# SYNTACTIC AND PROSODIC EFFECTS ON RECONSTRUCTION OF TONE SANDHI DOMAINS: EVIDENCE FROM XIAMEN DIALECT

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## ABSTRACT

Recent studies have addressed the syntactic and prosodic conditions on tone group reconstruction, indicating the syntax-prosody competition, but previous results show less consensus. This study investigates syntactic and prosodic effects on reconstruction of the tone sandhi domain in Xiamen Dialect. Findings are as follows: (1) The tone sandhi domain in Xiamen Dialect is reconstructed into a smaller one by producing the break of phonological phrases after the head verb and the adjunct XP. (2) The syntactic adjuncthood affects positions of the break of phonological phrases. Such break occurs more frequently after AdvPs than after head verbs and CLPs. (3) Prosody exerts restrictions on the number and positions of the break of phonological phrases, which limits syntactic effects on reconstruction of the tone sandhi domain.

Keywords: tone sandhi domain, prosody, syntax, Xiamen Dialect

## 1. INTRODUCTION

### 1.1. Effects of syntax and prosody on tone sandhi domain reconstruction

Previous studies addressed syntactic and prosodic conditions on tone group reconstruction, indicating an interface between syntax and prosody [1].

Two factors affecting reconstruction of the tone sandhi domain in Taiwanese have been discovered: syntactically the adjuncthood and prosodically the number of syllables in the domain. In terms of syntactic effects, the break of phonological phrases produced by young speakers may occur after a head verb and an adjunct XP, which appears inconsistent with prior research on general Taiwanese that breaks of phonological phrases only occur at the right edge of non-adjunct XPs [2, 3, 4, 5]. When it comes to prosodic effects, trisyllabic and tetrasyllabic fragments are preferred lengths for tone groups produced by young speakers [4, 6]. Yet, prior work shows less consensus as some studies on Taiwanese produced by the young generation found that a phonological phrase is restricted within three syllables [2, 3].

### 1.2. Tone sandhi conditioning in Xiamen Dialect

The tone inventory of Xiamen Dialect comprises seven tones, including five smooth tones and two checked tones [7]. All these seven tones have tonal alternations between base tones and sandhi tones. Table 1 lists the tone inventory of Xiamen Dialect.

|            | T1 | T2 | T3 | T4 | T5 | T6   | T7  |
|------------|----|----|----|----|----|------|-----|
| Base tones | H  | LM | HL | L  | M  | M    | H   |
| Sandhi tones | M | M | H  | HL | L  | H/HL | L/L |

**Table 1**: Tone Inventory [8, 9].

Base tones are regarded as underlying forms in the derivational process of tonal alternations while sandhi tones are regarded as surface forms deriving from corresponding base tones [10, 11, 12]. The tone sandhi rule is shown in (1).

(1)  Tone Sandhi Rule [13]
     base tone $\rightarrow$ sandhi tone / __ X #

The tone sandhi domain conditioning tone sandhi in Xiamen Dialect is related to syntactic structures [4, 13, 14, 15, 16]. Within a tone sandhi domain, base tones are only produced at right edges of sandhi domains while sandhi tones are produced in other positions. Chen [13] suggested that the tone group in Xiamen Dialect is marked at the right edge of a non-adjunct XP but not of an adjunct XP. Chen [5] defined that XP is an adjunct of Y if XP appears in [...XP...]$_{YP}$ and is not a strictly subcategorized argument of Y [17]. Examples are given in (2) and (3), with edges of tone groups marked with "#", base tones marked as B and sandhi tones marked as S. The NP in (2) is a non-adjunct XP, which is the internal argument of the verb 'take'. The base tone is retained at the right edge of this NP. By contrast, the AdvP in (3) is an adjunct XP modifying the verb 'rise-up' and carries the sandhi tone.

（2）XP as a non-adjunct [13]
   *t'eq tsih]$_{NP}$ # k'i puaq-kiao*
    S   B     S  S   B
   take money   to   gamble
   'take the money to gamble'

（3）XP as an adjunct [13]
   *tsa]$_{AdvP}$ k'i-lai*
    S     S  B
   early   rise-up
   'get up early'

The tone group in Xiamen Dialect is suggested as the tone sandhi domain, also referred to as the phonological phrase (φ) [4, 18]. The break of the phonological phrase (φ-break) is marked at the right or left edge of a syntactic XP and X$^{head}$ [19]. So the φ-break coincides with the right edge of the non-adjunct XP [6, 18, 20, 21]. And the phonological phrase is considered as the tone sandhi domain in previous studies [6, 13, 18, 20, 21].

So far, tone group reconstruction in Xiamen Dialect has been rarely studied. In addition, few attempts have been made to explore the discrepancies between effects of different adjunct XPs on tone group reconstruction. And prosodic restrictions on tone group reconstruction have not been convincingly presented as prior studies showed less consensus. Given great phonological similarities between Taiwanese and Xiamen Dialect but significant discrepancies in their contact with Mandarin Chinese, this study addresses the following research question. That is, whether syntax and prosody affect reconstruction of the tone sandhi domain in Xiamen Dialect in the same way as they do in Taiwanese.

## 2. METHOD

### 2.1. Participants

Nineteen participants were invited who were born and brought up in Xiamen, and they speak both Xiamen Dialect in their daily life and Mandarin Chinese when at work. They were divided into three groups, shown in Table 2.

|  | Participants | Mean Age |
|---|---|---|
| **Group A** | 3 female, 4 male | 20.6 (SD=0.5) |
| **Group B** | 2 female, 4 male | 48.0 (SD=2.1) |
| **Group C** | 4 female, 2 male | 75.2 (SD=2.5) |

**Table 2**: Information of participants.

### 2.2. Materials

The materials include 21 carefully designed test sentences, with various combinations of the number of syllables and syntactic structures, constructing adjunct XPs in different lengths. For the adjunct XP, the study focuses on the adverbial phrase (AdvP) and the classifier phrase (CLP) as adjuncts. For the X$^{head}$, this study focuses on the head verb. The example of the AdvP as an adjunct, the CLP as an adjunct and the head verb are respectively provided in (6), (7) and (8) in the discussion part. All sentences were read three times by all participants, producing 1,197 tokens (21 sentences× 3 repetition× 19 participants).

### 2.3. Procedure

The recording was carried out in a quiet room. Participants were instructed to read materials presented on an iPad screen at normal speed as if talking to a close friend. The recording equipment was a Lenovo YOGA C740 computer and a Plantronics Blackwire 3220 Series headset microphone. All sounds were recorded with PRAAT [22] at 44.1 kHz 16 bits and a mono soundtrack.

### 2.4. Data analysis

Tone bearing units in test sentences were manually annotated based on the spectrogram. Voice Sauce was used to extract F0 values [23]. Two well-trained native speakers of Xiamen Dialect worked as judges to decide whether or not tone sandhi occurred. Listening to all recorded sentences, judges annotated base tones and sandhi tones produced for each syllable in sentences, with the help of F0 for each recording. All their annotations reached a consensus. For each test sentence produced by each age group, patterns of the φ-break were calculated and presented in the percentage.

## 3. RESULTS AND DISCUSSION

### 3.1. The discovery of an intermediate φ-break

The study discovers an intermediate state of the φ-break (noted as φ'-break), which is only found after head verbs produced by GA, shown in (4b) and (5b). The tone bearing this φ'-break is a high level tone H, and such a tone value is included in neither the base tone L nor the sandhi tone HL of the word *sau*.

(4) [[pʰaʔ sau]$_V$ [[lak e]$_{CLP}$ [paŋ kūī]$_N$]$_{NP}$]$_{VP}$ — Frequency of φ-break patterns (%)

| | | clean | | six | CL | room | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 'Clean six rooms.' | | | | | | | |
| Base tones | | M | L | H | LM | LM | H | GA | GB | GC |
| φ-break | a. | (HL | HL | L | M | M | H)φ | 28.57 | 100 | 100 |
| Patterns | b. | (HL | H)φ' | (L | M | M | H)φ | 57.14 | 0 | 0 |
| | c. | (HL | L)φ | (L | M | M | H)φ | 14.29 | 0 | 0 |

(5) [[kūā kín]$_{AdvP}$ [[pʰaʔ sau]$_V$ [[lak e]$_{CLP}$ [paŋ kūī]$_N$]$_{NP}$]$_{VP}$ — Frequency of φ-break patterns (%)

| | | quickly | | clean | | six | CL | room | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 'Clean six rooms quickly.' | | | | | | | | | |
| Base tones | | HL | HL | M | L | H | LM | LM | H | GA | GB | GC |
| | a. | (H | H | HL | HL | L | M | M | H)φ | 14.29 | 100 | 100 |
| φ-break | b. | (H | H | HL | H)φ' | (L | M | M | H)φ | 28.57 | 0 | 0 |
| Patterns | c. | (H | H | HL | L)φ | (L | M | M | H)φ | 28.57 | 0 | 0 |
| | d. | (H | HL)φ | (HL | HL | L | M | M | H)φ | 28.57 | 0 | 0 |

In (4) and (5), either φ-break or φ'-break occurs after the head verb, which is the way for a high percentage of GA to reconstruct shorter sandhi domains. We suppose that φ'-break is an intermediate state of phonological phrasing break, as it provides a substitute for the base tone to distinguish the tone bearing such a break from the sandhi tone.

## 3.2. Syntactic effects on reconstruction of sandhi domains

### 3.2.1. Patterns of sandhi domain reconstruction

Results illustrate that the tone sandhi domain in Xiamen Dialect is reconstructed into a shorter domain. As presented in (6), (7) and (8) where VP and NP are non-adjunct XPs, Group C, whose members are older than 70, only preserve the base tone at the rightmost edge of the non-adjunct XP, while the younger group GA and a part of middle-aged group GB reconstruct shorter tone sandhi domains by producing base tones at the right edges of the adjunct XP and the head verb. Present results show at least three patterns for young Xiamen Dialect speakers to reconstruct shorter tone sandhi domains.

| (6) | [[kũã | kin]AdvP | [pʰaʔ | sau]V']VP | | | |
|---|---|---|---|---|---|---|---|
| | quickly | | | clean | Frequency of | | |
| | | 'Clean quickly.' | | | φ-break patterns (%) | | |
| Base tones | HL | HL | M | L | GA | GB | GC |
| φ-break a. | (H | H | HL | L)φ | 28.57 | 66.67 | 100 |
| Patterns b. | (H | HL)φ | (HL | L)φ | 71.43 | 33.33 | 0 |

| (7) | [[tsap | li | e]CLP | [paŋ | kũĩ]N]NP | | | |
|---|---|---|---|---|---|---|---|---|
| | twelve | | CL | | room | Frequency of | | |
| | | | 'Twelve rooms.' | | | φ-break patterns (%) | | |
| Base tones | H | M | LM | LM | H | GA | GB | GC |
| φ-break a. | (L | L | M | M | H)φ | 85.71 | 100 | 100 |
| Patterns b. | (L | L | LM)φ | (M | H)φ | 14.29 | 0 | 0 |

| (8) | [[pʰaʔ | sau]V | [[lak | e]CLP | [paŋ | kũĩ]N]NP]VP | | | |
|---|---|---|---|---|---|---|---|---|---|
| | clean | | six | CL | | room | Frequency of | | |
| | | | 'Clean six rooms.' | | | | φ-break patterns (%) | | |
| Base tones | M | L | H | LM | LM | H | GA | GB | GC |
| φ-break a. | (HL | HL | L | M | M | H)φ | 28.57 | 100 | 100 |
| Patterns b. | (HL | H)φ' | (L | M | M | H)φ | 57.14 | 0 | 0 |
| c. | (HL | L)φ | (L | M | M | H)φ | 14.29 | 0 | 0 |

First, the tone sandhi domain produced by the younger generation can be blocked by the adverbial phrase (AdvP) which is an adjunct, presented in (6b). The AdvP in (6) is an adjunct modifying the verb and *kin* is at the right edge of this adjunct XP. All GC produce sandhi tones for *kin*, while 33.33% of GB and 71.43% of GA retain base tones.

Second, the tone sandhi domain produced by 14.29% of GA is blocked by the classifier phrase (CLP) which is an adjunct, shown in (7b). The CLP in (7) is an adjunct modifying the noun 'room' and the syllable *e* is at the right edge of this adjunct XP.

Third, the φ-break also occurs after the head verb produced by GA, shown in (8c). *Sau* is at the right edge of the head verb 'clean'. All GB and GC produce sandhi tones for *sau*, while a high percentage of GA produce base tones for it..

Generally, young speakers of Xiamen Dialect reconstruct shorter tone sandhi domains by producing φ-breaks after head verbs and adjunct XPs, including AdvPs and CLPs.

### 3.2.2. Frequency of the three patterns

Between three tone-group reconstruction patterns in Xiamen Dialect, discrepancies are found in the use frequency in tone group reconstruction and in the order of appearance across the three age groups.

First, φ-breaks occur more frequently after the AdvP than the CLP when both of them are adjunct XPs, shown in (9) and (10). Results show 71.43% of GA and 33.33% of GB retain base tones at the right edge of AdvP in (9), while only 14.29% of GA preserve base tones at the right edge of CLP in (10). Such a trend is inconsistent with previous research in [4], which shows that φ-breaks after both AdvPs and CLPs are used by 99.6% of young Taiwanese speakers when reconstructing tone groups.

From the diachronic perspective, results suppose that the φ-break after the CLP appears later than that after the AdvP in the ongoing change. When the AdvP and CLP are both adjunct XPs, 33.33% of GB produce the φ-break after the AdvP and none of GB produces that after the CLP.

| (9) | [[kũã | kin]AdvP | [pʰaʔ | sau]V']VP | | | |
|---|---|---|---|---|---|---|---|
| | quickly | | | clean | Frequency of | | |
| | | 'Clean quickly.' | | | φ-break patterns (%) | | |
| Base tones | HL | HL | M | L | GA | GB | GC |
| φ-break a. | (H | H | HL | L)φ | 28.57 | 66.67 | 100 |
| Patterns b. | (H | HL)φ | (HL | L)φ | 71.43 | 33.33 | 0 |

| (10) | [[tsap | li | e]CLP | [paŋ | kũĩ]N]NP | | | |
|---|---|---|---|---|---|---|---|---|
| | twelve | | CL | | room | Frequency of | | |
| | | | 'Twelve rooms.' | | | φ-break patterns (%) | | |
| Base tones | H | M | LM | LM | H | GA | GB | GC |
| φ-break a. | (L | L | M | M | H)φ | 85.71 | 100 | 100 |
| Patterns b. | (L | L | LM)φ | (M | H)φ | 14.29 | 0 | 0 |

Second, the φ-break occurs more frequently after the AdvP than after the head verb. As (11) shows, 85.71% of GA and 33.33% of GB produce φ-breaks after AdvPs, while only 28.57% of GA produce φ-breaks after head verbs.

From the diachronic perspective, results imply that the φ-break after the head verb appears later than that after the AdvP in the ongoing change, as 33.33% of GB produce the φ-break after AdvPs but none of GB produces that after the head verb.

| (11) | [[ko | kʰa | kũã | kin]AdvP | [[pʰaʔ | sau]V | [paŋ | kũĩ]NP]V']VP | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | still | more | quickly | | clean | | room | Frequency of | | |
| | | | 'Clean the room much more quickly.' | | | | | φ-break patterns (%) | | |
| Base tones | HL | M | HL | HL | M | L | LM | H | GA | GB | GC |
| φ-break a. | (H | H | H | H | HL | HL | M | H)φ | 14.29 | 66.67 | 100 |
| Patterns b. | (H | H | H | HL)φ | (HL | HL | M | H)φ | 57.14 | 33.33 | 0 |
| c. | (H | H | H | HL)φ | (HL | H)φ' | (M | H)φ | 28.57 | 0 | 0 |

Third, the φ-break (also the φ'-break) occurs after the head verb but not after the CLP when the head verb and the CLP appear in the same sentence, presented in (12).

(12)

| | [[pʰaʔ sau]_V | [[lak e]_CLP [paŋ kũĩ]_N]_NP]_VP | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | clean | six | CL | | room | Frequency of | | |
| | | 'Clean six rooms.' | | | | φ-break patterns (%) | | |
| Base tones | M | L | H | LM | LM | H | | |
| | | | | | | | GA | GB | GC |
| φ-break a. | (HL | HL | L | M | M | H)φ | 28.57 | 100 | 100 |
| Patterns b. | (HL | H)φ' | (L | M | M | H)φ | 57.14 | 0 | 0 |
| c. | (HL | L)φ | (L | M | M | H)φ | 14.29 | 0 | 0 |

Taken together, in these three syntactic patterns of the tone group reconstruction, the φ-break after AdvPs occurs more frequently than that after head verbs, which occurs more frequently than that after CLPs. Their order of appearance in the ongoing change is that φ-breaks after AdvPs and head verbs appear earlier than those after CLPs. The Kruskal-Wallis test reports a significant difference in the use frequency of φ-breaks after AdvPs ($p=0.002<0.01$) and φ-breaks after head verbs ($p=0.000<0.01$) between age groups, while there is no significant difference in the use frequency of φ-breaks after CLPs between groups ($p=0.368>0.05$).

## 3.3. Prosodic restrictions on reconstruction of sandhi domains

Syntactic effects on tone group reconstruction are limited by prosodic restrictions. Although the φ-break after AdvPs occurs more frequently than that after head verbs, younger speakers tend to use the latter to balance the lengths of tone sandhi domains, shown in the comparison between (13) and (14).

(13)

| | [[kũã kin]_AdvP | [[pʰaʔ sau]_V | [paŋ kũĩ]_NP]_V']_VP | | | | | |
|---|---|---|---|---|---|---|---|---|
| | quickly | clean | | room | Frequency of | | |
| | | 'Clean the room quickly.' | | | φ-break patterns (%) | | |
| Base tones | HL | HL | M | L | LM | H | | |
| | | | | | | | GA | GB | GC |
| φ-break a. | (H | H | HL | HL | M | H)φ | 14.29 | 100 | 100 |
| Patterns b. | (H | H | HL | H)φ' | (M | H)φ | 28.57 | 0 | 0 |
| c. | (H | HL)φ | (HL | HL | M | H)φ | 57.14 | 0 | 0 |

(14)

| | [[kũã kin]_AdvP | [pʰaʔ sau]_V | [[lak e]_CLP | [paŋ kũĩ]_N]_NP]_V']_VP | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | quickly | clean | six | CL | | room | Frequency of | | |
| | | 'Clean six rooms quickly.' | | | | | φ-break patterns (%) | | |
| Base tones | HL | HL | M | L | H | LM | LM | H | | |
| | | | | | | | | | GA | GB | GC |
| a. | (H | H | HL | HL | L | M | M | H)φ | 14.29 | 100 | 100 |
| φ-break b. | (H | H | HL | H)φ' | (L | M | M | H)φ | 28.57 | 0 | 0 |
| Patterns c. | (H | H | HL | L)φ | (L | M | M | H)φ | 28.57 | 0 | 0 |
| d. | (H | HL)φ | (HL | HL | L | M | M | H)φ | 28.57 | 0 | 0 |

In (13), 57.14% of GA produce the φ-break after the AdvP. As (14) adds a CLP to increase syllables in NP, the longer length of the tone group forces young speakers to break the string into shorter fragments. Due to the lower use frequency of the φ-break after the CLP, younger speakers tend to shift the φ-break from after the AdvP to after the head verb, resulting in that the percentage of GA producing φ-breaks after the AdvP drops to 28.75%.

Moreover, prosodic restrictions on tone group reconstruction exert impacts on the number and positions of φ-breaks, shown in (15), (16) and (17).

(15)

| | [[ko kʰa kũã kin]_AdvP | [[pʰaʔ sau]_V | [paŋ kũĩ]_NP]_V']_VP | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | still more quickly | clean | | room | Frequency of | | |
| | | 'Clean the room much more quickly.' | | | | φ-break patterns (%) | | |
| Base tones | HL M HL HL | M | L | LM | H | | |
| | | | | | | | GA | GB | GC |
| φ-break a. | (H H H H | HL | HL | M | H)φ | 14.29 | 66.67 | 100 |
| Patterns b. | (H H H HL)φ | (HL | HL | M | H)φ | 57.14 | 33.33 | 0 |
| c. | (H H H HL)φ | (HL | H)φ' | (M | H)φ | 28.57 | 0 | 0 |

(16)

| | [[ko kʰa kũã kin]_AdvP | [[pʰaʔ sau]_V | [[lak e]_CLP [paŋ kũĩ]_N]_NP]_V']_VP | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | still more quickly | clean | six | CL | | room | Frequency of | | |
| | | 'Clean six rooms much more quickly.' | | | | | φ-break patterns (%) | | |
| Base tones | HL M HL HL | M | L | H | LM | LM | H | | |
| | | | | | | | | GA | GB | GC |
| φ-break a. | (H H H H | HL | HL | L | M | M | H)φ | 14.29 | 66.67 | 100 |
| Patterns b. | (H H H HL)φ | (HL | HL | L | M | M | H)φ | 42.86 | 33.33 | 0 |
| c. | (H H H HL)φ | (HL | H)φ' | (L | M | M | H)φ | 42.86 | 0 | 0 |

(17)

| | [[ko kʰa kũã kin]_AdvP | [[pʰaʔ sau]_V | [[ɕap li e]_CLP [paŋ kũĩ]_N]_NP]_V']_VP | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | still more quickly | clean | twelve | CL | | room | Frequency of | | |
| | | 'Clean twelve rooms much more quickly.' | | | | | | φ-break patterns (%) | | |
| Base tones | HL M HL HL | M | L | H | M | LM | LM | H | | |
| | | | | | | | | | GA | GB | GC |
| φ-break a. | (H H H H | HL | HL | L | L | M | M | H)φ | 14.29 | 66.67 | 100 |
| Patterns b. | (H H H HL)φ | (HL | HL | L | L | M | M | H)φ | 28.57 | 33.33 | 0 |
| c. | (H H H HL)φ | (HL | H)φ' | (L | L | M | M | H)φ | 57.14 | 0 | 0 |

From (15) to (17), with the increasing syllables in the CLP, the percentage of sentences with two φ-breaks (or φ'-breaks) rises from 28.57% to 57.14% in GA. Results also demonstrate that pressures brought by prosodic restrictions may transfer from CLPs to AdvPs and head verbs.

To elucidate prosodic restrictions and make a comparison with previous studies, preferred lengths of tone group are calculated in this study. GA tend to break the string into disyllabic and tetrasyllabic fragments, while GB prefer tetrasyllabic ones and GC prefer tetrasyllabic and hexasyllabic ones.

## 4. CONCLUSION

The purpose of this study is to explore syntactic and prosodic effects on reconstruction of the tone sandhi domain in Xiamen Dialect.

The study finds that the tone sandhi domain in Xiamen Dialect is reconstructed into a shorter domain. Previous studies have argued that sandhi domains are delimited only by the right edge of non-adjunct XPs [13, 24]. Our study has discovered that with reconstruction in the younger generation, sandhi domains can also be confined by the right edge of adjunct XPs and head verbs. In terms of syntactic effects, φ-breaks occur more frequently after AdvPs than after head verbs and CLPs. And φ-breaks after AdvPs and head verbs appear earlier than those after CLPs in the ongoing change of tone sandhi domains. In terms of prosodic effects, lengths of tone groups exert restrictions on the number and positions of φ-breaks. Younger speakers tend to break the string into disyllabic or tetrasyllabic fragments. Syntactic effects on reconstruction of the tone sandhi domain are limited by prosodic restrictions. And an intermediate state of the φ-break is discovered in this study.

## 5. ACKNOWLEDGEMENTS

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