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Trisyllabic tone 3 sandhi patterns in Mandarin produced by Cantonese speakers

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Abstract

The third tone sandhi in Mandarin is a well-studied rule, where a Tone 3 followed by another Tone 3 is changed as a rising tone, similar to Tone 2. This Tone 3 sandhi rule is straightforward in disyllabic words, which is phonetically driven for the ease of production. In three or more than three syllables with Tone 3, however, the Tone 3 sandhi application is more complicated and involves both the prosodic and morph-syntactic domains, which makes it difficult for L2 learners. This study aims to understand how L2 learners with another tone language experience could master the Mandarin Tone 3 sandhi rule. Specifically, the study investigates the production of Tone 3 sandhi in trisyllabic Mandarin words by Cantonese speakers. In the current study, 30 Cantonese speakers were requested to produce 15 trisyllabic words ("1+[2+3]" and "[1+2]+3" sandhi patterns) and 5 hexasyllabic sentences with Tone 3 in sequences. The analyses of results center on three major types of error patterns: overgeneralization, under application, and combination. The findings are discussed with regard to the phono-syntactic interactions of Tone 3 sandhi at the lexical and phrasal levels as well as the influence of the Cantonese tonal system.

Index Terms: Mandarin tones, trisyllabic words, tone sandhi, tonal production, Cantonese CSL learners

1. Introduction

Mandarin Chinese is a tonal language, and it is well-known for its third tone sandhi: when there are two third tones (low-dipping tones) in a row, the first one is turned into a rising tone. The third tone sandhi for disyllabic words is robust, while that for three or more than three syllables is more complicated, which involves both the prosodic and morph-syntactic domains. The application of the third tone sandhi rule to trisyllabic words then becomes quite challenging for second language (L2) learners of Mandarin. In particular, it is common that second language learners may oversimplify a rule in a target language. In line with this, the goal of this study is to understand how L2 learners would apply the Mandarin third tone sandhi to trisyllabic words and beyond. This study focuses on the production of trisyllabic tones in Mandarin by Hong Kong Cantonese speakers who are L2 learners with another tone language experience.

1.1. Tones in Mandarin Chinese

Mandarin Chinese uses four distinctive tones plus a neutral tone to convey lexical meanings. The tonal system can be depicted either by a numerical system, with 5 indicating the highest point and 1 the lowest [1] or by a system of tonal features, L, M, and H. In Mandarin Chinese, Tone 1 is a high-level tone. Tone 2 is a mid-rising tone. Tone 3 is a low-dipping tone. Tone 4 is a high-falling tone. In connected speech, it is found that a third tone always appears as a half third tone, with only the low-falling contour shape [2]. The tonal system in Mandarin is presented in Table 1.

Table 1: *Tonal system in Mandarin Chinese.*

Tone categories	Tonal feature	Pitch value	Height
1	high-level (HH)	55	High
2	mid-rising (MH)	35	High
3	mid-level (MLH)	214	Mid
4	low-falling (HL)	51	Low

The third tone sandhi in Mandarin Chinese is the mostly discussed rule, where a Tone 3 immediately followed by another Tone 3 is altered into (or substituted as) a rising tone, similar to Tone 2 (The sandhi tone for Tone 3 is transcribed as T2 in this study). A Tone 3 changes from a low-dipping tone to a mid-rising tone before another Tone 3 because of tonal dissimilation and ease of perception [3] as well as production.

1.2. Tones in Hong Kong Cantonese

The Cantonese tonal system is considerably more complex than that of Mandarin Chinese. In Hong Kong Cantonese, a system of six different tones is distinguished. Tone 1 is a high-level tone. Tone 2 is a mid-rising tone. Tone 3 is a mid-level tone. Tone 4 is a low falling (low-mid to low) tone. Tone 5 is a low rising (low to low-mid) tone. Tone 6 is a low level tone [4]. The tonal system in Hong Kong Cantonese is given in Table 2.

Table 2: *Tonal system in Hong Kong Cantonese.*

Tone categories	Tonal feature	Pitch value	Height
1	high-level	55	High
2	mid-rising	35	High
3	mid-level	33	Mid
4	low falling	21	Low
5	low rising	13	Low
6	low level	22	Low

Note that Tone 1 in Hong Kong Cantonese has a free variant, a high-falling (53) tone, and therefore high-level and high-falling tones do not contrast in Hong Kong Cantonese [5, 6], meaning that they are allotones of a toneme [5]. In addition, it

is reported that the two rising tones Tone 2 and Tone 5 are merging in Hong Kong Cantonese [7].

1.3. Tone sandhi in trisyllabic words/phrases

As mentioned earlier, the first Tone 3 in an adjacent Tone 3 sequence undergoes tone sandhi. However, a three-syllable phrase may have two morphological structures, [σ1+[σ2+σ3]] and [[σ1+σ2]+σ3], revealing different sandhi patterns. As a result, the Tone 3 sandhi applying to three or more than three syllables with Tone 3 in sequence becomes complicated, which is not solely phonetically determined. Mainly, the third tone sandhi application in word sequences or phrases involves both the prosodic domain and the morpho-syntactic domain. Mandarin Chinese prefers a disyllabic foot structure [3], and the basic unit that Tone 3 sandhi cyclically applies on connected speech is a minimal rhythm unit [6] or a stressless foot [8]. Foot building operates on the smallest morpho-syntactic domain. In other words, the base noun in a compound must be identified first. Once the morpho-syntactic bracketing is set up, the disyllabic foot is built on the identified base noun. After the disyllabic foot is formed for the smallest domain, the foot building for the whole phrase goes from left to right. The foot building process continues from the smaller domain (morphological domain) to the larger domain (phrasal domain). An unfooted syllable at the phrase level is incorporated into its adjacent syllable and then tone sandhi rules may apply. The derivation of Tone 3 sandhi in trisyllabic words and phrases is exemplified below.

1) Trisyllabic words
   a. *mǐlǎoshǔ*   *'Mickey Mouse'*
      [mǐ [lǎoshǔ]]   identify morpho-syntactic domain
      T3 T3 T3
      T3 (T2 T3)   word: disyllabic foot; tone sandhi
      (T3 T2 T3)   word: incorporation; no tone sandhi

   b. *yǎnjiǎnggǎo*   *'speech script'*
      [[yǎnjiǎng] gǎo]   identify morpho-syntactic domain
      T3 T3 T3
      (T2 T3) T3   word: disyllabic foot; tone sandhi
      (T2 T2 T3)   word: incorporation; tone sandhi

2) Trisyllabic words in phrases
   a. *bǎoshǒudǎng hěn yǒnggǎn* *'The Conservative Party is very brave.'*
      [[[bǎoshǒu]dǎn][hěn [yǒnggǎn]]]
      T3 T3 T3 T3 T3 T3
      (T2 T3) T3 T3 (T2 T3)   word: disyllabic foot; tone sandhi
      (T2 T3 T3) (T3 T2 T3) phrase: incorporation; no tone sandhi

   b. *zhǐlǎohǔ mǎi hǎo jiǔ*   *'The paper tiger bought good wine.'*
      [[zhǐ[lǎohǔ]] mǎi [hǎo jiǔ]] identify morpho-syntactic domain
      T3 T3 T3 T3 T3 T3
      T3 (T2 T3) T3 (T2 T3)   word: disyllabic foot; tone sandhi
      (T3 T2 T3) (T3 T2 T3)   phrase: incorporation;

   c. *zhǐlǎohǔ mǎi hǎo jiǔ*   *'The paper tiger finished buying wine.'*
      [[zhǐ[lǎohǔ]] [[mǎi] hǎo] jiǔ] identify morpho-syntactic domain
      T3 T3 T3 T3 T3 T3
      T3 (T2 T3) (T2 T3) T3   word: disyllabic foot; tone sandhi
      (T3 T2 T3) (T2 T2 T3) phrase: incorporation; tone sandhi

The morpho-syntactic bracketing may start at the right or left edge. It is noted that a word or phrase usually has two tone patterns when the morpho-syntactic bracketing starts from the left edge, as shown in (1b), but not from the right edge [3]. The Tone 3 sandhi rule is alternatively applied between two

T3s in different prosodic domains or in fast speech. Particularly, (2b) and (2c) demonstrate how the involvement of morpho-syntax influences the application of Tone 3 sandhi rule in phrases. That is, (2b) and (2c) have the same strings of words but with different morpho-syntactic structures, leading to two readings and sandhi patterns.

1.4. Research Questions

The current study intends to investigate the production of trisyllabic tones in Mandarin by Cantonese speakers. It aims to address two main research issues: a) the effects of phrasal structures on Tone 3 sandhi application in trisyllables by Cantonese speakers; b) the general error patterns of Tone 3 sandhi in trisyllabic tones by Cantonese speakers.

2. Method

2.1. Participants

There were 30 Cantonese speakers participating in this study, but the recordings from two speakers were excluded because there were missing data. Thus, the recordings from 28 participants (15 females, 13 males; age range: 19-24 years old; mean age: 20.3 years old) were analyzed. None had difficulty in hearing and speaking.

2.2. Stimuli

The stimuli included 15 trisyllabic words and five hexasyllabic sentences with Tone 3 in sequences. The trisyllabic sandhi patterns can be viewed as (1+[2+3]) (e.g., mǐlǎoshǔ 'Mickey Mouse') and ([1+2]+3) (e.g., yǎnjiǎnggǎo 'speech script') patterns. Based on their phrasal (morpho-syntactic) structures and sandhi patterns, the stimuli can be put into six categories, as given in Table 3.

Table 3: *The categories of stimuli.*

Category	Syllables	Phrasal structure	Sandhi pattern	Tonal realization
1		NP	(1+ [2+3])	(T3+[T2+T3])
2	trisyllabic	VP	(1+ [2+3])	(T3+[T2+T3])
3		NP	([1+2] +3)	([T2+T2+T3])
4		VP/AP	(1+ [2+3])	(T3+[T2+T3])
5	hexa-syllabic	NP+ VP	(1+ [2+3])+ (1+ [2+3])	(T3+[T2+T3])+ (T3+[T2+T3])
6		NP+ (Adv.-VP)	([1+2] +3)+ (1+ [2+3])	([T2+T3]+T3)+ (T3+[T2+T3])

(NP=noun phrase, VP=verb phrase, AP=adverbial phrase)

2.3. Procedures

The participants did the production experiment in a quiet room. First, the participants completed the background questionnaire. Then, the participants were requested to produce and record the stimuli. They saw a list of the stimuli and were asked to read out those words with the correct lexical tones at a normal rate.

2.4. Analysis

The recordings were judged by two phonetically trained native

speakers of Mandarin, who further identified the tonal errors made by the participants. The two native speakers evaluated the recordings and labelled the tone of each syllable in the trisyllabic words and hexasyllabic sentences with a choice among the four lexical tones. When a production was too ambiguous and could not be categorized as any lexical tone, then an acoustic analysis was carried out using the software PRAAT with visual pitch contour to decide the label of the tone with an agreement between the annotators.

The misproduction of the stimuli was analyzed as four tone sandhi error patterns: overgeneralization, under application, combination, and others. The "overgeneralization" pattern indicates the Tone 3 sandhi rule was overgeneralized to the syllables that should not undergo tone sandhi, that is, the correct form should be Tone 3 but the actual output was the sandhi tone. In contrast, the "under application" pattern means the Tone 3 sandhi rule was under applied to the syllables that should undergo tone sandhi, that is, the correct form should be the sandhi tone but the actual output was Tone 3. The "combination" pattern includes the errors with a combination of both overgeneralization and under application. The "others" pattern covers those errors involving tonal productions other than Tone 3 and its sandhi tone.

The preliminary analysis for the recordings showed that two trisyllabic words (containing the character 導 dǎo) were misproduced due to lexical tonal error rather than tone sandhi error, and therefore the recordings of the two trisyllabic words were removed from the analysis for tone sandhi errors. The results for the lexical tonal error were separately analyzed.

3. Results

3.1. Overall accuracy

The overall accuracy for all stimuli was 54.7%. The accuracy rate for the trisyllabic words was 63.8% and that for the hexasyllabic sentences was 45.5%, as shown in Table 4.

Table 4: *Accuracy rate of trisyllabic words.*

	Trisyllabic	Hexasyllabic	All
Accuracy rate	63.8%	45.5%	54.7%

3.1.1. Trisyllabic words

One-way analysis of variance (ANOVA) was conducted for the cross-category accuracy in the trisyllabic words. The main effect of Category was significant [$F(3, 359) = 2.905$, $p < .05$]. The accuracy of Category 2 (M = .74, SD = .440) was significantly higher than Category 1 (M = .55, SD = .503) and Category 3 (M = .59, SD = .494) (see Figure 1).
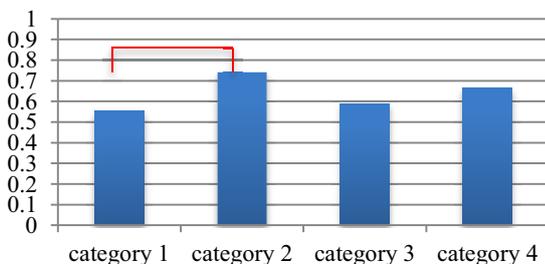

Figure 1: *Accuracy for the four categories in the trisyllabic words (* means p<.05).*

3.1.2. Hexasyllabic sentences

A paired sample t-test was conducted for the cross-category accuracy in the hexasyllabic sentences. The main effect of Category was significant [$t(27)=2.499$, $p<.05$]. The accuracy rate for Category 5 (M = .554, SD = .438) was significantly higher than Category 6 (M = .357, SD = .427) (see Figure 2).

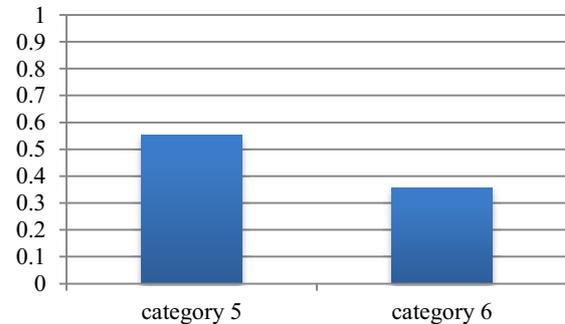Figure 2: *Accuracy for the two categories in the hexasyllabic sentences (* means p<.05).*

3.2. Tone 3 sandhi error patterns

The tone sandhi errors in the current study were classified as four patterns: overgeneralization, under application, combination, and others. The overall error rate in each pattern for the trisyllabic words and hexasyllabic sentences were given in Table 5.

Table 5: *Tone 3 sandhi error rate in each pattern.*

	Trisyllabic	Hexasyllabic	All
Overgeneralization	21.4%	30.4%	25.9%
Under application	2.9%	7.1%	5.0%
Combination	3.5%	8.0%	5.8%
Others	8.7%	8.9%	13.0%

3.2.1. Trisyllabic words

The average error rate of each error pattern for Category 1-4 in the trisyllabic words was presented in the interaction plot (see Figure 3).
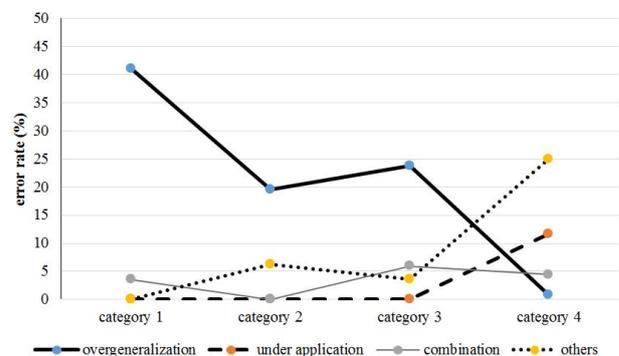

Figure 3: *Error rate of each pattern for category 1-4 in the trisyllabic words.*

3.2.2. Hexasyllabic sentences

The average error rate of each error pattern for Category 5 and 6 in the hexasyllabic sentences was also presented in the interaction plot (see Figure 4).
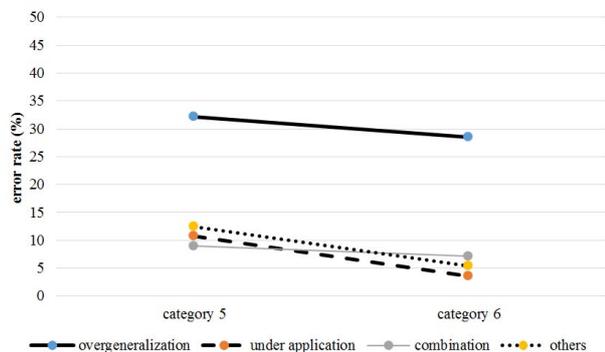

Figure 4: *Error rate of each pattern for category 5-6 in the hexasyllabic sentences.*

4. Discussion

4.1. Tone 3 sandhi and sandhi domain

The overall accuracy from the results showed that the accuracy rate of trisyllabic words was higher than that of hexasyllabic words, which indicates that Tone 3 sandhi was more accurately applied to the domains at the lexical level than those at the sentential level.

Among the trisyllabic words, the accuracy rate for individual categories showed the effects of phrasal structure on the production of Tone 3 sandhi by the Cantonese speakers. The accuracy rate for Category 2 (VPs) was significantly higher than that for Category 1 and Category 3 (NPs with "1+[2+3]" and "[1+2]+3" sandhi patterns, respectively). The results demonstrated that the Tone 3 sandhi rule was better applied to VPs than NPs by the Cantonese speakers. The sandhi domain in VPs was more obviously recognized than that in NPs. The results suggested that the sandhi domain for Tone 3 in trisyllabic NPs, comparing to trisyllabic VPs, is more difficult to the L2 learners. The syntactic structure of a VP, a verb followed by a NP, helps distinguish domain parsing because the syntactic categories of the two are definite. However, the syntactic relation of an NP compound does not elicit a clear cue for domain parsing.

Similarly, the accuracy rate in the hexasyllabic sentences also showed the effects of morph-syntactic structures on the application of Tone 3 sandhi. The error rate for Category 5 (NP+VP) was significantly higher than that for Category 6 (NP+Adv-VP). The results may imply that the sentences consisting of phrases other than NPs+VPs are more difficult for L2 learners to identify the sandhi domains in trisyllabic tones.

4.2. Tone 3 sandhi error patterns

The errors made by the Cantonese speakers were analyzed as four patterns: overgeneralization, under application, combination, and others. The results showed that the overall error rate in the "overgeneralization" pattern was the highest among the four error patterns. It implied that Cantonese speakers tend to apply Tone 3 sandhi in trisyllables in an overgeneralized way, changing Tone 3 into a rising tone in trisyllables with Tone 3 in a row.

For the trisyllabic words, the error rate in individual categories showed that most errors for Category 1-3 were found in the pattern "overgeneralization," and most errors for Category 4 were found in the pattern "others." With further analysis of the errors in Category 4, we noticed that most errors in the pattern "others" came from the trisyllabic word 洗澡水 xǐzǎoshuǐ 'bath water,' in which the character 澡 zǎo with Tone 3, was misproduced as Tone 4 by 46.4% of the participants. It is speculated that Cantonese speakers have a tendency to pronounce unknown characters with Tone 4 in Mandarin, which needs further investigation. As to the hexasyllabic sentences, the majority of errors were also found in the pattern "overgeneralization" for both Category 5 and 6.

4.3. Influence from Cantonese phonology

Recall that the recordings of the two trisyllabic words containing the character 導 dǎo were removed from the analysis for tone sandhi errors. When analyzing the recordings of trisyllabic words with this character, we noticed that over half (60.7% in 好領導 hǎolǐngdǎo 'good leader' and 57.1% in 請指導 qǐngzhǐdǎo 'please advise') of the productions were judged as Tone 4. It is probably because of lexical effects since 導 and 道 (dào 'path') are pronounced exactly the same in Cantonese ([dou], and both are in Tone 6), and 道 seems to have a higher frequency and is easier to recognize. It can be viewed as lexical tonal error since it may result from character misrecognition (導 vs.道). This might be the reason why most Cantonese speakers in this study tended to pronounce 導 with the same tone as 道, which is Tone 4 in Mandarin.

5. Concluding Remarks

This study examined the production of Mandarin tone sandhi in trisyllables with Tone 3 by Cantonese speakers. The results showed that the Tone 3 sandhi domain in trisyllabic NPs is more confusing than trisyllabic VPs. The trisyllabic tones in sentences with phrases other than NPs+VPs are more difficult for Cantonese speakers to accurately apply Tone 3 sandhi. With regard to the general error patterns, the results indicated that Cantonese speakers tend to apply Tone 3 sandhi to trisyllables in an overgeneralized way. The findings suggested the effects of phono-syntactic interactions of Tone 3 sandhi and those of tonal system in Cantonese phonology.

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