

Morphosyntax-Prosody Mismatch in Beijing Mandarin: Evidence from Retroflex Lenition

Richard Wang

1. Introduction

Lenition is a process in which consonants become more sonorous with wider constrictions (Kingston 2008). In Beijing Mandarin, there exists a lenition process where the retroflex obstruents /ʂ/ [ʂʰ] in the onset variably change into a retroflex approximant [ɹ], increasing in sonority. An example is given in (1), where a word-medial syllable with a retroflex obstruent onset (henceforth, retroflex syllable) undergoes lenition. This phenomenon is mostly observed in fast speech and casual speech style.

- (1) /p^hai ʂ^hu swo/ → [p^hai ɹu swo] ‘police station’

In this paper, I will focus on the question of where retroflex lenition can occur in Beijing Mandarin. In (2), we see that although the same retroflex obstruent is in the same segmental (u_a) environment, it undergoes lenition in (2b) but not in (2a). This suggests that retroflex lenition is not triggered by a particular segmental environment.

- (2) a. /tʂ^hu ʂ^ha ji ʂʒ/ → [tʂ^hu ʂ^ha ji ʂʒ] ‘exit the tea room’
b. /tu ʂ^ha tey ʂaŋ/ → [tu ɹa tey ʂaŋ] ‘chief of the inspection bureau’

Morphosyntactic structures appear to affect where lenition can occur. Below in (3), we see two examples where retroflex syllables in the same (peninitial) position can (3a) or cannot (3b) undergo lenition in different morphosyntactic structures.

- (3) a. /[[tu ʂʒ]_{NP} [[ʂ^hwuan ʂwuo]_{NP}]_{NP} / → [tu ɹʒ ʂ^hwuan ʂwuo] ‘urban legend’
b. /[k^han [[ʂʒ teje] _{NP} pei]_{VP} / → [k^han ʂʒ teje pei] ‘watch World Cup’

However, counterexamples are listed in (4), where lenition can occur in any morphosyntactic positions: initial, final and medial. This suggests that lenition is not triggered directly at a fixed morphosyntactic position.

- (4) a. Initial position: /pu [ʂʒ tau]/ → [pu ɹʒ tau]. ‘not know’
b. Medial position: /[pwo ʂʒ tun]/ → [pwo ɹʒ tun] ‘Boston’
c. Final position: /[teɪŋ ʂ^ha tey]/ → [teɪŋ ɹa tey] ‘police station’

To resolve the conflicting observations in (3) and (4), I will argue that retroflex lenition is conditioned by prosodic structures, which are influenced by, but not perfectly mapped from morphosyntactic structures in Beijing Mandarin. In other words, there is a morphosyntax-prosody mismatch. This explains why morphosyntax appears to influence lenition sites in (3), but retroflex lenition does not occur at a fixed morphosyntactic position in (4).

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I should also note that retroflex lenition itself is a phonetic process, sensitive to segment duration, and not directly linked to stress or prosodic positions. Rather, stress is one of the factors that can affect duration, among other factors. In this paper, I will only discuss the prosodic factor that triggers lenition, i.e., retroflex syllables on prosodically unstressed positions are realized as phonetically short and can lenite. I will not discuss the phonetic details of retroflex lenition, as well as other factors like lexical frequency and speech rate.

So far, I have been referring to both morphological and syntactic structures with respect to lenition. Importantly, both morphological compounds and syntactic phrases behave identically to lenition when they have the same hierarchical structures. This is shown in example (5), where one morphological compound (5a) and one syntactic phrase (5b) with a retroflex syllable in the same position both undergo lenition in the same position.

- (5) a. /[[[tu tʂʰa]NP tɛy]NP [ʂaŋ]NP/ → [tɛiŋ ɹa tɛy [ʂaŋ] ‘chief of the inspection bureau’
 b. /[[[tɛjan tʂʰa]V ʂwei]NP tɛʰy]VP/ → [tɛjan ɹa ʂwei tɛʰy] ‘go check the water’

In the following sections, I will provide an analysis to derive the prosodic structures for disyllabic, trisyllabic and tetrasyllabic structures along with the lenition sites. I present evidence that lenition is best analyzed with recursive foot structures, and demonstrate that Optimality Theory with strict ranking (Prince & Smolensky 2004) fails to derive prosodic structures which predict the observed lenition sites. Instead, I use Harmonic Grammar (Legendre et al. 1990, Smolensky & Legendre 2006, Potts et al. 2010 among others) to capture the lenition patterns and resolve a gang effect (Farris-Trimble 2008, a.o.).

2. Analysis

2.1. Evidence of foot structure

Before we dive into the analysis, there are additional conditions retroflex lenition is subject to. First, lenition never occurs in initial positions, as shown in (6).

- (6) /tʂaŋ lau ʂz/ → [tʂaŋ lau ʂz] / *[ɹaŋ lau ʂz] ‘Teacher Zhang’

Another observation is that lenition cannot occur in adjacent positions, as shown in (7).

- (7) /waŋ ʂaŋ tʂaŋ tɛja/ → [waŋ ɹaŋ tʂaŋ tɛja] / *[waŋ ɹaŋ ɹaŋ tɛja] ‘Governor Wang’s home’

I propose that these two observations are better analyzed as that the lenition domain is the weak branch of a binary foot, and more specifically, a trochee. Lenition occurs on the weak syllable of the trochee. This captures the fact that lenition cannot occur initially, as a trochee never starts with a weak beat. And the reason why lenition does not occur in adjacent syllables is because two weak beats of a binary foot cannot be adjacent to each other. Many existing analyses of Mandarin prosody also support the concept of trochaic footing (Duanmu 2007 and references within).

In (3), we see that different trisyllabic structures all have the same medial lenition site. This leads to another possible analysis where the domain of retroflex lenition is a ternary foot, and the medial syllable is unstressed and a possible lenition site. However, as we see in (8) below, lenition can occur in the final position when the retroflex syllable carries a neutral tone. A flat ternary foot structure cannot capture this shift of lenition site unless we also stipulate that the final syllable of a ternary foot is also a prosodically weak position and thus a possible lenition site. But this would predict lenition can occur in adjacent positions, which is not what we observe, as shown in (8a). On the other hand, a binary trochee can account for this pattern, where the final retroflex syllable is footed on the unstressed position and the syllable immediately precedes it is stressed, as shown in (8b). Thus, it demonstrates that the lenition’s immediate domain is a binary trochee.

- (8) /pu51 ʂz35 tʂʰaŋ/ ‘not honest’
 a. Flat ternary foot: *(pu51 ɹz35 ɹaŋ)
 b. Binary trochee: pu51 (ʂz35 ɹaŋ)

Furthermore, as mentioned earlier, morphological and syntactic structures with the same hierarchical bracketing are analyzed in the same way with regards to lenition. This requires us to make a stipulation that feet can form across both morphological and syntactic boundaries.

2.2. *OT analysis*

In the previous section, I propose that lenition occurs on the weak syllable of a foot. In this section, I will detail the analysis first in classical OT to derive the prosodic structures to predict lenition sites for disyllabic and trisyllabic structures and then show it is not enough for tetrasyllabic structures. There is a gang effect between PARSE- σ , ALL-FT-LEFT and MATCH constraints that can only be resolved in an alternative framework, such as Harmonic Grammar, along with recursive footing.

2.2.1. *Disyllabic structures*

As proposed earlier, lenition site is the unstressed syllable of a trochee. Then by default, all disyllabic words shall have the same lenition site on the final syllable, as shown in (9).

- (9) /teinj tʂ^ha/ → (ˈteinj ɹa^l) ‘police’

2.2.2. *Trisyllabic structures*

In (3a-c) (repeated in 10a-c), we see that only the medial position is a possible lenition site, which I propose is because all three types of trisyllabic structures have the same footing, determined through constraint interaction between ALL-FT-LT (definition given in (11)) and MATCH.

- (10) a. /pu [tʂɹ tau]/ → [(ˈpu ɹɹ) tau] ‘not know’
 b. /[pwo ʂɹ tun]/ → [(ˈpwo ɹɹ) tun] ‘Boston’
 c. /[teinj tʂ^ha tey]/ → [(ˈteinj ɹa) tey] ‘police station’

- (11) ALL-FT-LT: Assign a violation for each syllable that separates the left edge of a (minimal²) foot from that of a prosodic word in the output. (McCarthy & Prince 2001)

The original MATCH constraint proposed in Selkirk (2011), listed in (11), requires specific label mapping, e.g., syntactic word to prosodic word.

- (12) *Category-specific MATCH constraints* (Selkirk 2011:5)
 MATCHWORD: A word in syntactic constituent structure must be matched by a corresponding prosodic constituent, call it ω , in phonological representation.

However, the key claim in my analysis is about structures: compounds and syntactic phrases appear to receive the same prosodic parse when they have the same hierarchical structures. For an example in (13), under the definition of the category-specific MATCH constraint, both NP₁ and NP₂ need to match to a prosodic word ω (13a). This specific syntax-prosody mapping fails to capture the mapping between syntactic word to foot, which is crucial in capturing lenition sites as illustrated in (13b).

- (13) [[teinj tʂ^ha]_{NP1} tey]_{NP2} ‘police+station’
 a. *[[teinj tʂ^ha] _{ω} tey] _{ω}
 b. [(ˈteinj ɹa)_F tey] _{ω}

¹ The final syllable in a prosodic domain is often subject to final lengthening (Paschen et al. 2022), which makes retroflex lenition less likely to occur.

² See discussion later.

Thus, I propose an updated category-general version of MATCH (14a-b) which are capable of matching either morphological compounds or syntactic structures to prosodic structures, without specific label mapping.

(14) *Category-general MATCH constraints*

- a. MATCH(M-S,Π): Assign a violation for each morphosyntactic constituent M-S that does not have a corresponding prosodic constituent π .
- b. MATCH(Π, M-S): Assign a violation for each prosodic constituent π that does not have a corresponding morphosyntactic constituent M-S.

For example, in (15), a left-branching morphosyntactic structure (in brackets) can be mapped to a prosodic structure (15b) without referring to labels. This satisfies the category-general MATCH(M-S,Π) constraint. To make sure forms in (15b) are ruled out, I assume a highly ranked constraint HEADEDNESS (16) (Selkirk 2014) so that a prosodic word ω always needs to dominate at least one foot.

(15) Morphosyntactic: $[[\sigma \sigma] \sigma]$

- a. Prosodic: $((\sigma \sigma) \sigma)$
- b. Prosodic: $*((\sigma \sigma)_\omega \sigma)_\omega / *((\sigma \sigma)_\omega \sigma)_F$

(16) HEADEDNESS: Assign a violation for each ω that does not dominate any foot in the output.

In tableau (18), we see candidates with degenerate (18c) and ternary foot (18d) get eliminated due to violations of the undominated FTBIN(σ) (definition shown in 17a), though they satisfy PARSE- σ (17b) better. The winner (18a) satisfies ALL-FT-LT while violating both MATCH constraints, the opposite of candidate (18b). This shows the constraint ranking that ALL-FT-LT outranks both MATCH constraints. Lenition sites are underlined.

(17) *OT constraints* (McCarthy & Prince 2001)

- a. FTBIN(σ): Assign a violation for each non-binary branching foot in the output.
- b. Parse- σ : Assign a violation for each unfooted syllable in the output.

(18)

$[\sigma \underline{\sigma} \sigma]$	FTBIN(σ)	PARSE- σ	ALL-FT-LT	MATCH (M-S,Π)	MATCH (Π, M-S)
☞ a. $[(\sigma \underline{\sigma} \sigma) \sigma]_\omega$		*		*	*
b. $[\sigma (\sigma \underline{\sigma})]_\omega$		*	*W	L	L
c. $[(\sigma) (\sigma \underline{\sigma})]_\omega$	*W	L	*W	L	*
d. $[(\sigma \sigma \sigma)]_\omega$	*W	L		*	L

In the left branching trisyllabic structure in (19), candidate (19a) satisfies both ALL-FT-LT and two MATCH constraints and harmonically bounds candidate (19b).

(19)

$[[\sigma \underline{\sigma}] \sigma]$	FTBIN(σ)	PARSE- σ	ALL-FT-LT	MATCH (M-S,Π)	MATCH (Π, M-S)
☞ a. $[(\sigma \underline{\sigma} \sigma) \sigma]_\omega$		*			
b. $[\sigma (\sigma \underline{\sigma})]_\omega$		*	*W	*W	*W

2.2.3. *Tetrasyllabic structures*

Next, for tetrasyllabic structures, I will first show that using binary trochees alone cannot account for the observed lenition patterns, and neither can OT with strict domination derive prosodic structures which correctly predict the observed lenition sites. Foot recursion and an analysis in Harmonic Grammar are both necessary to derive the prosodic structures that capture the observed lenition sites.

First, in tableau (18), since ALL-FT-LT outranks both MATCH constraints, for (20a) to surface as the winner, PARSE- σ needs to outrank ALL-FT-LT, as illustrated in the pairwise comparison between (20a-b) and (20a-c). This shows a preference in the grammar to have iterative footing, which satisfies PARSE- σ better, than to have a single left-aligned foot, which satisfies ALL-FT-LT better.

(20)

$[\sigma \underline{\sigma} [\sigma \underline{\sigma}]]$	PARSE- σ	ALL-FT-LT	MATCH (M-S, Π)	MATCH (Π , M-S)
☞ a. $[(\sigma \underline{\sigma}) (\sigma \underline{\sigma})]_{\omega}$		**	*	*
b. $[(\sigma \underline{\sigma}) \sigma \sigma]_{\omega}$	**W	L	**W	*
c. $[\sigma (\sigma \underline{\sigma}) \sigma]_{\omega}$	**W	*L	**W	*
d. $[\sigma \sigma (\sigma \underline{\sigma})]_{\omega}$	**W	**	*	L

Next, for the structure in tableau (21), because of the higher-ranked PARSE- σ and ALL-FT-LT, all syllables in the winner (21b) are footed, and the prosodic word starts with a foot. However, this prosodic structure predicts the peninitial and final syllable to be lenition sites (weak syllable of a trochee), as opposed to the penultimate syllable which is the observed lenition site (underlined in the input). In fact, all tetrasyllabic structures with different morphosyntactic bracketing will surface as $[(\sigma \underline{\sigma}) (\sigma \underline{\sigma})]_{\omega}$, with identical lenition sites (underlined) under this constraint ranking because of the higher-ranked PARSE- σ and ALL-FT-LT and the lower-ranked MATCH constraint. This is not what we observe: not all tetrasyllabic structures have the same lenition sites.

(21)

$[\sigma [[\sigma \underline{\sigma}] \sigma]]$	PARSE- σ	ALL-FT-LT	MATCH (M-S, Π)	MATCH (Π , M-S)
☹ a. $[\sigma (\sigma \underline{\sigma}) \sigma]_{\omega}$	**	*	*	
☞ b. $[(\sigma \underline{\sigma}) (\sigma \underline{\sigma})]_{\omega}$	L	**W	**W	**W

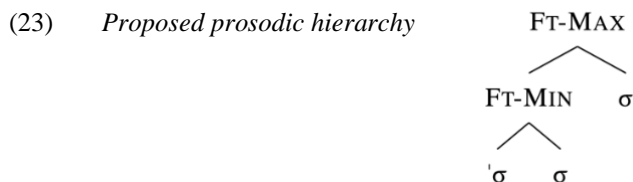
Here, we run into a ranking paradox, where PARSE- σ needs to outrank ALL-FT-LT in (20) to derive the correct winner, whereas in (21), the opposite ranking relation is required. To resolve this paradox, I propose that we need to first introduce a new prosodic structure and provide an analysis in different framework than classical OT.

Previous literature has argued for the existence of the ternary foot in Mandarin. In Middle Chinese poetry, the number of syllables in a line is always odd-numbered, either five or seven. The rhythm pattern is shown in (22), with both binary and ternary units.

(22) *Poetic meter pattern in Middle Chinese poetry* (Duanmu 2007)

- a. 5-syllable: $(\sigma \sigma) (\sigma \sigma \sigma)$
- b. 7-syllable: $(\sigma \sigma) (\sigma \sigma) (\sigma \sigma \sigma)$

Thus, I propose that there is a ternary unit above the level of the binary foot and below the level of the prosodic word, which I term the MAXIMAL FOOT³ (Itô & Mester 1992, Bennett 2013, among others). This unit is derived through foot recursion, where a maximum foot is defined to be a foot not dominated by any foot, and a minimal foot does not dominate any foot. The proposed prosodic hierarchy is shown in (23), which is left-branching. A right-branching recursive, maximal foot is also possible.



Within a recursive foot like (23), I will assume the weak syllable of a minimal foot is the weakest, followed by the weak syllable of a maximal foot, and the strong syllable of a minimal foot is the strongest, following Kager & Martínez-Paricio (2018). As discussed earlier, a ternary foot without any internal structure cannot account for the lenition pattern in (8), so the existence of layered feet is crucial for the current analysis. One thing to note is that a minimal foot on its own is also a maximal foot, as it does not dominate nor is dominated by any foot.

Now, notice that the recursive $[\sigma ((\sigma \underline{\sigma})_{\text{FT-min}} \sigma)_{\text{FT-max}}]_{\omega}$ in (24a) has fewer violations of PARSE- σ and both MATCH constraints than $[\sigma (\sigma \underline{\sigma}) \sigma]_{\omega}$ in (21a), while still correctly predicting the relevant lenition sites, under the assumption that lenition targets minimal feet. This makes $[\sigma ((\sigma \underline{\sigma})_{\text{FT-min}} \sigma)_{\text{FT-max}}]_{\omega}$ a relatively viable candidate. However, we see that classical OT still fails to select a winner that predicts the observed lenition site in recursive candidates, because the violation in the highest-ranked PARSE- σ still immediately eliminates (24a). As shown in tableau (24), the winner (24b) predicts the lenition site to be the peninitial syllable, whereas the actual lenition site is the penultimate syllable as underlined in the input.

(24)

$[\sigma [[\sigma \underline{\sigma}] \sigma]]$	PARSE- σ	ALL-FT-LT	MATCH (M-S,II)	MATCH (II, M-S)
⊖ a. $[\sigma ((\sigma \underline{\sigma})_{\text{FT-min}} \sigma)_{\text{FT-max}}]_{\omega}$	*	*		
⊙ b. $[(\sigma \underline{\sigma})_{\text{FT-min}} (\sigma \underline{\sigma})_{\text{FT-min}}]_{\omega}$	L	**W	**W	**W
c. $[(\sigma \underline{\sigma})_{\text{FT-min}} \sigma]_{\text{FT-max}} \sigma]_{\omega}$	*	L	**W	**W

Comparing the observed form (24a) and the winner (24b), we see that (24a) violates the higher-ranked PARSE- σ but does better on the lower-ranked ALL-FT-LEFT, MATCH(M-S,II) and MATCH(II, M-S). Similarly, when comparing (24a) and (24c), the observed output violates a higher-ranked ALL-FT-LEFT but does better on the lower-ranked MATCH(M-S,II) and MATCH(II, M-S). Therefore, for (24a) to surface as the winner, we want it to be the case that violating the higher-ranked constraints once is better than violating the lower-ranked constraint(s) multiple times, also known as a gang effect. Classical OT cannot account for this pattern. I will provide an analysis in Harmonic Grammar, which can capture the pattern with weighted constraints. A tableau with weighted constraints is shown in (25) and the weighting relations in (26) select a winner that correctly predicts the lenition site for this input.

³ According to the definition of FTBIN(σ) in (13a), maximal feet only contain binary-branching feet and thus satisfy that constraint (see Bellik & Kalivoda 2015 for more discussion on the branchingness violation in feet).

(25)

$[\sigma \text{ [[}\sigma \underline{\sigma} \text{]}\sigma \text{]}]$	PARSE- σ 9	ALL-FT-LT 7	MATCH (M-S, Π) 3	MATCH (Π , M-S) 3	\mathcal{H}
☞ a. $[\sigma \text{ ((}'\sigma \underline{\sigma})_{\text{Ft-min}} \sigma)_{\text{Ft-max}}]_{\omega}$	-1	-1			-16
b. $[(\text{'}\sigma \underline{\sigma})_{\text{Ft-min}} (\text{'}\sigma \underline{\sigma})_{\text{Ft-min}}]_{\omega}$		-2	-2	-2	-26
c. $[((\text{'}\sigma \underline{\sigma})_{\text{Ft-min}} \sigma)_{\text{Ft-max}} \sigma]_{\omega}$	-1		-2	-2	-21

(26) *Constraint weighting relations in (25)*

- a. $W(\text{PARSE-}\sigma) < W(\text{ALL-FT-LT}) + 2*W(\text{MATCH}(\text{M-S},\Pi)) + 2*W(\text{MATCH}(\Pi, \text{M-S}))$ (21a vs. 21b)
 b. $W(\text{ALL-FT-LT}) < 2*W(\text{MATCH}(\text{M-S},\Pi)) + 2*W(\text{MATCH}(\Pi, \text{M-S}))$ (21a vs. 21c)

Next, I show that only adopting the HG analysis without using foot recursion does not generate the correct winner, as illustrated in (27). The observed output (27a) still loses to (27b) because (27a) violates the highest-ranked PARSE- σ too many times that its harmony is lower than (27b) that has more violations in the lower-ranked constraints. That is why foot recursion is necessary, because it allows the winner to have fewer PARSE- σ violations and makes sure its harmony is lower than candidates that have more violations in the lower-ranked constraints ALL-FT-LEFT, MATCH(M-S, Π) and MATCH(Π , M-S).

(27)

$[\sigma \text{ [[}\sigma \underline{\sigma} \text{]}\sigma \text{]}]$	PARSE- σ 9	ALL-FT-LT 7	MATCH (M-S, Π) 3	MATCH (Π , M-S) 3	\mathcal{H}
⊗ a. $[\sigma (\text{'}\sigma \underline{\sigma}) \sigma]_{\omega}$	-2	-1	-1		-25
☛ b. $[(\text{'}\sigma \underline{\sigma}) (\text{'}\sigma \underline{\sigma})]_{\omega}$		-1	-2	-2	-19
c. $[(\text{'}\sigma \underline{\sigma}) \sigma \sigma]_{\omega}$	-2		-2	-1	-27

In sum, we need both foot recursion and the HG analysis to capture the observed lenition sites.

3. Theoretical implications and future directions

In this paper, I examine a phonetic process, retroflex lenition, to look back into the phonological factors that affect duration, namely stress. This provides a new avenue to probe phonological structures using processes sensitive to phonetic properties, in languages in which stress is not distinctive. While many existing sources using native speaker judgments to report stress positions in Mandarin are variable and lacks consistency, speakers' judgment on the lenition site is more robust, and thus we can examine phonetically and prosodically weak positions in Mandarin more systematically (for discussion of Mandarin stress, see Duanmu 2000, Duanmu 2007 and references within).

In the analysis of lenition sites, we have seen that there is a morphosyntax-prosody mismatch in the language. This is also an area that has not been thoroughly studied in Mandarin. Little has been said about whether the prosodic hierarchy exists in the language, or about the criteria that distinguish the levels foot, prosodic word and phonological phrase. In this paper, I use category-general MATCH constraints to match both morphological and syntactic units to prosodic units, given that they share the same tree structure. This is different than what we see in languages like English, where morphological compounds and syntactic phrases behave differently with regards to stress assignment (Hayes 1995). Yet, wordhood is a murky subject in Mandarin, as each syllable can usually be a morpheme and also join to form new morphemes together (Duanmu 1998). However, the idea of treating morphology and syntax as the same is not new, and can find its way back to DISTRIBUTED MORPHOLOGY (Harley & Royer 1999). Whether they are treated the same with respect to prosody needs more careful examination and cross-linguistic evidence.

One other contribution of this paper is that I propose that foot recursion exists in Mandarin, and the maximum number of syllables a foot can have in Mandarin is three. Although it has been previously proposed that ternary footing exists in the language (Shih 1997), the recursive foot analysis is a new contribution for Mandarin. A valuable future step is to look for other processes that target this recursive foot to validate its existence. Since now I have proposed the phonological domain for retroflex lenition, under the theory of DOMAIN CLUSTERING, there should be other phonological phenomena that target the same domain (Inkelas & Zec 1990). I plan to examine a famous domain-sensitive process, Tone 3 Sandhi, in Mandarin and compare their structures.

Lastly, retroflex lenition is essentially a phonetic phenomenon, and shows gradience across speakers, meaning its production varies across different speech rates and is sensitive to lexical frequency. For example, the same retroflex syllable [ʂʐ] in a more frequently used word (28a) is more likely to lenite than in a less frequent word (28b), although both retroflex syllables are in an unstressed position.

- (28) a. /ku ʂʐ xwei/ → [((('ku ɻʐ)_{Ft-min} xwei)_{Ft-max}] 'story-telling circle'
 b. /kuŋ ʂʐ te^hjau/ → ?[((('kuŋ ɻʐ)_{Ft-min} te^hjau)_{Ft-max}] 'arch-shaped bridge'

It is also not clear whether or how much of the tone on the retroflex syllable still remains after lenition, and how syllables are realized differently in different prosodic positions. To better understand the mechanisms driving lenition and the prosodic structures in Mandarin, a phonetic study is necessary.

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