Life across life span on tone sandhi domain: A case study on Huai'an Mandarin*

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Based on the apparent time and real time data of tone sandhi patterns of the Huai'an dialect of Jianghuai Mandarin, this paper argues that as ages grade, speakers apply Tone 1 sandhi more frequently at the post-lexical level. This phenomenon should be categorized as lifespan change (Sankoff 2008) due to the ongoing diachronically change at the community level where Tone 1 sandhi becomes less frequent at the post-lexical level. By assigning Tone 1 Sandhi variation to sociolinguistic factor of age. This study opens up the possibility that tone sandhi domain variation can be modelled outside phonology and under sociolinguistic framework. Therefore, the issue of tone sandhi domain variation should be seen in a panoramic view where sociolinguistic factors, phonological constraints should be taken into consideration.

1. Introduction

In Mandarin languages, Tone Sandhi is used to indicate phonological tonal change under certain phonological and morpho-syntactic contexts. For example, in Standard Mandarin, a Tone 3 (low tone) becomes Tone 2 (rising tone) before another Tone 3. And this process can optionally be blocked by morpho-syntactic boundaries like the one between subject and predicate (Duanmu 2007; Wang & Lin 2013; inter alia). The issue of tone sandhi domain-building process in Mandarin languages has been extensively researched not only for its complicated patterns, but also for its potential implication to the general theory of phonology and syntax-phonology interface. One of biggest theoretical challenges is how to explain the tone sandhi domain variation at the post-lexical level under the same morpho-syntactic contexts. Two examples of Tone 3 Sandhi (low tone sandhi) in Standard Mandarin are shown in (1). In this paper, to make it easier for the reader, I use number to represent tones in examples, i.e. 3 for Tone 3 instead of 'T3' or simply 'Tone 3'. Here two surface representations (SR1 and SR2) are possible for tri-syllabic utterances with all syllables being underlying Tone 3. It is also worth noting that here each syllable forms a separate word

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by itself, so there is no doubt that there is variation of Tone 3 Sandhi domain at the post-lexical level.

(1) a. o mai tɕiou
1sg buy wine
'I buy wine.'
[[DP][V[DP]]$_{VP}$]$_{TP}$

UR 3 3 3
SR1 2 2 3
SR2 3 2 3

b. li ʈʂau ma
name find horse
'Mr/Mrs. Li finds horses.'
[[DP][V[DP]]$_{VP}$]$_{TP}$

UR 3 3 3
SR1 2 2 3
SR2 3 2 3

Note: UR: Underlying Representation
SR: Surface Representation
I use number after 'SR' to indicate variations in surface representations, in (1), each utterance has two possible surface representations, namely 'SR1' and 'SR2'. Tone 3 is a low tone in Standard Mandarin, and Tone 2 is a rising tone.

To explain the variation issue, multiple efforts have been made inside phonological theory. The earliest attempt is probably Duanmu (2007) where he proposes an extra-mechanism as an addition to the traditional rule-based grammar. This extra-mechanism allows a Tone 3 to undergo tone sandhi before a Tone 2 that is derived from Tone 3, so the theory can correctly predict two surface representations for utterances in (1). The widely-recognized rule-based grammar by Chen (2000) and Shih (1997) is stated in (2), and the derivations for (1a) with and without the extra mechanism are shown in (3). It is clear in (3) that without the extra-mechanism, only one surface representation is predicted, which is opposed to the fact. In contrast, with the extra-mechanism proposed by Duanmu, two surface representations can be correctly predicted. However, to let a Tone 3 undergo tone sandhi before a Tone 2 that is derived from Tone 3, the information of previous steps have to be retrieved, which is an obvious violation of the basic assumption of a modular feed-forward model in traditional formal

phonology (Bermúdez-Otero 2007; Chomsky & Halle 1968; Keating 1996; Pierrehumbert 2002; inter alia).

(2) The Chen (2000) and Shih's (1997) Rule of Tone 3 Sandhi Domain-Building Process at the Post-Lexical Level in Standard Mandarin

a. Build di-syllabic Tone 3 Sandhi domains at the lowest branches.
b. Build di-syllabic Tone 3 Sandhi domains left-to-right for other syllables.
c. Join free syllables to neighboring Tone 3 Sandhi domains.

(3) o mɛ tɕiəɯ
1sg buy wine
'I buy wine.'
[[DP][V[DP]]$_{VP}$]$_{TP}$

Derivation without extra-mechanism

UR	3 3 3
Lowest Branch	3(2 3)
Free Syllables Joining	(3 2 3)
SR1	3 2 3

Derivation with extra-mechanism

UR	3 3 3
Lowest Branch	3(2 3)
Free Syllables Joining	(3 2 3)
Optional Rule	(2 2 3)
SR1	3 2 3
SR1	2 2 3

In another attempt the explain the variation issue, Wang and Lin (2013) employ Coetzee's (2006) model under the Optimality Theory framework (Prince & Smolensky 2008). According to Coetzee, there is a clear cut-off line in tableau. The constraints below such line does not rule out candidates. Therefore, in many cases multiple candidates can be selected by one single tableau. To give a simple example, in (4), there are two candidates (1 and 2) and three constraints (A, B and C). The ranking of the constraint is Constraint A >> Constraint B >> Constraint C, and the cut-off line is between Constraint B and C. The number of asterisks correlates with how many times a constraint gets violated in all following examples. The two candidates have the same violation condition for Constraint A and B while Candidate 1 violates Constraint C for one more time than Candidate 2.

However, since Constraint C is below the cut-off line, this constraint cannot rule out candidates. As a result, Candidate 1 and 2 are both selected by this tableau.

(4)

Cut-off line ↓

	Constraint A	Constraint B	Constraint C
→Candidate 1	**	*	**
→Candidate 2	**	*	*

With this theoretical tool, I will then go to the proposal by Wang and Lin. The full set of constraints proposed by Wang and Lin is rather complex, I only present here what is essential in their theory and also relevant to the current discussion. The two constraints that are essential and relevant are Match constraint and identity constraint ID(T), which are stated in (5).

(5) Two Constraints

Match: For each prosodic domain, there must be some syntactic constituent that matches with it. If a proposed domain does not have a syntactic domain that matches it, assign a violation mark.

ID(T): The tone in the output is faithful to its tone in the input.

Crucially, Wang and Lin suggests ID(T) is below the cut-off line that can rule out candidates and Match constraint is above the line. For the two surface representations in (1a), their violation conditions are shown in the tableau in (6). Remember the syntactic structure for the utterance in (1a) is $[[DP][V[DP]]_{VP}]_{TP}$. Therefore, '(2 2 3)' violates the Match constraint for three times for not matching the two DPs and the VP, '3 (2 3)' also violates Match constraint for three times for failing to match the first DP, the VP and the TP. The underlying representation is '3 3 3', so '(2 2 3)' violates ID(T) twice while '3 (2 3)' violates for once. Although the two candidates have different violation conditions for ID(T), they are both selected by the tableau since ID(T) does not function to rule out candidates.

(6)

Cut-off Line ↓

	Match	ID(T)
(2 2 3)	***	**
3 (2 3)	***	*

Despite all these efforts of explaining variation inside phonology, an unanswered question of previous studies is whether variation should only be modelled inside grammar. In other words, can variation be caused by performance factors like speech rate or sociolinguistic factors like age? The current paper probes the question of whether tone sandhi variation can be assigned to sociolinguistic factor of age. Since Tone 3 Sandhi are widespread inside Mandarin languages, the variation may be due to dialectal difference (Chen 2000; Shih 2013; inter alia). The current paper investigates one unique tone sandhi process in Huai'an dialect of Jianghuai Mandarin (Huai'an hereafter). In Huai'an, Tone 1 (high falling tone) becomes Tone 3 (low/low rising tone) before another Tone 1. Based on the apparent time and real time data of tone sandhi patterns of Huai'an, this paper argues that (i) as ages increases, speakers apply Tone 1 sandhi more frequently at the post-lexical level, and (ii) this phenomenon should be categorized as lifespan change (Sankoff 2008) due to the ongoing diachronic change at the community level where Tone 1 sandhi becomes less frequent at the post-lexical level.

2. Background

Huai'an has four phonemic tones, they are conveniently labelled as Tone 1, Tone 2, Tone 3 and Tone 4. In Table 1, the four tones are given in a contour description by words.

Phonemic Tone	Contour Description
Tone 1	high falling
Tone 2	high rising
Tone 3	low/low rising
Tone 4	high level

Table 1. Descriptions of phonemic tones in Huai'an

The Tone 1 Sandhi rule is shown in (7). A Tone 1 optionally becomes Tone 3 before another Tone 1. According to Du and Lin (2019), this rule is optional at the post-lexical level across the boundary between verb and object as shown in (8).

(7) High-Register Tone Sandhi

1 + 1 → 3 + 1

(8) tin in
listen sound
'to listen to some sounds'

UR	1 1
SR1	3 1
SR2	1 1

As a contrast, in Standard Mandarin, a falling tone (Tone 4) does not undergo tone sandhi before another underlyingly identical tone. Previous literature has shown the dramatic influence of Standard Mandarin on other dialects (languages) inside the Mandarin language family (Duanmu personal communication) and even on neighboring language families (Duanmu personal communication; Gao 2017; Zhang & Meng 2016). The general trend is that other dialects (languages) become more and more similar with Standard Mandarin and therefore lose their unique phonological processes and features. If Huai'an is not exempt from this general trend, then at the community level, Tone 1 sandhi should become less frequent over generational time. This prediction has been testified by the experiment that I will introduce in the next section.

3. Methods, Analysis and Result

For this section, I will provide details of the experiment.

3.1. Participants

I recruited 10 native speakers of Huai'an Mandarin by personal relations in Huai'an City. The age range is from 31 to 58 years old. Among them, 4 are female, 6 are male. All the participants are born and raised in Huai'an City.

3.2. Stimuli

The stimuli are only composed of tri-syllabic sentences with each syllable forming a separate word. Therefore, we can be sure that the process is truly post-lexical and productive. The stimuli are divided into two sets as shown in (9). The rightmost syllables are always Tone 1. The middle syllables are also always Tone 1 that can optionally undergo Tone 1 Sandhi to become Tone 3. The first syllables can be underlyingly Tone 3 that can undergo Tone 3 Sandhi to become Tone 2 with reference to the middle syllables which are derived Tone 3 from Tone 1, the first syllable can also be underlyingly Tone 2 that does not undergo any tone sandhi in Huai'an. The full stimuli list is summarized in Appendix 1.

(9) Two sets of rest stimuli

a. Tone 2 as the subject: /2 1 1/ → [2 3 1] or [2 1 1]

b. Tone 3 as the subject: /3 1 1/ → [2 3 1] or [3 1 1]

Each participant produced 6 repetitions of 10 test sentences at natural speech rate with 10 fillers, which means the total number of utterances a participant has read is 120.

3.3. Procedure

Each participant was recorded by a trained research assistant in a quiet room that was either located in the participants' homes or workplaces using audacity (version 2.3.2) and a Popu Line BK USB microphone on a Lenovo laptop. The participants were instructed to read under normal rate using their everyday voice. The participants were also encouraged to read through the stimuli list to be familiar with the reading materials before producing them.

3.4. Analysis

The data was impressionistically annotated by a native speaker and the accuracy was checked by a 94.6% matching rate with the judgements by another native speaker on 100 tokens. The data for each speaker is summarized in Table 2 and the overall result is shown in Figure 1 and Table 3. I count ambiguous a token that is somewhat between a sandhi tone and the underlying tone as 0.5, so not all numbers in the third column of Table 2 are integers. In Figure 1, a linear model is fit for dots that represent speakers. The summary of the linear model is shown in Table 3.

The linear model suggests the existence of positive correlation between age and the frequency of Tone 1 Sandhi application ($p < 0.05$). This means that as a speaker ages, he/she/they tends to apply Tone 1 Sandhi more frequently. It is also worth noting that the slope is steep for the linear model (1.437). There are just a few cases of young speakers under the age 40 applying Tone 1 Sandhi. In contrast, speakers over 50 apply Tone 1 Sandhi in at least 37.7% of the tokens. This finding is further confirmed by comparing one single speaker's speech in 1986 and 2018 where he applied Tone 1 Sandhi in one token in 1986 (China Central Television 1986) but not in another token in 2018 (Huai'an Television 2018).

Speaker	Age	Tone Sandhi tokens	No Tone Sandhi tokens	Tone Sandhi rate (%)
1	41	2.5	47	5.32
2	36	1	49	2.04
3	31	8	48	16.67
4	35	6.5	48	13.54
5	49	12.5	48	26.04
6	51	24.5	44	55.68
7	40	26	47	55.32
8	58	18	48	37.5
9	56	28	48	58.33
10	51	16	48	33.33

Table 2. Individual result for the experiment

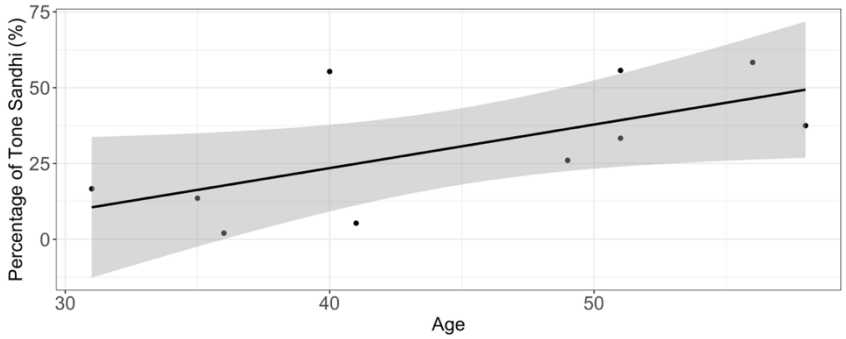

Figure 1. The correlation between age and the percentage of applying T1 sandhi at the post-lexical level

	Estimate	Standard Error	t value	Pr(>|t|)
(intercept)	-33.990	27.944	-1.216	0.259
age	1.437	0.612	2.349	0.047*

Table 3. Summary of linear model

4. Conclusion

As an initial step to probe sociolinguistic factors on tone sandhi domain variation, the current study provides substantial experimental evidence for the correlation between the factor of age and the variation of Tone 1 Sandhi domain in Huai'an. By assigning Tone 1 Sandhi domain variation to sociolinguistic factor of age, this study opens up the possibility that tone sandhi domain variation can be modelled outside phonology and under sociolinguistic framework. Therefore, the issue of tone sandhi domain

variation should be seen in a panoramic view where sociolinguistic factors, phonological constraints and other performance factors should all be taken into consideration.

In the future, follow-up studies are solely needed to prove that the finding of the current study is not false positive. For future studies, I suggest exploring a wider age range of 18-80. I also suggest exploring potential effect from gender on tone sandhi domain variation. From my experience in data collecting, female speakers tend to build smaller domain than male speakers and this intuition remains to be confirmed by future experimental studies.

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APPENDICES

Appendix 1: "Stimuli for the experiment"

IPA	Pinyin	UR	SR	Vowel	Type
u pa tɕi	wubache	211	211/231	a	Tone 2 as subject
u ku fən	wugufen	211	211/231	u	Tone 2 as subject
u ta tɕi	wudache	211	211/231	a	Tone 2 as subject
u pa xa	wubaxia	211	211/231	u	Tone 2 as subject
u pɔ tɕi	wubaoche	211	211/231	ɔ	Tone 2 as subject
u pa tɕi	wobache	311	311/231	a	Tone 3 as subject
u ku fən	wogufen	311	311/231	u	Tone 3 as subject
u ta tɕi	wodache	311	311/231	a	Tone 3 as subject
u pa xa	wobaxia	311	311/231	u	Tone 3 as subject
u pɔ tɕi	wobaoche	311	311/231	ɔ	Tone 3 as subject