

A Preliminary Study on Third Tone Sandhi in Malaysian Mandarin

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ABSTRACT

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Mandarin Chinese language has increased in importance among the Chinese community in Malaysia. At present, the Mandarin language is the only medium of instruction in Chinese schools, but it has also become a lingua franca of local Chinese Malaysians of various dialect groups. With the expansion of the Global Chinese concept, numerous studies have been carried out on the Mandarin language used in Malaysia (henceforth, Malaysian Mandarin). These studies have mainly focused on lexical and syntactic aspects rather than on the phonetic system of Malaysian Mandarin. This could be because many researchers consider the standard spoken form of Malaysian Mandarin similar to Standard Mandarin, although they are different. To better understand the development of the sound systems in regional Mandarin varieties, this paper investigates Malaysian Mandarin, specifically the standard spoken variety, by examining the acoustic realisation of third tone sandhi, a well-known Mandarin language tonal variation phenomenon. Forty-four Malaysian Chinese undergraduate students have been selected as speakers of the standard spoken variety. A nursery rhyme consisting of nineteen third tone (T3) syllables was used as the reading material to analyse the effect of different prosodic and syntactic structures on T3 realisation. The findings indicated that generally, the T3 sandhi phenomena in Malaysian Mandarin match Standard Chinese's sandhi rule. However, the acoustic realisation of T3 in terms of pitch contour and voice quality showed some differences. The implementation of T3 sandhi is also affected by the syntactic and rhythmic structure if a disyllabic or trisyllabic T3 sequence occurs across two feet. The findings suggest that the prosodic structure in the standard spoken form of Malaysian Mandarin may be developing differently from Standard Mandarin.

1. INTRODUCTION

In pace with the growing demand for learning Mandarin Chinese (henceforth Mandarin), the research on Mandarin use by overseas Chinese communities and second language learners has a corresponding increasing trend. The Chinese academia shows interest to investigate Mandarin varieties outside of China, such as in Singapore, Malaysia, Thailand, and Indonesia. If compared to lexical and syntactic aspects, the study on phonetics is still lacking. This paper explores the standard spoken form of Mandarin in Malaysia by examining the acoustic realisation of third tone sandhi, a well-known Mandarin tonal variation phenomenon. As mentioned, currently, there is more than one variety of Mandarin. This paper will use "Standard Chinese" to refer to the phonological system of Mandarin as summarised by the academia and "Mandarin" to refer to the spoken varieties of Mandarin to avoid confusion in the discussion.

1.1 The Current Status of Mandarin Usage in Malaysia

Malaysia, located in Southeast Asia, is a multi-ethnic and multilingual country ("Malaysia", 2021). According to the Department of Statistics Malaysia (2020), Malaysia's population in 2020 is estimated at 32.7 million, 90.9% citizens and 9.1% non-citizens. There are three major ethnic groups from the 29.7 million citizens, whereby 69.6% are Malay (*Bumiputera*), 22.6% are Chinese, and 6.9% are Indians.

As reported by Eberhard et al. (2021), with the exception of Standard Malay as the national language, English and Mandarin have been granted the status of statutory national working languages in Malaysia. This means that English and Mandarin are also used in working occasions at the national level but are not languages of national identity for Malaysian citizens (Eberhard et al., 2021). English is used widely in many sectors of Malaysia, such as business, media and private education (Pillai et al., 2015). Meanwhile, Mandarin is the medium of instruction in Chinese schools, lingua franca of the ethnic Chinese across various dialect groups, and is also used in business and media in Malaysia (Ghazali, 2012; Pillai et al., 2015).

The ethnically Chinese people in Malaysia primarily use Mandarin. The spread and expansion of the language at the international level are much lower than English. However, the economic rise of China has increased the need for learning Mandarin, which is the national language in China (this variety is generally known as *Putonghua*). Some researchers believe that Mandarin can become a global language after English (Diao, 2015; Goh, 2017). Based on the current situation, there are two groups of Mandarin users in Malaysia, the local Chinese ethnic speakers and Mandarin second-language speakers. The first group of speakers has a more extended usage history. They are the main contributors to Mandarin in Malaysia or Malaysian Mandarin, while the second group of speakers is developing and increasing.

1.2 A Global Perspective on Varieties of Mandarin Chinese

Following the international spread of Mandarin, more and more scholars are aware that the difference in Mandarin varieties exists and cannot be ignored. The concept of Global Chinese has been proposed to confront the issue of Mandarin varieties, and it has rapidly expanded in a short period. One of the academics, Diao (2015), explained the differences between Mandarin varieties from a historical perspective. Mandarin varieties in some regions such as Taiwan, Singapore, and Malaysia did not directly evolve from *Putonghua* (the Contemporary Standard Mandarin, henceforth, Standard Mandarin). These Mandarin varieties, including Standard Mandarin, are developed from the original version, the Traditional Mandarin (传统国语). Still, their evolution is based on different social and regional linguistic backgrounds (Diao, 2015). In

a multi-ethnic and multilingual country, Malaysia Mandarin has a development tendency and is represented in phonetic, lexical and syntax aspects (Khoo, 2017; Guo, 2017).

1.3 Problem Statement

Chinese academia conducted more linguistic studies on these Mandarin varieties, and they discussed language planning and standardisation issue across these varieties with the expansion of the concept of Global Chinese (Wang, 2020). However, previous descriptive studies of Mandarin varieties (including Malaysian Mandarin) mainly focused on the lexical and syntactic aspects, less on the pronunciation (Guo, 2017; Guo & Wang, 2018; Wang, 2017). Wang (2017) summarised that the study on the pronunciation of Mandarin varieties lacks because of the strong stability of the phonological system. Theoretically, the standard spoken form of the Mandarin variety is similar to Standard Mandarin, and the difference mainly occurs in the colloquial spoken form (Wang, 2017). This is not surprising as many researchers have a similar perspective on the standard spoken form, regardless of the language. Standard Mandarin in Malaysia is similar to standard Mandarin in China (Guo, 2017). Standard English in Malaysia is equated to standard English in British (Baskaran, 1987 and Morais, 2000, as cited in Pillai & Ong, 2018). There is still a shortage of systematic descriptions on realisation and features of the standard spoken form of a Mandarin variety. This may be why the implementation of the Standard Mandarin system in Malaysia's Chinese education is always an issue and frequently raised among the Chinese Malaysian community (Khoo, 2017). Hence, a standard spoken form should get more academic attention instead of only focusing on the colloquial spoken form.

Among the studies on phonetic variation in Malaysian Mandarin, the lexical tone gets some attention (Guo, 2017; Wang, 2017). A study by Khoo (2017) found that Malaysian Mandarin has some unique tonal variation that distinguishes it from Singaporean Mandarin, labelled the "federal accent". However, the feature of "federal accent" and how it is realised in the standard spoken and colloquial spoken forms remains unknown. In a tone language such as Mandarin, tonal variation in speech is non-linear, and it constantly interacts with prosodic and syntactic structure. It is not easy to have a comprehensive understanding if we exclude the prosodic syntax information in the tonal variation study. A specific lexical tone in various phonetic environments needs to be investigated instead of a general observation or case analysis to be more systematic. Among the four lexical tones of Standard Chinese, the sandhi phenomena of the third tone and its relation to a prosodic and syntactic structure are well investigated and understood. Hence, third tone sandhi is a suitable start point for a better understanding of the standard spoken form of Malaysian Mandarin. There are two research aims in this paper: 1) to investigate the acoustic features of T3 in utterances; 2) to explore the effect of syntactic and rhythmic structure on the implementation of T3 sandhi.

2. LITERATURE REVIEW

2.1 Lexical Tone System and Tone Sandhi of Standard Chinese

Standard Chinese is a tone language in which syllable pitch movement is used to distinguish word meaning. There are four contrastive lexical tones, first tone (T1) is described as "high-level ˥", second tone 2 (T2) is described as "high rising ˨˨˥", third tone (T3) is described as "low dipping ˨˨˨˥" and fourth tone (T4) is described as "high falling ˥˨" (Duanmu, 2007; Peng et al., 2005). Below is the example of a syllable with four lexical tones written in Hanyu Pinyin (Duanmu, 2007, p. 225), "mā" (mother), "má" (hemp), "mǎ" (horse) and "mà" (scold).

Therefore, in Standard Chinese utterances, a pitch contour is not a linear sequence of intonation like in English. It is a superimposition of two-layer pitch movement, the surface contour of intonation, and a lexical tone's base contour. Thus, it is necessary to differentiate tone in isolation and tone in connected speech, even in a polysyllabic word: citation tone and sandhi tone (Chen, 2000; Duanmu, 2007).

In connected speech, almost all lexical tones have tonal variation. This phonetic phenomenon is named 'tone sandhi'. It is familiar and usually conditioned by tonal context and other prosodic factors such as stress, prosodic boundary, speech rate. Among the four lexical tones of Standard Chinese, T3 has the most variation, and T3 sandhi is the most notable. According to T3 sandhi rules, a realisation of preceding T3 depends on the tone category of the following syllable. If another T3 follows it, the preceding T3 will change to T2 (high rising tone), such as "mǎ wěi" (horsetail) → "ma¹ wei¹". If it is followed by non-T3 (T1, T2 and T4), the preceding T3 will keep its underlying tone with the low feature, such as "mǎ chē" (carriage) → "ma¹ che¹", "mǎ tǐ" (horse's hoof) → "ma¹ tǐ¹", "mǎ shù" (horsemanship) → "ma¹ shu¹".

However, T3 sandhi is quite complicated and relates to syntactic and rhythmic structure (Peng et al., 2005; Wang et al., 2018). If T3 appears in a phrase continuously and the phrase is right-branching structure, there are two or more possible tonal patterns. For example, the tonal patterns of "[xiǎo [zhǐ [lǎohǔ]]]" (small paper tiger) could be "1 - 1 - 1 - 1", "1 - 1 - 1 - 1" or "1 - 1 - 1 - 1" (Duanmu, 2007, p. 256). The example above shows that the possible changes always happen at a word boundary because syntactic relation across words is looser than within a word. It means the T3 sandhi is not only a phonetic phenomenon but also affected by other linguistic aspects, representing certain syntactic or rhythmic structures.

2.2 Previous Studies on Lexical Tone and Prosody of Malaysian Mandarin

As explained earlier, previous studies on phonetic aspects in Malaysian Mandarin is still lacking and not systematic. However, the descriptive studies on tone and prosodic features of Malaysian Mandarin started to increase after 2010. In addition, the way of analysis is not limited to pure auditory determination but also include some acoustic analysis. Researchers such as Guo (2017), Huang (2016), and Khoo (2017) mentioned that there is a new lexical tone category in Malaysian Mandarin apart from the four tone categories of Standard Chinese. It is realised as a falling tone with a shorter duration and ends with a glottal stop, and scholars usually call it the "fifth tone". Based on their summary, it is commonly present in the everyday spoken variety and is influenced by the Chinese dialects in Malaysia.

As Khoo (2017, 2018) indicated, Malaysian Mandarin has some unique tonal variations, distinguishing it from other regional Mandarin varieties. The most noticeable difference is T4 being commonly produced as a high-level tone instead of a high falling tone when it occurs in polysyllabic words and the final position of utterance (Khoo, 2017). For example, "kàn diànyǐng" (watch movie) → "kan¹ dian¹ying¹" and "xiànzài" (now) → "xian¹zai¹" (Khoo, 2018, p. 2251). Similarly, Yeoh (2019) analysed the pitch contour of T4, which appeared in different tonal combinations and positions of an utterance, and found that T4 pitch movement varies with the conditions above. The findings of these studies have described a phonetic phenomenon that T4 in Malaysian Mandarin is not stable in connected speech. However, how T4 varies and its relation with prosodic structure remain relatively unknown.

Two studies examined Mandarin T3 citation tone and sandhi tone in Malaysia. The findings by Huang (2016) and Khoo (2018) showed that the T3 citation tone is a low falling tone, not a dipping tone. For T3 in disyllabic words, Huang (2016) found that T3 changes to a low rising

tone when followed by another T3, while Khoo (2018) discovered no sandhi change in his study. These inconsistent findings may result from the difference in speakers and material for data collection. The former study collected data through a sentence read by younger speakers (below 40 years old) who were born and raised in Penang, on the northwest coast of Peninsular Malaysia. The latter study collected data through a disyllabic word reading and conversational interviews with older speakers (above 50 years old). They were born and raised in Kluang, a town in Johor, located south of Peninsular Malaysia. Undeniable, these two studies have partly described T3 of Malaysian Mandarin. But there is still a need to explore the T3 sandhi phenomena in Malaysian Mandarin, either the standard spoken variety or the colloquial spoken variety.

Apart from this, there are a few studies on the prosodic features of Malaysian Mandarin. Hlinka (2018) found that the duration distribution of disyllabic words in Malaysian Mandarin is similar to Standard Mandarin, while Kong (2019) and Yang and Chen (2016) have the opposite results. In a study by Lee (2017), the acoustic features of different prosodic boundaries in Malaysian Mandarin differ from Standard Mandarin. In the study by Chiew (2019), it was found that the perception of sentence focus by Chinese Malaysian is relevant to tonal categories. Overall, these studies hinted that prosodic features in connected speech are related to the lexical tone system. It is challenging to deliver a comprehensive analysis without considering the lexical tone.

In summary, there is a research chasm between lexical tone and prosody of Malaysian Mandarin. Generally, a study on prosodic features could not ignore the effect of lexical tone, while a study on lexical tone should not be merged with sandhi change in connected speech. Thus, the tone sandhi domain could be a joint unit of the base pitch contour and surface pitch contour. Similar to Malaysian English (Pillai, 2012, as cited in Pillai & Ong, 2018), the everyday spoken variety of Malaysian Mandarin is not homogeneous. It is not easy to give a concrete summary of its phonological features unless we sufficiently understand the standard spoken variety. For this reason, it is worthwhile to examine the T3 variation in the standard spoken form of Malaysian Mandarin as the Chinese academic has more understanding of the T3 sandhi phenomena.

3. METHOD

3.1 Participants

This study focused on the standard spoken form of Malaysian Mandarin as there was a lack of understanding of this spoken variety. There was a specific condition in recruiting participants to fulfil the research need. Referring to the model of Malaysian English varieties and Malaysian speakers of English (Ong, 2016, as cited in Pillai & Ong, 2018, p. 154), a standard variety speaker was mainly highly educated in a specific language. Since the local Chinese ethnic speakers were the main contributor to Malaysian Mandarin, this study recruited Chinese Malaysians who had completed 12 years of Chinese education and could use Mandarin in formal and informal situations. Forty-four Chinese Malaysian undergraduate students were recruited in this study, thirty-eight females and six males, aged 20-23 years old. All of them were major in Chinese language and linguistics at a public university in Malaysia and were able to use Mandarin fluently. Written informed consent was obtained from all participants in this research project. All of them were compensated financially for their participation in it.

The participants used different languages at home. As presented in Table 1, four of them mainly spoke Chinese dialects (such as Hokkien, Cantonese, Hakka, which are derived from the southern dialect in China) at home, twenty-nine of them mainly spoke Mandarin at home, eight

of them spoke Chinese dialects and Mandarin equivalent at home. In contrast, three of them spoke Mandarin/Chinese dialect and Malay/ English at home. Although the participants had various language backgrounds, the production of T3 sandhi and acoustic realisation were similar. Hence, this paper reported and discussed the finding based on the 44 participants as a group.

Table 1. Language Use Information of Participants

Main language(s) used at the home domain	Female	Male	Total
Chinese dialects (Hokkien, Cantonese, Hakka etc)	3	1	4
Mandarin Chinese	25	4	29
Chinese dialects and Mandarin Chinese	7	1	8
Mandarin Chinese/Chinese dialects and Malay/English	3	0	3
Total	38	6	44

3.2 Data Collection

A nursery rhyme "上山找老虎" (climb up the mountain to find a tiger) was used as reading material of this study (refer to Appendix). It was obtained from "A beautiful reading of Chinese nursery rhymes" (Wu, 2004), a book that provided prosodic information such as foot, stress, intonation and suggestion of reading. This nursery rhyme "上山找老虎" was selected because the prosodic structure is fixed and consists of nineteen T3 syllables (refer to the appendix, the Chinese characters and Pinyin in bold). There were eight lines in this rhyme, five-syllable for each line (utterance), and each utterance was divided into three feet (2 syllables + 2 syllables + 1 syllable).

All recording sessions were conducted in a soundproof room at the Universiti Malaya, Faculty of Languages and Linguistics. Zoom H6 handy audio recorder and a Sennheiser shotgun microphone were used for recording. The participants were seated about 15-20 cm from the microphone. During the recording, Audio-Technica ATH-ANC7B Headphones were used for monitoring. All data were recorded with a sampling rate of 44.1 kHz, 16-bit, mono.

The participants had five to six minutes to familiarise themselves with the reading material and recording environment before starting a recording session. The participants were reminded to read at their regular comfortable speech rate and as natural as possible. The participants were requested to read the rhyme twice. However, only the first reading was analysed in this study. It is to make sure the reading is produced naturally, and no post-self-correction happens.

3.3 Data Analysis

The annotation and data analysis was conducted using Praat (Boersma & Weenink, 2020), a free software package for speech analyses. Several relevant acoustic parameters for acoustic analysis of prosodic features include fundamental frequency (f_0), duration, and intensity. No matter tone or intonation, the perception of the pitch has a close relationship with f_0 , the vibration rate of vocal folds (Beckman & Venditti, 2013). Hence, f_0 was the main acoustic parameter in this study to examine the pitch level and pitch contour of T3 syllables. Spectrographic analysis and auditory examination were carried out throughout the data analysis. A broadband spectrogram was used to determine the boundaries of the syllabic rhyme and voice quality, while a narrowband spectrogram was used to analyse the pitch level and contour.

By referring to the spectrogram and auditory perception, the acoustic realisation of each T3 syllable was analysed as follows: firstly, pitch level: high (H), mid (M) or low (L); secondly, pitch contour: falling, level, rising, falling-level, or level-rising; third and lastly, voice quality: normal or creaky voice. The labelling of pitch level was based on the pitch height of each utterance and pitch range of a participant. The pitch contour of a T3 syllable was compared with the neighbouring syllable and auditory justification before determining the pitch level (H, M or L). For pitch contour, if the pitch changes on the rhyme of syllable (whether rising or falling) was less than 20 Hz, it was labelled as level. The labelling of voice quality was necessary for T3 variation. The creaky voice was associated with an extra-low f_0 frequently occurred in T3 production as T3 is a lexical tone with a low pitch target. Besides that, a creaky voice also contributed to the perception of Mandarin lexical tone (Huang, 2019; Kuang, 2018). Therefore, the voice quality of T3 was as important as pitch features in this study.

4. RESULTS

The result showed that not all T3 which was followed by another T3, underwent a tonal change. Implementation of the T3 sandhi rule is relevant to the number of T3 syllables and the position of T3 in an utterance. Therefore, a T3 will be addressed as "sandhi form" (SF) or "citation form" (CF) in this section, which refers to sandhi tone occurring or retaining of the underlying tone. The frequency of T3 tonal variation will be explained first, followed by the reports of acoustic realisation of T3 sandhi form and citation form in the utterances. Descriptive statistics and spectrogram of sample data were used to present the findings of this study.

4.1 Implementation of Third Tone Sandhi Rule

Figure 1 presents the tonal variation of T3 of the current study. Suppose a T3 is followed by one T3 syllable, which is a disyllabic T3 sequence. The results are shown under the labels of "1", "2a", "2b(i)" and "2b(ii)". Meanwhile, if a T3 is followed by two T3 syllables, which is trisyllabic T3 sequence, the results are shown under the labels of "3a & 3b". In addition, the labels "a" and "b" represent the prosodic structure, particularly the rhythmic unit of Standard Chinese; "a" refers to a T3 sequence within a foot, "b" refers to a T3 sequence across two feet.

When disyllabic T3 sequence appeared within a word such as "老虎" (tiger), the frequency of change to sandhi form is 94.3% (refer to data "1"). If the sequence appeared across two words, the frequency of change is related to the foot, the rhythmic unit. If it is within a foot "[3-3]" such as "有几" (have how many), the frequency of change is 100% (refer to data "2a"). If it is across two feet "[x-3][3-x]", the syntactic and rhythmic relation affects it. For T3 sequence with close syntactic and rhythmic relation such as "我数" (I count), refer to data "2b(i)", the tone sandhi is more than 90%. For T3 sequence with looser syntactic and rhythmic relation such as "虎找" (tiger to find), refer to data "2b(ii)", the frequency of change and retention is almost half for both.

For the trisyllabic T3 sequence, the result is consistent. Sandhi Tone in Standard Chinese is leftward spreading, meaning the tonal variation starts from the right to the left. The second T3 syllable prioritises changing to sandhi form, while the initial T3 can only retain as citation form as it loses the condition for sandhi tone. It is the same even if the previous two T3 is within a foot "[3-3][3]" (refer to data "3a" in Figure 1) or across two feet "[x-3][3-3]" (refer data "3b" in Figure 1). Therefore, for data "3a and 3b", the frequency of initial T3 changed to sandhi form is 2.3% and retained as low tone is 97.7%.

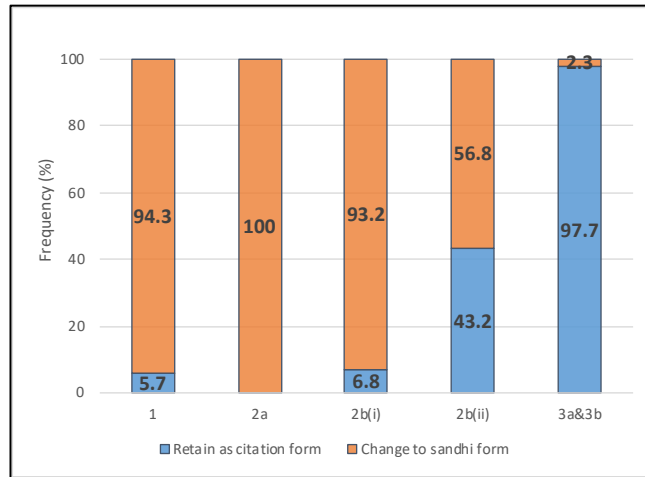


Figure 1. Tonal variation of T3 in Malaysian Mandarin

4.2 Acoustic Realisation of T3 Sandhi Form

The pitch features (pitch level and pitch contour) of the T3 sandhi form are shown in Figure 2. As reported before, only the initial T3 in the disyllabic T3 sequence will undergo tone sandhi. For T3 within a word and also within a foot (data "SF-1" and "SF-2a"), more than 95% is realised as a high rising or high level-rising tone. For T3 across two feet, the frequency of high rising or high level-rising tone is decreased while the frequency of the mid-level tone is increased. This phenomenon is evident when the syntactic and rhythmic relation of a T3 sequence is looser; 28% of participants produced sandhi form as mid-level tone (data "SF-2b(ii)").

Figure 3 presents two sample data of the third utterance (line 3) of the rhyme. The syntactic and rhythmic relation between the second syllable "12 虎" and following T3 is looser. Hence, there are two possible realisation sandhi forms, high level-rising tone and mid-level tone (refer to the pitch contour between two dash lines in the picture "(a)" and "(b)"). Besides, Figure 3 also shows that T3 sandhi within a word is very stable and not affected by the leftward spreading rule. The first syllable, "11 老" must be joined with the second syllable for a full lexical meaning ("老虎" tiger of the data "1"); therefore, it is changed to a rising tone without referring to the neighbouring condition.

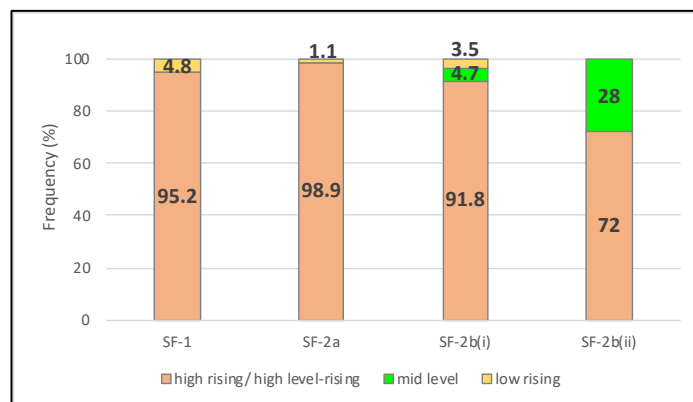


Figure 2. The acoustic realisation of T3 sandhi form in Malaysian Mandarin

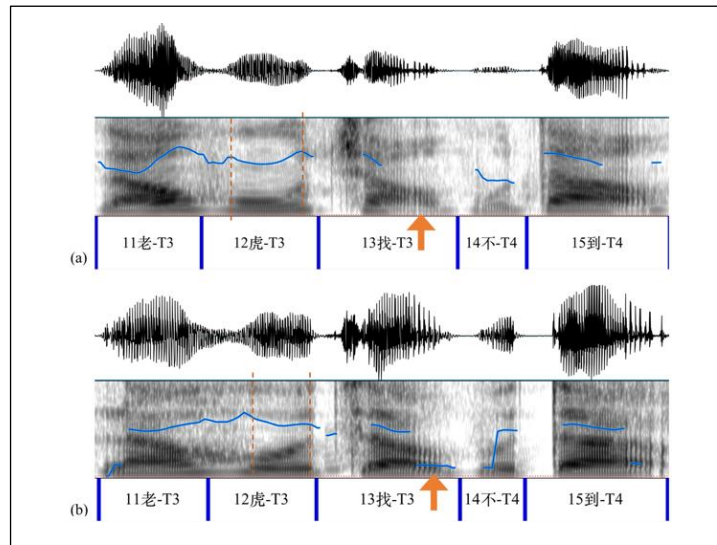


Figure 3. Two sample data of T3 sandhi form which has looser syntactic and rhythmic relation (across two feet) in waveform and spectrogram

4.3 Acoustic Realisation of T3 Citation Form

T3 followed by non-T3 syllable and T3 in the final position are retained as citation form, which is a low pitch target. However, the realisation of the T3 citation form in the non-final position and final position of utterance shows some differences, mostly at the non-final position and final position of utterance, mainly in voice quality.

As shown in Figure 4, there are two main realisation types of T3 citation form that includes low a falling, low-level tone with normal phonation and low falling, low-level tone with creaky voice. Both realisation types applied on T3 of non-final position (data "*CF-nf*") and T3 of final position (data "*CF-f1*" and "*CF-f2*") with different frequency. The occurrence of normal phonation is reduced from a non-final position (data "*CF-nf*") to final position (data "*CF-f*"), from 61.7% dropping to 9.2%. The creaky voice of T3 in the final position increases if it is located closer to the end of the nursery rhyme. The data "*CF-f1*" to "*CF-f2*" have shown the trend of increasing T3 realisation with creaky voice, from 70.3% to 90.8%.

For T3 citation forms in disyllabic and trisyllabic T3 sequences, the realisation differs based on its position in a rhythmic unit. If the first two T3 syllables are within a foot, the occurrence of normal phonation and creaky voice is nearly half and a half (data "*CF-3a*"). If these T3 syllables are across two feet, the occurrence of normal phonation is more than 84%, which is much higher than the realisation with creaky voice (data "*CF-3b*" and "*CF-2b(ii)*").

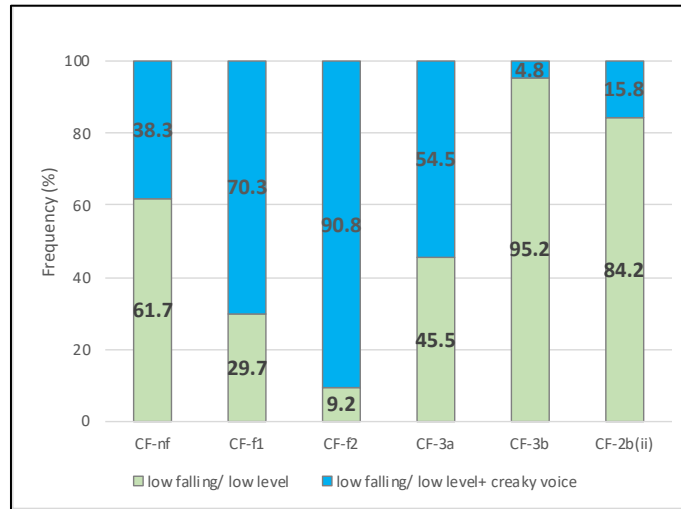


Figure 4. The acoustic realisation of T3 citation form in Malaysian Mandarin

There are not many differences in the quality of creaky voice in non-final and final positions. However, the quality of creaky voice varies from one individual to another. Some female participants produced much lower pitch than male participants. Nevertheless, females and males do not differ in how they use creaky voices in T3 syllables. The irregular glottal pulse may occur at the last 30%-40% portion of a rhyme as in Figure 3 and Figure 5 (indicated with an upper arrow). It may also occur almost throughout a rhyme, such as in Figure 6 (indicated with an upper arrow). Besides, there was an interesting finding in the creaky voice and tone category; a creaky voice of the non-final position mainly occurs on the T3 syllable. In contrast, a creaky voice of the final position occurs on the T3 and T4 syllables (refer to the spectrogram of "15 到" in Figure 3, a sample data of creaky voice on the T4 syllable).

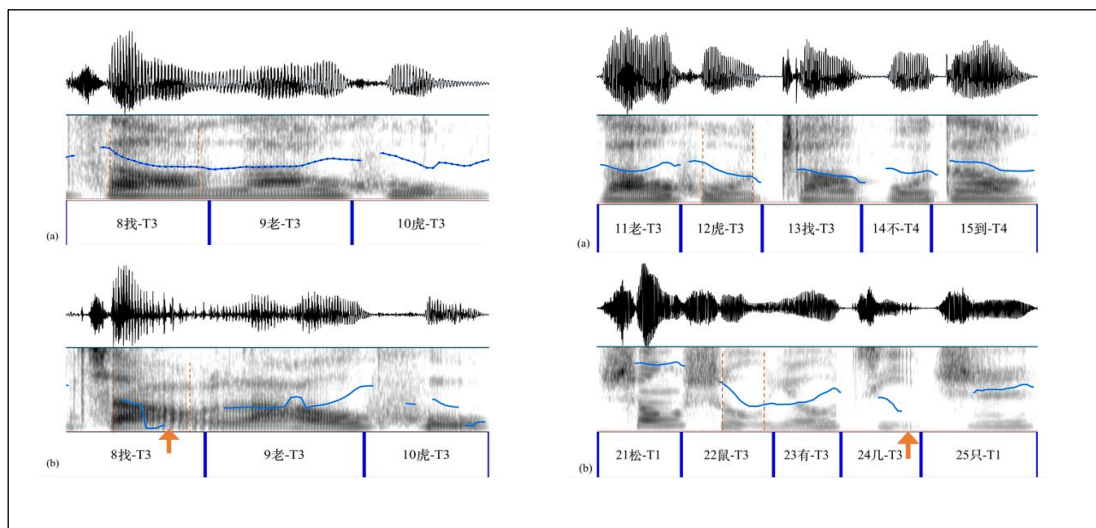


Figure 5. Sample data of T3 citation form which has looser syntactic and rhythmic relation (left: within a foot; right: across two feet) in waveform and spectrogram

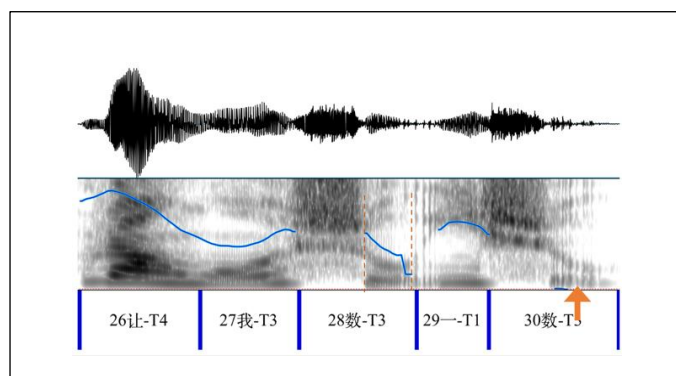


Figure 6. Sample data of T3 citation form at the final position in waveform and spectrogram

5. DISCUSSION AND CONCLUSION

By conducting analyses of both acoustic and descriptive statistics, the acoustic realisation of T3 in a nursery rhythm was examined. This study found that, generally, the T3 sandhi phenomena in the standard spoken form of Malaysian Mandarin matched the sandhi rule of Standard Chinese in this study. However, not all preceding T3 before another T3 will undergo sandhi change. It is constrained by a rhythmic unit's position and the syntactic and rhythmic relation within a T3 sequence. Sandhi change within a T3 disyllabic word is the most stable combination which is not affected by the neighbouring tonal condition and rhythmic unit. If a T3 sequence occurs across a word but within a foot, the result is similar to the T3 disyllabic word. If a T3 sequence occurs across two feet, the syntactic and rhythmic structure affects the T3 implementation. A T3 tends to sandhi change if the syntactic and rhythmic relation of the T3 sequence is tight; otherwise, a T3 tends to remain a low tone if this relation is loose. The acoustic realisation of the T3 sandhi form also varies when a T3 sequence occurs within or across two feet. High raising or high level-rising tone is the typical realisation of T3 sandhi form. In contrast, the mid-level tone is an atypical realisation that predominantly appears in the T3 sequence across two feet with a looser syntactic and rhythmic relation. On the other side, all T3 syllables retained the underlying tone in the utterances when preceding non-T3, and it is located in the final position. The T3 citation form is fixed as realised as low falling or low-level tone. Besides of low pitch target, a creaky voice frequently occurs at the T3 syllable in the non-final and final position. The creaky voice could be identified as the realisation of the T3 low pitch target and the boundary mark of a larger prosodic hierarchy (Kuang, 2018).

The pitch movement in a Mandarin utterance is non-linear. It results from superimposing the underlying tone, lexical tone, the underlying tone, lexical tone, and surface tone, which is intonation (Duanmu, 2007). This paper has initially confirmed the effect of prosodic and syntactic factors on the realisation of T3 in an utterance. In other words, the T3 sandhi is not a "pure" phonetic change in Malaysian Mandarin, which is similar to Standard Mandarin (Wang et al., 2018). The high occurrence of creaky voice and non-consistent realisation of the T3 sequence across two feet may hint that tone sandhi domain in Malaysian Mandarin, particularly the standard spoken variety, may not equate to Standard Mandarin. The tone sandhi domain is the fundamental unit of rhythmic structure (Chen, 2000). It is also a suitable interface for conducting a systematic phonetic study on Malaysian Mandarin. By investigating sandhi change, the previous scattered findings on tone realisation and prosodic structure could be integrated to provide a better understanding of Malaysian Mandarin, especially on the phonetic and phonology system.

A nursery rhythm has a fixed prosodic structure and limited syntactic categories, which is easier to analyse. However, it is not equivalent to an actual speech, and at the same time, it may not

be sufficient to discover the tone sandhi domain of a Mandarin variety. To further explore the T3 sandhi domain and the rhythmic structure of the standard spoken form of Malaysian Mandarin, it is recommended to use different spoken contexts such as paragraph reading and semi-spontaneous speech in future studies.

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APPENDIX

Appendix 1: Reading material

Line 1	一二三四 <u>五</u> , yī èr sān sì wǔ	"One two three four five"
Line 2	<u>上山</u> <u>找老虎</u> , shàng shān zhǎo lǎohǔ	"Go up the mountain to find a tiger"
Line 3	<u>老虎</u> <u>找不到</u> 。 lǎohǔ zhǎo bú dào	"A tiger could not be found"
Line 4	<u>找到</u> <u>小松鼠</u> ; zhǎo dào xiǎo sōngshǔ	"Find the little squirrel"
Line 5	<u>松鼠</u> <u>有几只</u> ? sōngshǔ yǒu jǐ zhī	"How many squirrels are there?"
Line 6	<u>让我</u> <u>数一数</u> ; ràng wǒ shǔ yī shǔ	"Let me count"
Line 7	<u>数来</u> <u>又数去</u> , shǔ lái yòu shǔ qù	"Counting and counting"
Line 8	一二三四 <u>五</u> 。 yī èr sān sì wǔ.	"One two three four five"

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