/ -h
8	kóng "tâm-tâm" tsi't pái.	Say "tâm-tâm" again.	Tone 5
9	kóng "tiām-tiām" tsi't pái.	Say "tiām-tiām" again.	Tone 7
10	kóng "tsia'p-tsia'p" tsi't pái.	Say "tsia'p-tsia'p" again.	Tone 8 w/ -p
11	kóng "ba't-ba't" tsi't pái.	Say "ba't-ba't" again.	Tone 8 w/ -t
12	kóng "si'k-si'k" tsi't pái.	Say "si'k-si'k" again.	Tone 8 w/ -k
13	kóng "tsia'h-io'h" tsi't pái.	Say "tsia'h-io'h" again.	Tone 8 w/ -h

Table 3: Script of Tone Sandhi Experiment

Participants: In this experiment, there are two participants: one is a native speaker from south area, the other one is a native speaker from north area. The native speaker from south speaks South Min at home and partially at school, while the native speaker from north speaks South Min only at home. Two native speakers are bilingual speaker in South Min and Mandarin. All of them are female and in age range 20-30 year-old.

There is an point of view that South Min accents are nowadays in some degree mixing together because of the convenient transportation in the small island. Although there are no specific research about it, however, we expect experiment 2 can provide some observation.

Analysis Tools: All the audio files are record in wav file in 16kHz and analyzed in Praat.

3 Results

3.1 Experiment1: Citation and Sandi Tone Performance

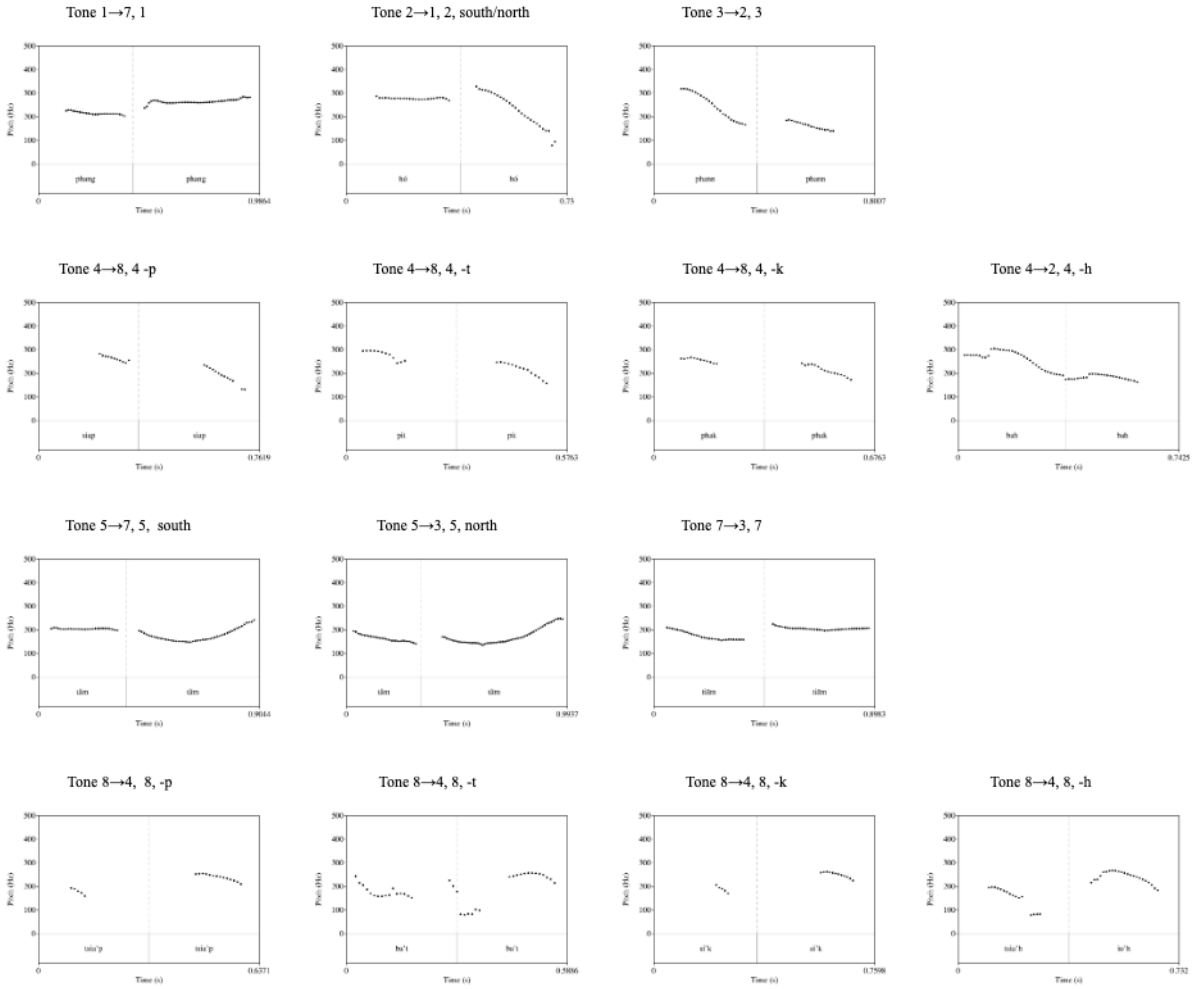

Figure 5: Pitch Results including South and North Accent.

In this experiment, the goal is to compare the actual tone pitch with the previous research. The results are shown in Figure 5, including 14 pitch graphs. These graphs are selected by the standard of perception difference. If the voice sounds the same, then only one graph is shown in the report; while the voice sounds significantly different, both two graphs are provided for analysis.

Firstly, we want to compare both citation pitch and sandhi pitch with the original Figure3. In each graph, the pitch on the right side is citation tone, while the pitch on the left side is sandhi tone. There are seven citation tone data and six sandhi tone data because there is no sandhi shift to *Tone5*.

In *Tone1*, the original pitch is a flat line in 400Hz. In citation and sandhi tone, we can see it is still a flat line but the frequency is slightly lower during 300Hz.

In *Tone2*, the original pitch is a steep sliding line from 500Hz to 100Hz. Compares to the actual data, the falling line in both citation and sandhi tone are not that drastic from 400Hz to 200-100Hz. It might be influenced by the former or latter syllable in order to perform a more natural speaking prosody.

In *Tone3*, the original pitch is a falling line second only to *Tone2*, from 300Hz to 100Hz. In actual data, they are similar to the case of *Tone2* and only show slightly falling 200Hz to 100Hz. From the cases above, we can see that the pitch shape of citation tone and sandhi tone does not have many differences. They might be adjusted or shifted into higher or lower frequency by the neighboring syllables but still maintain the same original tone shape.

In *Tone4*, the original pitch is a slightly falling line from 300Hz to 250Hz. In actual data, the frequency performs between 200Hz to 100Hz. However, if we compare *Tone4* and *Tone8* together, we see that in the orginal data, they have similar tone shape but different frequency, which is also shown in the actual data that *Tone8* always has a higher frequency then *Tone4*.

Besides, *Tone4* and *Tone8* are both ”checked tone” or ”entering tone” that happen in consonants such as -p, -t, -k. This checked tone can be divided into two registers, which is the distinguish between *Tone4* and *Tone8*. In general, consonants -p, -t, -k have more standard checked tone and feature in very short syllable ending with voiceless stop or even a glottal stop. The spectrum are shown in the Figure6. In two syllables checked tone words in our data, not the former syllable is much shorter than the latter one, but also the pitch becomes noncontinuous especially in the middle when the first syllable is about to shift to the next one.

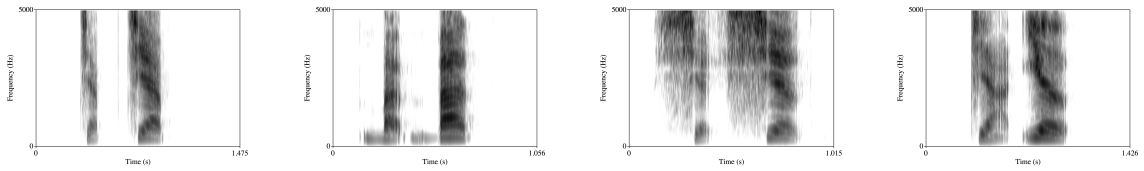

Figure 6: Spectrum of Register Consonant -p, -t, -k, -h.

Finally, *Tone5* is a raising pitch from 200Hz to 400Hz, and *Tone7* is a long flat pitch in about 300Hz. Both of them does not have many differences from the original data.

3.2 Experiment2: South and North Accent Sandi Tone Performance

The goal of this experiment is to observe the different tone sandhi phenomena in south and north accent in Taiwanese South Min. According to the former research, south accent performs tone sandhi from *Tone2* to *Tone1*, and *Tone5* to *Tone7*, while north accent performs *Tone2* to *Tone5*, and *Tone5* to *Tone3*. In the experiment, the participants are asked to record 10 words, 5 words containing sandhi of *Tone2* and another 5 words containing sandhi of *Tone5*. In each 5 words set, 2 of them are double syllables words in the format of ”AA”, such as ”bing-bing”; and three of them are triple syllables words in the format of ”BAA”, such as ”hai-liau-liau”. In the double syllables word, the first syllable performs sandhi; while in the triple syllables word, the second syllable performs sandhi.

There are two participants, one is a native speaker from south area and the other one is also a native speaker from north. The experiment results are shown in Figure7.

In the experiment of *Tone2* sandhi results, two speakers do not speak very different. According to the sandhi rule, the results of the south speaker should show the first syllable with flat tone (*Tone1*), and then show the falling tone (*Tone1*). On the other hand, the results of the north speaker should show the first

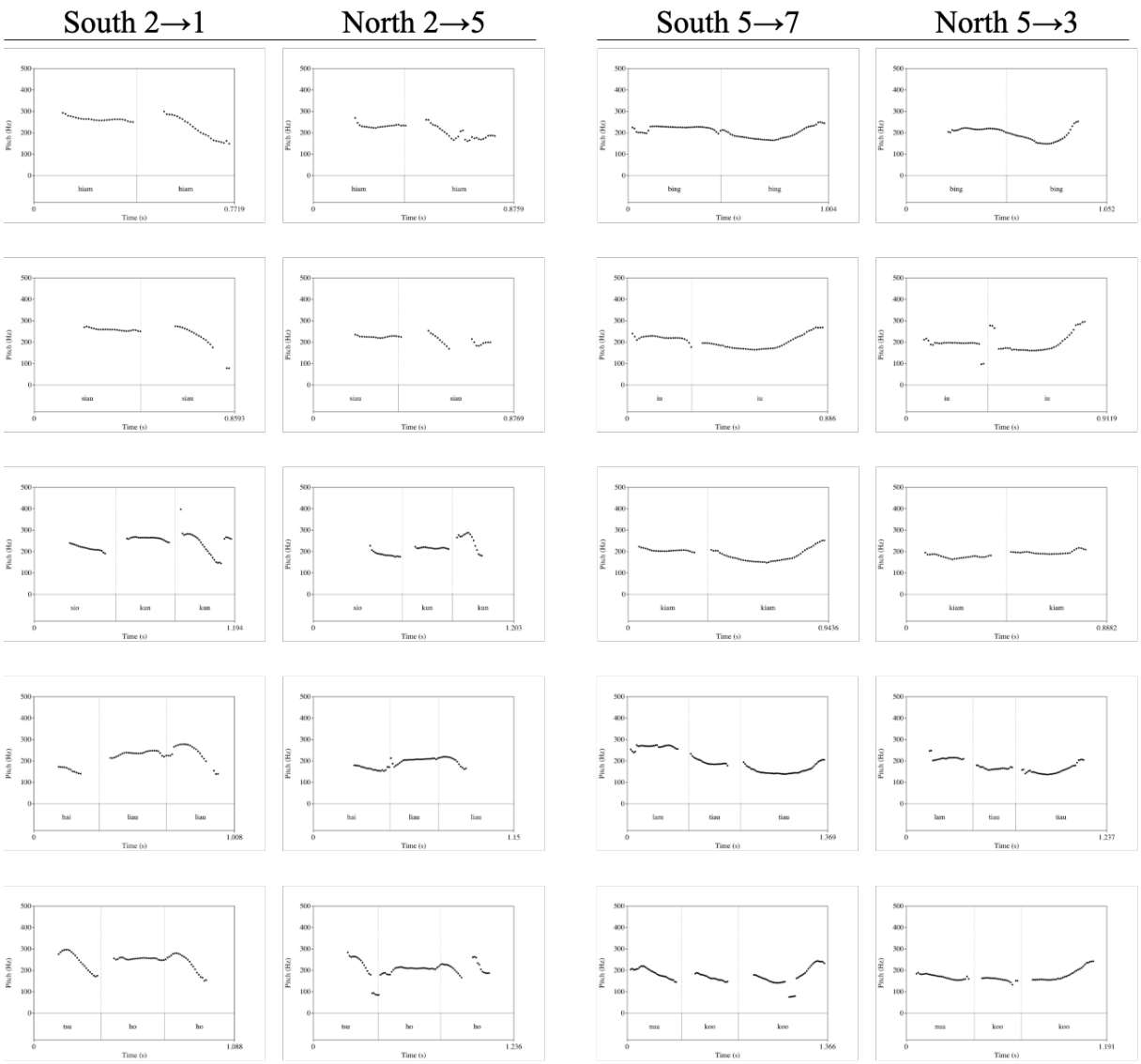

Figure 7: Tone Sandhi Observation in South-North Difference of Rule 21/25, 57/53.

syllable with raising tone (*Tone5*), and then falling tone.

However, in the results, only the first word ”hiam-hiam”, the speaker with the north accent raise the tone slightly. The rest of the words are all close to the south accent performance. Besides, the pitch lines of the north speaker are more unstable then the south speaker. We can observe many broken line in the north speaker side.

In the experiment of *Tone5* sandhi results, according to the sandhi rule, the results of the south speaker should speak the first syllable with flat tone in lower frequency (*Tone7*), and then speak the raising tone (*Tone5*). In the other side, the results of the north speaker should speak the first syllable with falling tone (*Tone3*), and then raising tone.

In the results from the south speaker, the first syllable (or the second syllable of the triple syllables words) is flat in the first two sets, however, it shows a little bit falling trend in the last three sets, especially in the triple syllable words. If we compare to the the first experiment, in which we found that the second syllable (citation tone) may be affected by first syllable (sandhi tone). In this case, we found that in triple

syllables words, the second syllable (now it is sandhi tone) is affected by the first syllable (citation tone) even stronger than the first experiment because the tone trend is almost different (from flat to slightly falling). We assume that sandhi tone is not very stable compares to the citation tone, it will be strongly affected inside the word unit than independent as one token in the sentence.

In the results from the north speaker, only the first word "bing-bing" and the fifth word "nua-koo-koo" show the falling sandhi tone.

4 Discussion

In this section, we discuss the results of the experiments and analyze the cause and effect. Besides, the advantage and disadvantage of the experiments are also mentioned for further improvement.

4.1 Experiment 1: Citation and Sandi Tone Performance

In this experiment, by comparing graph from the previous research and actual data. We found that (1) Pitch trend is more important than exact frequency. (2) Pitch of the tone might be affected by the neighboring syllables. (3) Checked tones are much shorter than the other tones and non-continuous.

The first point, we assume that in the pitch trend is more important than exact frequency. During in the actual audio analysis, we found that most of the frequency from our data tend to be flatter, constrain in the range of 200-400Hz. The experiment is recording in the reading manner, all participants are awarded they are recording. We assume that, people tend to speak in a flatter way and not exaggerate their tone during the daily life. The distinguish of different tones are more relative, such as *Tone1* will be spoken in higher frequency when it comes with *Tone7*, but it might shift or change its frequency when it comes with another tone.

The second point is followed by the first point. Since the exact frequency is not very strict, the tone will be affected by its neighbor syllables in order to maintain the naturalness of the speaking prosody. However, according to the position in the sentence, this influence might change accordingly.

The third point is the research about the checked tone, *Tone4* and *Tone8*. These tones are seem as the feature of South Min because these tones are all disappear in the modern Mandarin. The consonants ending -p, -t, -k show the same feature with short and non-continuous pitch while consonants ending -h perform generally longer also with different sandhi rule.

4.2 Experiment 2: South and North Accent Sandi Tone Performance

The main purpose of this experiment is the differentiate north and the south accent sandhi. In the results, the north and the south different sandhi phenomena is still exist. However, we can also observe that the north speaker tends to say more words in southern manner. Although the weakness of this experiment is that the participants are not enough for the representation. For example, the age range (younger/elder), living place (city/country) or even education level will all be the uncertain factors. In Taiwan, the domain language is still Mandarin. Although South Min has the second speaking population, people who speak South Min more often are usually live in the south, country or elder people. Besides, Taiwan is a small island and has very convenient transportation from north to south. In this case, the language might flow by the commute, migration, or social media. The language may exchange and influence each other, the

side which has stronger population is more advantage than the smaller one. In this experiment, we still need more data for more representative analysis.

5 Conclusion

This report presents tone sandhi phenomena experiments in Taiwanese South Min. One of the experiment focus on tone sandhi rules and the other one focus on the different sandhi of south and north accent. It analyze the contemporary data compares to the previous research. In the future, we may suggest to conduct the experiment with larger recording participants and collect people from different age, living and education range in order to show a more representative results.

References

Zhiming Bao. 1999. *The tonal phonology of Chinese*. Oxford University Press.

Mao-Hsu Chen. 2018. Tone sandhi phenomena in taiwan southern min. *Publicly Accessible Penn Dissertations*, 3049.

H. J. Hsu. 2006. Tone and stress in mandarin. *LANGUAGE AND LINGUISTICS.*, pages 7.1:109–137.

Un-gian Iun, Kiat-gak Lau, Sheng-an Li, and Cheng-yan Kao. 2005. A study on implementation of southern-min Taiwanese tone sandhi system. In *Proceedings of the 19th Pacific Asia Conference on Language, Information and Computation*, pages 119–130, Taipei, Taiwan, R.O.C. Institute of Linguistics, Academia Sinica.

J. J. Ohala. 1978. The production of tone. *Tone: a linguistic survey.*, V. A. Fromkin (ed.):5 – 39.

TSM-Dictionary. 2011. *Taiwanese South Min Common Words Dictionary*. https://twblg.dict.edu.tw/holodict_new/compile1_3_9_3.jsp.

Yi Xu and Q. Emily Wang. 2001. Pitch targets and their realization: Evidence from mandarin chinese. *Elsevier Science B.V.*

M. Yip. 1980. The tonal phonology of chinese. *Dissertation, MIT.*