Title of manuscript:
Casual Speech Elision of Tianjin Trisyllabic Sequences♠

Name of author:	WEE, Lian Hee
Affiliation:	Hong Kong Baptist University
Address:	Department of English Language and Literature. Hong Kong Baptist University. Hong Kong, SAR.
Email :	lianhee@hkbu.edu.hk

Abstract

In the Tianjin dialect, casual utterance of familiar trisyllabic sequences induces deletion of phonological segments, which interacts with the rich Tianjin tone sandhi system. This paper explains that Casual Speech Elision (CSE) is the result of syllable mergers triggered by mora deletion. Sonority peak requirements determine the kind segments retained and the vowel coalescence patterns found in CSE. Since tone features hang off the mora, CSE could set off derived sandhi-triggering sequences in this sandhi-rich dialect. The intricate patterns here bring to the foreground the gaps in earlier analyses of Tianjin tone sandhi, leading to an account that shows how a combination of OCP constraints and iambicity based on tonal complexity can provide a fuller account with OT devices of comparative markedness and constraint conjunction.

Keywords:

Casual Speech Elision, Sandhi, Coalescence, Comparative Markedness, Constraint conjunction, Tianjin

1.   Introduction

Casual and allegro speech is often garbled, perhaps best characterized by some kind of truncation or elision to the "original" word string of more careful or normal utterances. English provides us with many familiar examples like *wanna* and *gotta* from "want to" and "got to" respectively. In these cases, the /t/ (two of them in fact) is elided followed by the spreading of /n/ to form the onset of the following syllable in the case of *wanna* (for more data, see Labov 1969; Selkirk 1972; Pullum 1997 and references therein). For languages like English, the patterns of elision are confined to the segments/phones involved, but for tonal languages the situation is further complicated by the presence of lexical tone. This paper explores one such tonal language, the Tianjin dialect of the Northern Mandarin genus, where Casual Speech Elision (henceforth CSE) is common and highly productive, and where there is a complex system of tonal alternation. Some data exemplifying the object of this study is presented in (1), using capitalized letters to denote the tonal contour on each syllable: R = rising, F = falling, L = Low, H= high.

(1)   Tianjin Casual Speech Elision
  a.   /ɕauR ɕiL kuanL/[1]   "little west fort"
     → [ɕɔiR kuanL]
  b.   / kuŋF tsʰanR taŋR/   "Communist Party"
     → kuanH taŋR
  c.   / tɕʰɛL tsʰaiF tauL /   "cleaver"
     → [tɕʰɛR tauL]

As may be in seen in (1), a number of things seem to be happening all at once. Firstly, there is the alternation of tones from the input string to the output string. Secondly, there is the loss of segments which is the character of CSE. In the cases shown here, trisyllabic strings are reduced to disyllabic ones presumably following the loss of consonants intervening between the initial and medial syllables of the input strings. Thirdly, there is also the change of segmental quality so that we see [ɔ] in the output of (1a) where there was no such phone in the input string. These three observations may be reduced to the interaction of two main sub-patterns of the suprasegmental level, where tone sandhi occurs and the segmental level where elision and syllable merging happen.

  In trying to provide an account for Tianjin CSE, including the relevant tone sandhi patterns, this paper argues for the following claims.

(2)   Main claims of the paper
  a.   The syllable structure of Tianjin is derivable by a set of mapping constraints between the melodic (features) tier, skeletal/root tier and the mora;
  b.   Contour tones are the result of simple tone features associated to the mora in Tianjin;
  c.   Elision applies to the mora, consequently suppressing the manifestation of phonemes;

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[1] Readers familiar with Mandarin dialects might contend that there should be a medial glide [i], so [ɕau] should have been [ɕiau]. I will return to this issue in section 3.2.

d. Residue moras and segments merge to form a new bimoraic syllable guided by sonority peak requirements;

e. Derived and underived OCP are ranked differently; and

f. Lower constraints may gang-up to override higher ones.

Without the items in (2), a coherent account of Tianjin CSE with tone sandhi is impossible.

To adequately address the issues behind the data exemplified in (1), this introduction is followed by section 2 which provides a description and analysis of CSE in Tianjin, sans tone, drawing upon the work of Wee, Yan and Lu (2005) and Wee and Yan (2006) and their recordings made available to the author.[2] To do so, a somewhat extended discussion on the syllable structure of Tianjin would be necessary. Section 3 then introduces the basics behind Tianjin tone, drawing mostly from Chen (2000), Wee (2004) and the recordings from Wee, Yan and Chen (2005). A brief outline of the tone sandhi patterns would be presented and how tones may be formed when syllables merge after CSE would be discussed. When both tone sandhi and CSE subpatterns are separately understood, section 4 puts them together to reveal a paradox in the interaction between CSE elision and tone sandhi. The paradox will find resolution in the recognition of three things: firstly that derived and underived OCP are different (comparative markedness, McCarthy 2002); secondly that lower constraints can gang-up to override higher ones (constraint conjunction, contra "strict dominance" in classical OT, Smolemsky 1993, 1997), and thirdly that contour tones are "heavier" than level ones. This is followed by a conclusion.

2.   Tianjin Casual Speech Elision

In this section, we put aside the matter of tone sandhi for a moment and concentrate first on the patterns of CSE sans tone. The section begins with a discussion on the Tianjin syllable, which is crucial for an understanding of the CSE patterns.

2.1.   Patterns of CSE

Tianjin CSE was first reported in a dialectoglogical study in Wee, Yan and Lu (2005) where they presented data involving trisyllabic strings, the minimal length needed before CSE could apply. Li (2006) has subsequently made further investigations in Tianjin on this matter, the major difference being on the tonal aspects, presumably due to a different set of informants.[3] Similar dialectological studies have been made in at least three other Chinese languages, notably Zhang (2000) on place names in Beijing Mandarin, Hsu (2003a, 2004) on Taiwanese Southern Min, and Ong (2006, 2007) on Malaysian Cantonese. Presumably, CSE in longer strings can be reduced to combinations involving trisyllabic substrings. For convenience, (3) provides a schematic representation of trisyllabic strings.

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[2] The recordings contain more data than those reported in Wee, Yan and Lu (2005) and Wee and Yan (2006), left out in those works due to constraints of space. In this paper, the recordings collected in Wee, Yan and Lu (2005) have been used and transcribed afresh with the aid of spectrograms.

[3] As far as I can tell, this does not have any major impact on the present study, but it is noteworthy that the set of informants used in the Wee, Yan and Lu (2005) study belonged to an older generation who are arguably less influenced by the very dominant Beijing speech. One major difference is that the speakers from Li would have a LL→ HL ditonal sandhi, but the older speakers would have a LL→RL pattern. Also, unlike Beijing and younger speakers of Tianjin, old Tianjin does not make a distinction between retroflex and non-retroflex apical consonants, but this does not matter for CSE.

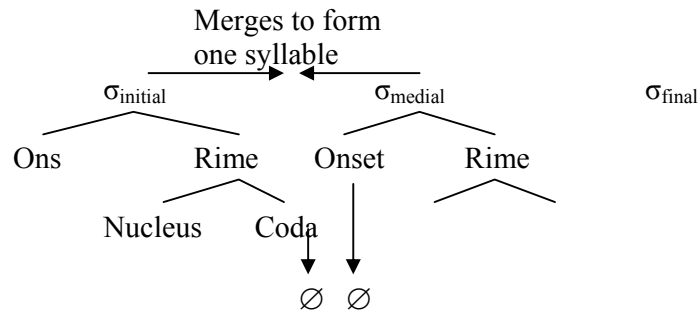(3)   Schematic representation of trisyllabic strings

Initial σ (syllable)   Medial σ   Final σ

          ⌣‿⌣   ⌣‿⌣
          Window I   Window II
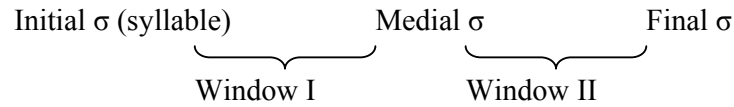
A number of different CSE patterns are identified in Wee, Yan and Lu (2005), summarized here in (4).

(4)   a.   Basic CSE at Window I
                i.   miɛn faŋ tsʰaŋ → miaŋ tsʰaŋ   "cotton factory"
                ii.   pau kuŋ tʰou → pɔŋ tʰou   "foreman"
                iii.   tɕi kuan tɕʰaŋ → tɕyan tɕʰaŋ   "machine gun"
                iv.   tuŋ faŋ xuŋ   → tɔŋ xuŋ   "The east is red"
                v.   ɕiŋ xua tsʰuən → ɕy ã tsʰuən   "gingko blossom village"
                vi.   pei tsʰən tɕʰy → pen tɕʰy   "Beichen area"
                vii.   tɕau tai xuɛ   → tɕɔɛ xuɛ   "teachers' representatives meeting"
                viii.   lai tsʰaŋ ɕiŋ → lɛŋ ɕiŋ   name "Lai Changxing"
                ix.   kuŋ tsʰan taŋ → kuan taŋ   "Communist Party"

        b.   Onset Preserving CSE
                i.   jən min pi   → jəm pi   Renminbi
                ii.   kuo min taŋ   → kom taŋ   Kuo Min Tang
                iii.   tʰai pʰiŋ tɕiɛ → tʰam tɕiɛ   "Peace Street"
                iv.   tʰai piŋ iaŋ   → tʰam iaŋ   "the Pacific Ocean"
                v.   tsu pa tɕɛ   → tsup tɕɛ   "Piggy"[4]
                vi.   pai rən li   → pər li   name "Bai Renli"
                vii.   pa li tʰai   → pal tʰai   place name "Balitai"
                viii.   sou liu tan   → sol tan   "hand grenade"

        c.   CSE to medial syllable
                i.   mau tsɤ tuŋ   → mau tuŋ   name of Chairman Mao
                ii.   pʰai tsʰu suo → pʰai suo   "police station"
                iii.   tɕʰyɛn iɛ tsʰaŋ → tɕʰyɛn tsʰaŋ   name of mall

The pattern in (4a) is by far the most robust and is attested in a large number of cases. It is always possible to coin novel sequences from which once familiarized, the Tianjin speaker will be able to produce in CSE form. Wee, Yan and Lu (2005) was able to characterize that (i) all coda elements of the initial syllable will be elided, including vowel glides /i/ and /u/; and (ii) onsets of the medial syllable would be elided if they are any of [k, kʰ, x, ts, tsʰ, s, tʂ, tʂʰ, ʂ, ʐ, tɕ, tɕʰ, ɕ, f]. In these cases, phonological material, in particular the consonants, at Window I are elided. Once the intervening consonants are removed, the initial and medial syllables merge, schematically shown in (5).

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(5)   CSE at Window I (cf. (4a))

Merges to form
one syllable

$\sigma_{initial}$ σ_{medial} σ_{final}

Ons   Rime   Onset   Rime

Nucleus   Coda

∅   ∅

Merging of syllables to form a new one sometimes involves vowel coalescence (e.g. (4aii) where /a/ and /u/ coalesce to form [ɔ]). That there is syllable merger in the cases of (4a) is supported by phonetic evidence. Wee, Yan and Lu (2005) provided acoustic measurements comparing normal and CSE utterances for the (4a) type, extracted and represented below in (6). For clarity, I have included a pair of spectrograms generated (using Praat, Boersma and Weenink 2008) from Wee, Yan and Lu's (2005) fieldwork recordings.

(6)   a.   Comparative measurements of Type (4a) normal and CSE utterances

	Average length	Average length of non-final string	Average length of final syllable	Non-final string:Final ratio
Normal	0.6173s	0.3615s	0.2557s	58.56%
CSE	0.4623s	0.2179s	0.2444s	47.13%

        b.   Pair of Spectrograms
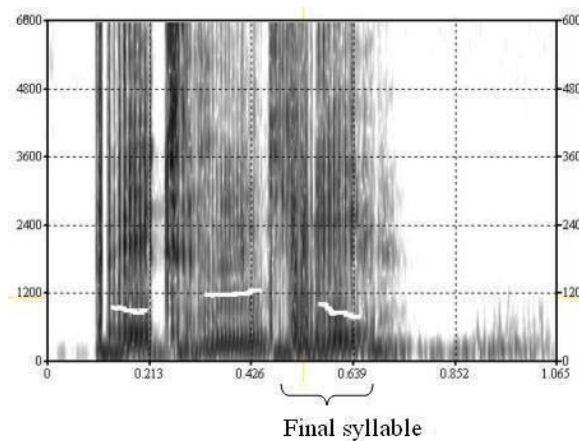
Normal utterance of
pei tsʰən tɕʰy "Beichen area"
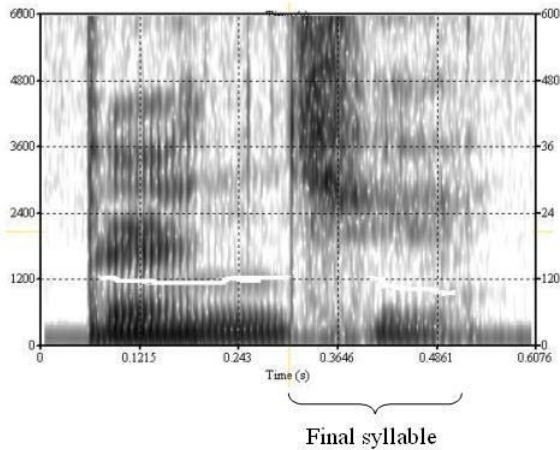
Final syllable

CSE utterance of
pei tsʰən tɕʰy "Beichen area"

Final syllable

In (6a), the column under "average length" shows that CSE reduces the utterance time by about 25%. It is striking that average lengths of the final syllables in normal articulation and CSE show that hardly any of the reduction as may be seen in the penultimate column. This means that CSE is targeting the non-final syllables. The ratio between the non-final material and the final syllable (rightmost column) indicates that in normal articulation the first two syllables take up roughly 60% of the time. Under CSE, non-final syllable material takes up slightly less than 50% of the total length. This shows that there are only two syllables under CSE for cases of (4a). In (6b), the white lines represent pitch which values are read off the right margin. The x-axis represents time (s) and the y-axis frequency (Hz). It should be obvious that the final syllable takes up about 50% of the utterance time in CSE, but about 40% in normal utterance. It should be noted that one would not expect the final syllable in normal articulation to take up exactly one-third of the utterance time since utterance-final syllables tend to be somewhat longer. Likewise under CSE, the final syllable takes up slightly more than 50% of the utterance time. In short, under CSE, acoustic evidence suggests that material from non-final syllables merges to form a new syllable.

This set of onset segments that could undergo CSE are [-sonorant], and with the exception of /f/, also [-labial]. This set is expanded when the initial and medial consonants alliterate, so the full list would include all onset segments.

(7) a. pa liŋ tɕhi → pa liŋ tɕhi   "8-0-7"
     b. xuaŋ liaŋ ɕi → xuaŋ liaŋ ɕi   name of the present author
     c. li liaŋ i → liaŋ i   "Li Liangyi" (a name)

In (7), the medial syllable has /l/ for an onset, which does not undergo CSE (7a, b) unless it is alliterative with the initial syllable as in (7c).

Moving on to (4b), these cases systematically involve labial stops [p, pʰ, m] or coronal sonorants [l, r] as the onset of the medial syllable in the input strings. It is also hard to ascertain if CSE is applying in Window II for these cases, although the following generalizations may be made.

(8) i.   [r, l] and [+labial, -continuant] become the coda of the merged syllable.
     ii. [p, pʰ] → [m] if the medial syllable of the input has a nasal coda.

The generalization in (8i) is easy to observe from the data in (4b). (8ii) can be seen in comparing cases like (4biii, iv) with (4bvii). Saying that the CSE cases in (4b) also involve the merger of the initial and medial syllables is supported by phonetic evidence similar to those in (6). (9) below provides the comparative measurements of type (4b) cases[5] with normal utterances obtained from the Wee, Yan and Lu (2005) recordings.

(9) Comparative measurements of type (4b) normal and CSE utterances

	Average length	Average length of non-final string	Average length of final syllable	Non-final string:Final ratio
Normal	0.6173s	0.3615s	0.2557s	58.56%
CSE	0.4206s	0.2247s	0.1977s	53.20%

In (9), it can again be seen that the after CSE, there is syllable merger, similar to that in (6), although unlike (6), CSE of the type (4b) cases have a slightly shorter final syllable. In any case, the (4b) cases may be roughly represented as (10). Notice that (10) and (5) are similar in that the merger happens at Window I, the difference is that this time, it is the material from the medial onset that is merged as the coda of the new syllable (indicated by the dotted arrow).

(10) Onset Preserving CSE (cf. (4b))
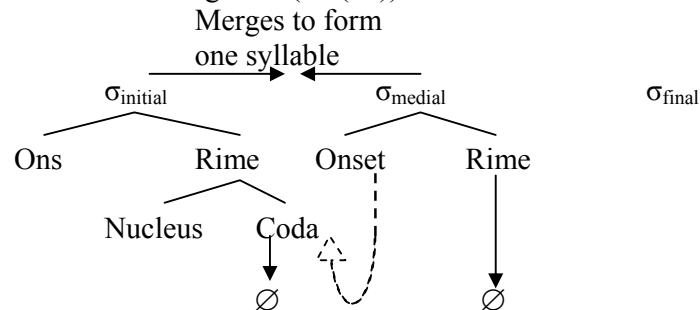
Finally, the (4c) type involves the deletion of the entire medial syllable. These examples are relatively rare and highly unsystematic. In the three examples given in (4c), (4cii) is certainly lexicalized as many Tianjin speakers actually do not know that it is truncated from the longer string, thinking that the term is a Tianjin local form. (4ciii), though the name of a mall, was established since 1928 by Prince Qing of the then defunct Qing Dynasty (Shi 1991:128-9), and hence again likely to be lexicalized. In any case, the paucity of such cases makes it unviable for deeper theoretical speculation, and hence will be left aside for now.

In what follows, I will deal with the basic CSE of the (4a) type first. When the basic analysis is in place, I will then move on to the (4b) type where the medial onset is preserved. However, given the generalizations in (5) and (10), a grasp of CSE in the Tianjin dialect is impossible without a discussion on the syllable structure, and it is to this that this section shall turn to next.

[5] The recordings used are for the items listed in (4b).

As typical of the Northern Mandarin cluster of languages, there is considerable lack of clarity on the status of the medial glide in the Tianjin syllable. The general idea has been that the maximal Tianjin syllable is a CGVG/N string where the final segment can either be a glide /i, u/ or one of the nasals [m, n, ŋ]. Prima facie, this is identical to the Beijing syllable, which textbooks have described as having a structure like (11).

(11)   Typical assumption of the Mandarin Syllable Structure[6]
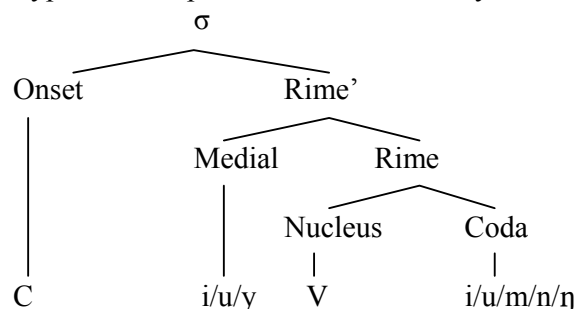
Alternatives have been suggested, notably Bao (1990), Wang (1999), Duanmu (1990, 2000, 2002), Ma (2003) and Lin (2007) who argue that the medial glide should form a constituent with the onset; and Sun (2006) who believes that the medial should be directly dominated by the syllable which is ternary branching.[7] (12) presents a version of the complex onset model where the medial is construed as part of the onset.

(12)   Complex onset model
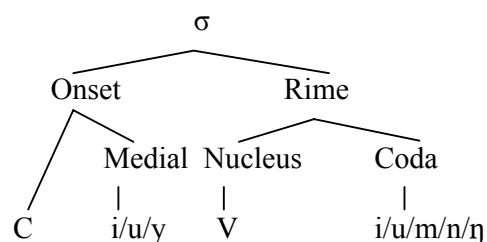
Clearly the disagreement is solely on the status of the medial glide, a point highlighted in Yip (2003). When evidence points both ways, the hint to be gotten is that perhaps an alternative approach is needed.

Since neither Duanmu, nor Sun, nor any of the other researches I know about relates directly to the Tianjin dialect, the ensuing paragraphs shall have to do so more or less from scratch. Unlike these earlier approaches, perhaps it is first and foremost noteworthy that the minimal word in Tianjin is the syllable. Since minimal words are necessarily binary feet at either the mora or syllable level, it follows that the typical

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[6] In Pan (2006), an influential paper among linguists in China, this model is expanded so that the Nucleus is ternary. His concern was in finding the maximal structure that would allow the expression of the syllable of all Chinese languages, though when applied to any particular language, Pan's model would grossly overgenerate.

[7] Sun's (2006) argument is that since there is evidence for the medial forming a constituent with the onset, and there is evidence for it forming a constituent with the rime, then it must be neither and should hang off directly the syllable. However, such a model captures neither set of facts.

Tianjin syllable must be a bimoraic foot (McCarthy and Prince 1995:320-1, and numerous references cited therein). This is perfectly consistent with both models in (11) and (12) which have binary branching rimes, so one simply needs to note that any segment associated with the rime must be moraic.[8]

(13)   Bimoraic model

$$\begin{array}{c} \sigma \\ \diagup \diagdown \\ \text{Onset} \quad \text{Rime} \\ \diagup \diagdown \\ \mu \quad \mu \end{array}$$
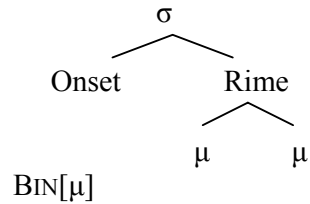
BIN[μ]
Every syllable must be bimoraic.

The model in (13) can be encapsulated in a constraint such as BIN [μ], a consequence of minimal prosodic words being a binary foot (sometimes written as FT-BIN, Kager 1999:156 among others). With BIN[μ], an interesting result follows. Consider a /CV/ input. In order for BIN[μ] to be satisfied, the V has to be linked to two timing slots in the skeletal tier,[9] producing in effect a long vowel. At first blush, this seems motivated only theory-internally since if Tianjin syllables are bimoraic, there can also be no vowel length distinction. Care needs to be taken here. While it is true that the minimal word in Tianjin is the syllable, not all syllables are words. There are "light" syllables in Tianjin (generally bearing neutral tone) which are often bound morphemes (for such examples, see Wang 2002). In other words, it would be untrue to claim that there is no weight contrast (and by manifestation, length) at all.

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[8] There is really no need for the onset-rime distinction. The distinction between moraic entities and non-moraic ones would suffice (as in Hayes 1989, Yip 2003 and specifically to Mandarin in Wang 1993, and Ma 2003). I continue to use onset-rime here mostly out of convenience and the reservation that references to moraic entities would include geminate onsets, in such languages as Finnish, so that monosyllabic $C_iC_iV_j$ and C_jV might be perhaps erroneously predicted to not rhyme since the two syllables no longer have the same moraic segments. Nothing in this paper hinges on the onset-rime distinction, so I shall not discuss this further.

[9] They cannot be linked directly to the mora because affricates exist in Tianjin. Affricates are either understood as two phones at the melodic linked to one timing slot at the skeletal tier or as a root node having both [+continuant] and [-continuant] features (McCarthy and Prince 1986:87-89, citing Clements and Keyser 1983; Clements 1985; Sagey 1986; Archangeli and Pulleyblank 1986; and also Broselow 1995, citing McCarthy 1982). Whether we use X slots in the skeletal tier or appeal to root nodes is immaterial here, since in both models there would be a distinction between a mora that is mapped to two entities (root nodes or X-slots) and a mora that is mapped to a branching entity (root node with two continuant features or X-slot with two root nodes). The model of the syllable here, though different from the typical moraic model extensively discussed in Hayes (1989) and Morén (2001) in its use of skeletal slots, is really just a mater of convenience.

(14)   Mapping CV to a bimoraic model

Input: /CV/	BIN [μ]
i.☞ (syllable tree: σ → Onset, Rime; Onset → X → C; Rime → μ, μ; μ → X, μ → X; both X → V)	
ii. (syllable tree: σ → Onset, Rime; Onset → X → C; Rime → μ, μ; first μ → X → V; X X with no association)	*!

The result in (14) is thus a desirable consequence. Regular CV syllables would have a long V because they are minimal prosodic words. In contrast, neutral tones syllables which are not minimal words would have a shorter V like candidate (14ii), presumably when additional constraints come into play.[10] Capturing this distinction in moraic terms is explicitly explained in Yip (2002:182-6) in her treatment of Mandarin.

The model in (13) is incomplete. To flesh out all the details, one needs to consider more data, presented below.

(15)   a.   i.   [tʰian] "sky"   ii.   [tan]   "single"
        b.   i.   [kuan] "pass/fort"   ii.   [kan]   "liver"
        c.   i.   [xuan] "change"   ii.   [xan]   "sweat"
        d.   i.   [suan] "sour"   ii.   [san]   "three"

The facts in (15) are interesting in two ways. Firstly, each pair is judged to alliterate despite the difference in aspiration. Secondly, the left column has four phones in each of the syllables. Alliteration suggests that the [i/u] in all the examples above do not form a complex segment with the initial consonant, that is, they do not merge with that consonant as secondary articulations. Phonetically, of course, each of the consonants that precede the [u] would be labialized, and the [t] that precede [i] in (15ai) would be laminal rather than apical. This can easily be demonstrated with palatograms and lingograms such as those in Zee (2002). However, that these are judged as cases of alliteration suggests that the labialization and the laminality are phonologically irrelevant.[11] Since each pair is minimally contrastive with respect to

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[10] Deriving when CV is light or heavy is beyond this paper, but a possible approach can be found in Wee (2004:Chapter 4).
[11] But this will have an impact on [s] and [ɕ], since a laminal [s] would hardly be distinct phonetically from [ɕ], see Zsiga 1995 for a similar case between [s] and [ʃ] when followed by [j] in American

the presence of the medial glide, it follows that the glide is phonologically relevant as a segment in its own right. In short, the data in (15) brings us back to the dispute over where that medial belongs in the syllable structure. Proponents of the traditional analysis that the glide is part of the rime argue that for many speakers, the items in the first and the second columns of (15) do not rhyme, though for many other speakers rhyming is accepted. The story would have been simple if not for (16).

(16) a. i. [ɕyɛn]   ii. *[ɕuɛn]   "announce"
      b. i. [ɕiɛn] or [ɕɛn]   "first"
      c. i. [san]   ii. *[syan] / *[sian] "three"

All speakers agree that (16ai) and (16b) rhyme, even for those who do not find the left column of (15) rhyming with the right column. Further, there are no minimal pairs involving the medial glide [i/y]. (16c) is a case in point here because it shows that the front vowel glide is incompatible with [s]. In fact, [y] is not compatible with any other consonant segment except [ɕ, tɕ, tɕʰ], all of which are alveolopalatal. [i] shows a similar selectiveness in disallowing /k/, /kʰ/, /x/, /s/, /ts/, and /tsʰ/ to precede it. Historically, /s, ts, tsʰ/ preceding /i/ have either triggered /i/ to surface as apical [ɻ] or else the /s, ts, tsʰ/ themselves will become laminal [tɕ, tɕʰ, ɕ]. As such, modern Mandarin [tɕ, tɕʰ, ɕ] has two historical sources: /s, ts, tsʰ/ and /k, kʰ, x/ (Dong 1965/2001:213-4). In short, (16) suggests that the medial glide is part of the onset. In fact, Ladefoged and Wu (1984) in their study of Beijing Mandarin (with problems very similar to Tianjin in this respect) uses the transcription in the right column of (16), omitting the glide altogether, implicitly saying that the glide effect is an acoustic by-product of the alveolopalatal consonants.

A detailed analysis of the Tianjin syllable structure is neither possible nor is it necessary for the purposes of this paper, and the suggestion from Ladefoged and Wu (1984) appears to work well enough in making all the necessary distinctions found in Tianjin, with additional stipulation that [y] is really the result of [+front][12] spreading from the alveolopalatal to a neighboring /u/ as in (17).

(17) [y] as a derived vowel[13]

         ɕ   (u → y)
         |.........⌐
      [+front]   [+labial] [-consonant]

In (17), without spreading, the second X would have been a [u]. This would explain why (16aii) is bad and why [y] appears only with alveolopalatals, never with other consonants. We shall see in section 2.3 that this has other desirable consequences in predicting patterns of CSE. Taking Ladefoged and Wu's cue, then (16b) would have to be transcribed as [ɕɛn] "first".

English. The relevance of this will become clearer when one considers why Mandarin does not allow *[siV] type syllables. Historically, */siV/ → /ɕV/, more later in this subsection.

[12] Alveolopalatals are the only consonantal phones in Tianjin that require the tongue body to be fronted.
[13] This derivation of [y] would naturally raise the question on [ly~lu] and [ny~nu] contrasts attested in both Beijing and Tianjin varieties of Mandarin. It is noteworthy that in both cases *[lui] and *[nui] are unattested, though [liu] and [niu] may be accepted as variations of [liou] and [niou] respectively. As such, it is still possible that even with /l/ and /n/ onsets, the [y] is derived from [ui] coalescence. The exact analysis would be beyond the scope of the present paper.

The conceptualization in (17) resolves the controversy over the position of the medial glide in recognizing that at the melodic tier, there can be multiple associations to the skeletal tier. Likewise, there can be multiple associations between the skeletal tier and to each mora or to the onset. Given that there are affricates in Tianjin, it follows that multiple associations between the melodic tier and the skeletal tier must be sanctioned. In OT terms, that would mean that some faithfulness constraints to preserve input phones would outrank *MULTI-X where multiple melodies are associated to the same timing unit. Likewise, given that there are only 2 moras, cases like (15) demand that moras should be free to take multiple associations. The characterization in (17) would require [+front] features to spread from onsets, also at the expense of multiple associations. Hence,

(18)   MAX[f]
       Do not delete any input phone features.
       *MULTI-X
       Do not allow multiple associations between melodies and timing slots.
       *MULTI-μ
       Do not allow multiple associations between moras and timing slots.
       AGREE[front]
       [+high] vowels must agree in [+front] with preceding [+front] consonants. [14]

       MAX[f]; AGREE[front] » *MULTI-X »*MULTI-μ

None of the constraints in (18) are new. *MULTI-X and *MULTI-μ mark non-uniform mappings including spreading. MAX[f] is from the MAX family of faithfulness constraints and AGREE[front] is from the family of constraints that triggers consonant assimilation (or vowel HARMONY, Kager 1999:410). With (18), let's consider two inputs /tuan/ and /ɕuɛn/ to see the effects of the constraints. Here are some of the candidates.
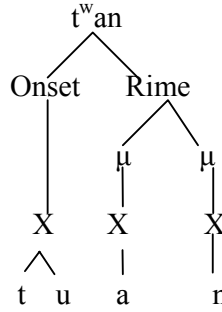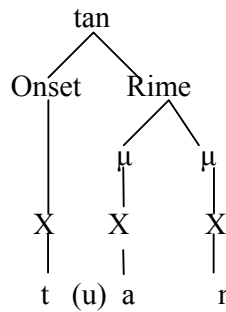
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[14] [+front] phones are those which articulation requires the tongue body to be fronted, and would include vowels such as [i, y, e] as well as laminal-palatal consonants. A similar effect could be gotten with a combination of [+anterior] and other features depending on one's choice of distinctive feature framework (see Chomsky and Halle 1968, or Clements and Hume 1995 for such possibilities).
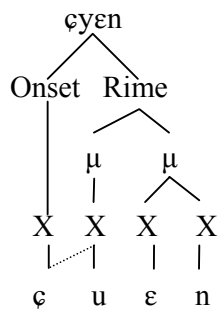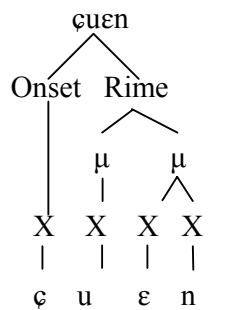
(19)   a.   Candidates of /tuan/

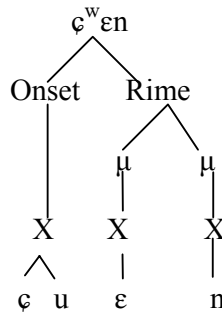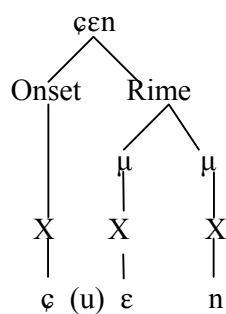i.   tuan   ii.   tuan

         Onset   Rime   Onset   Rime

                μ   μ   μ   μ

         X   X   X   X   X   X   X   X

         t   u   a   n   t   u   a   n

iii.   tan   iv.   tʷan

         Onset   Rime   Onset   Rime

                 μ   μ   μ   μ

         X   X   X   X   X   X

         t   (u) a   n   t   u   a   n

b.   Candidates of /ɕuɛn/

i.   ɕuɛn   ii.   ɕyɛn

         Onset   Rime   Onset   Rime

               μ   μ   μ   μ

         X   X   X   X   X   X   X   X

         ɕ   u   ɛ   n   ɕ   u   ɛ   n

iii.   ɕɛn   iv.   ɕʷɛn

         Onset   Rime   Onset   Rime

                 μ   μ   μ   μ

         X   X   X   X   X   X

         ɕ   (u) ɛ   n   ɕ   u   ɛ   n
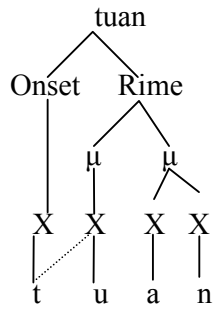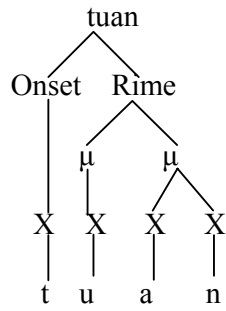
(20)

/tuan/	MAX[f]	AGREE[front]	*MULTI-X	*MULTI-μ
i. ☞(19ai)				*
ii. (19aii)			*!	*
iii. (19aiii)	*!			
iv. (19aiv)			*!	

/çuɛn/	MAX[f]	AGREE[front]	*MULTI-X	*MULTI-μ
i. (19bi)		*!		*
ii.☞ (19bii)			*	*
iii. (19biii)	*!			
iv. (19biv)		*!	*	

As can be seen in (20), the correct predictions can be made on the outputs in a way that is consistent with all the inventory of syllables in Tianjin. It also provides a resolution to the dispute on the syllable structure, drawing from the traditional analysis in including the medial as part of the rime, but capturing also the insight in the complex onset that the alveolopalatals have a very close relationship with the medial (most convincingly presented in Duanmu 1990, 2000, 2002). To capture the rhyming patterns, one needs to allow for two possibilities: (i) for some speakers two syllables rime when the Rime is identical; (ii) for some other speakers rhyming is accepted if at least two contiguous segments at the right-edge of a syllable are identical.[15]

It goes without saying that the constraints in (18) would find easy solutions to inputs such as /tun/ and /çun/ as well, only this time involving no multiple associations between the skeletal tier and the moras, such cases would look like (21).

(21)   a.   [tun] type of syllables

---

b.   [ɕyn] type of syllables

ɕyn

Onset   Rime

μ   μ

X   X   X

ɕ   u   n

A more challenging case is to be found with the unacceptability of *[si(X)] types, where X refers to some variable segment. Since AGREE[front] makes no reference to [s], it does not disallow this unaccepted form. In this case, this effect is actually desirable since other [+coronal]iX syllables such as [liX] and [tiX] are allowed. This indicates that AGREE[front] is probably of the right strength and *[siX] should find its explanation elsewhere. Presumably, coronal consonants preceding /i/ would become laminal due to anticipatory assimilation, and the /t/ in [tiX] is really more like [ȶ], likewise for /l/ (see Zee 2002 for discussions and palatograms and lingograms, which I shall not reproduce here). If so, the /s/ in /siX/ inputs is also going to become something like [ɕ]. This is supported by historical evidence. Recall that the modern Mandarin [ɕ] has two sources: velar fricatives preceding /i/ and apical fricatives preceding /i/ (see Dong 1965/2001:213-214 for discussion), that is, */hi(X)/ → [ɕi(X)] and a number of */si(X)/ → [ɕi(X)]. Those that didn't neutralize persisted as [sɿ], with the /i/ becoming an apical. /ha/ and /sa/ continue to stay distinct. A complete treatment of the Mandarin syllable would not be possible here and certainly beyond the current scope of interest, but it should suffice to know that */siV/ does not pose any real challenge to the account given above. In any case, one might conceive of a stronger version of AGREE[front][16] that would force all coronal consonants (including /t/ and /l/) to become laminal, and laminal /s/ would simply surface as [ɕ].

The preceding paragraphs had argued that *MULTI-X » *MULTI-μ which would have non-trivial consequences for affricates as it would have preferred consonant clusters for onsets rather than affricates (recall footnote 9). This matter can be addressed by including a dominant *CC constraint above *MULTI-X, that would have the effect of preferring affricates rather than consonant clusters. This move is certainly viable since there are no consonant clusters in Tianjin, suggesting that *CC is very highly ranked.

The bimoraic model with the constraints in (18) has a very interesting implication. If one of the mora units (presumably together with associated timing slots) is removed, such as due to CSE, it would follow from MAX[f] » *MULTI-X » *MULTI-μ that vowels would coalesce, shown in (22) where the second mora has been removed.

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[16] Something along the lines of "[+high] vowels and preceding [-back] consonants must agree in tongue position." Together with Max-feature, this would guarantee that [+high] and [+front] would persevere creating [y] and [ɕ] in the right places. This detail would have an impact on the syllable inventory of Mandarin, but is tangential to the CSE issue at hand.

(22)   Vowel coalescence
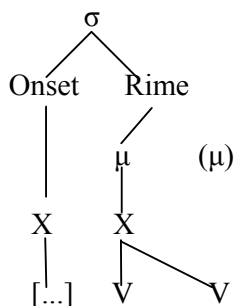
The possibility in (22) calls to mind the examples in (4aii, iv) where there is vowel coalescence during CSE (e.g. pau kuŋ tʰou → pɔŋ tʰou "foreman"). Such coalescence is quite systematic and generally symmetrical, examples given below, with underlining to indicate the coalesced vowels.[17]

(23)   a.   a+u / u+a → ɔ
             i.   p<u>au</u> k<u>uŋ</u> tʰou → p<u>ɔ</u>ŋ tʰou   "foreman"
             ii.   t<u>uŋ</u> f<u>aŋ</u> xuŋ → t<u>ɔ</u>ŋ xuŋ   "The east is red"
       b.   a+i / i+a → ɛ
             i.   l<u>ai</u> tʂʰ<u>aŋ</u> ɕiŋ → l<u>ɛ</u>ŋ ɕiŋ   name "Lai Changxing"
             ii.   tɕau t<u>ai</u> xuɛ → tɕɔ<u>ɛ</u> xuɛ   "teachers' representatives meeting"
       c.   i+u / u+i → y
             i.   tɕ<u>i</u> k<u>u</u>an tɕʰiaŋ → tɕ<u>y</u>an tɕʰiaŋ   "machine gun"
             ii.   tɕou i pa → tɕøy pa   "Sept 18 incident"[18]
       d.   i+e / e+i → e
             i.   l<u>ei</u> <u>i</u>n sʅ → l<u>e</u>n sʅ   "Leiyin Temple"
             ii.   li<u>ɛ</u> <u>i</u>ŋ tsuan → l<u>e</u>ŋ tsuan   "Tales of Heroes"
       e.   u+o / o+u → o
             i.   ts<u>ou</u> k<u>uɔ</u> pau → ts<u>o:</u> pau   name "Zhou Guobao"
             ii.   ku<u>ɔ</u> s<u>ou</u> tsaŋ → ku<u>o</u> tsaŋ   "Guo, Head of State"[19]

The data in (23) provides a fairly comprehensive list of vowel-pairings that coalesce, leaving out the apical vowels and schwa-like ones which would warrant a lengthy study beyond the scope of the present one. In Tianjin, [e] and [ɛ] are allophones of /e/ as are [o] and [ɔ] of /o/. The lax ones occur in the environment V__. There is a further complication from /a/ which surfaces as [ɛ] when i__n.[20] This makes it impossible to construct clear examples on how [a] and [e] might coalesce. Other than [a,e], [a,o], [e,o] and [i,o] combinations are not presented here as well because

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[17] (23a, c, ei) are from Wee, Yan and Lu (2005). However, the Wee et al (2005) recordings do not contain enough vowel pairings that will comprehensively illustrate the vowel coalescence. The remaining examples from recordings of a female native Tianjin speaker, aged 30, engaged for this study. Sampling frequency set at 22050 Hz, using Praat (Boersma and Weenink 2008).

[18] This refers to a conflict between the Japanese and the Chinese during WWII.

[19] A more accurate transcription would in fact be [kuozsaŋ], the [zs] which I suspect is a phonetic implementation problem of [ts] at a intervocalic juncture, possibly gestural overlap of some kind. See appendix for more discussion on gestural overlap.

[20] This only apply to some speakers who find that [iɛn] rhymes with [an].

15

syllable phonotactics make it impossible to construct the right inputs for obtaining coalescence.

Given that there is elision, it is not always easy to determine which vowels have coalesced and which vowels have been deleted. Due to phonotactics on what syllables are attested in the Tianjin inventory, in (23d) for example, it is hard to tell if the vowel [e] is the result of what combination of [i], [e] or [ɛ], though by any measure, this should suffice to show that /i/+/e/ produces [e].

In (23dii), presumably, [i,u] coalesce to produce [y], which then triggers assimilation of the preceding [o] so that the [oy] sequence end up as [øy].

2.3.   Deriving the basic CSE pattern with OT

The long detour into the syllable structure of Tianjin makes it possible to apprehend the basic patterns of CSE, the relevant ones in (4a) repeated here.

(24)   CSE at Window I (from (4a)
        i.   miɛn faŋ tsʰaŋ → miaŋ tsʰaŋ   "cotton factory"
        ii.   pau kuŋ tʰou   → pɔŋ tʰou   "foreman"
        iii.   tɕi kuan tɕʰaŋ → tɕyan tɕʰaŋ   "machine gun"
        iv.   tuŋ faŋ xuŋ   → tɔŋ xuŋ   "The east is red"
        v.   ɕiŋ xua tsʰuən → ɕy ã tsʰuən   "gingko blossom village"
        vi.   pei tsʰən tɕʰy → pen tɕʰy   "Beichen area"
        vii.   tɕau tai xuɛ   → tɕɔɛ xuɛ   "teachers' representatives meeting"
        viii.   lai tsʰaŋ ɕiŋ → lɛŋ ɕiŋ   "name, Lai Changxing"
        ix.   kuŋ tsʰan taŋ → kuan taŋ   "Communist Party"

To derive the relevant patterns of CSE, here is a description of the general pattern of CSE at Window I with merger of the initial and medial syllables.

(25)   Possible mappings after CSE at Window I
        a.   Vowel coalescence

$$\sigma_{\text{initial+medial}} \qquad \sigma^{\text{final}}$$

$$\mu \quad (\mu) \quad\quad (\mu) \quad \mu$$

$$X \qquad X \ \ X \ \ X \ \ X \ \ X$$

$$[m_1] \quad [m_2][m_3][m_4][m_5][m_6]$$

16
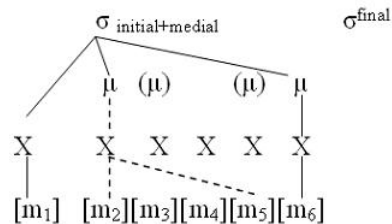
b.   Plain merger without coalescence[21]
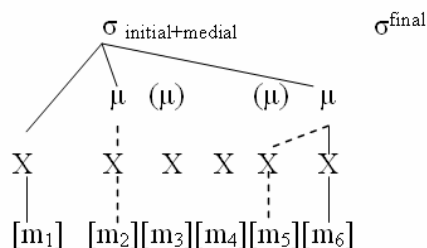
In (25), the effect of syllable merger is attributed to a reduction in the number of moras, indicated by the parenthesis. The X represents the skeletal tier, though the third and fourth slots, corresponding respectively to the coda of the initial syllable and the onset of the medial syllable. With only two moras left, the residue melodies, represented as $[m_{num}]$, and X-slots from the initial and medial syllables have to compete for mapping. There are hence two possibilities: (I) melodies share an X-slot triggering vowel coalescence as in (25a); or (II) melodies each have their X-slots, but X-slots share a mora as in (25b).

Beginning with (25a), if $[m_3]$ and $[m_4]$ are [+consonantal] it follows that they would be disprefered from being mapped by the requirements of sonority peak. $[m_1]$ and $[m_6]$ would be mapped to the onset and coda of the new merged syllable respectively. This leaves $[m_2]$ and $[m_5]$ unmapped with one mora position left, though many X-slots remain available. One possibility is that they both associate to one X-slot which in turn associates with the first mora, like (24ii) where [a] and [u] merge to become [ɔ] with the loss of intervening [u] and [k], giving us [pɔŋ] from [pau kuŋ]. Also, if $[m_3]$ is [-consonantal], then it may be mapped with $[m_2]$ to one X slot, triggering vowel coalescence as well, like (23bii) tɕau tai xuɛ → [tɕɔɛ xuɛ] "teachers' representatives meeting", where [au] of the first syllable merges to [ɔ] and [ai] of the second merges to [ɛ]. The representation in (25a) is not intended to exclude vowel coalescence possibilities such as that in (23bii), but should be taken as an illustration that coalescence can occur when there are more melodies than there are timing slots.

Moving on to (25b), two syllables basically combine after elision has applied, as in kuŋ tsʰan taŋ → kuan taŋ "Communist Party" (24ix). In this case, the final mora is multiply linked to two X-slots. Technically, it should be possible for both moras to be associated to two X-slots each, producing a five-segment syllable. However, the Tianjin syllable template allows only a maximum of four segments. Hence all CVVVC outputs are unattested.

The illustration in (25) is not without exception, but it is the general case. To get this effect in OT, one would need the following constraints.

(26)   BI-σ RU/CSE (similar to TRUNCATE, Kager 1999:265)
        Casual speech allows only for binary Rhythmic Units.
        PT-σ (ad hoc constraint)
        Tianjin syllables must obey phonotactic requirements.

---

[21] $[m_5]$ could have just as well been associated to the first mora. However, if evidence from rhyming is taken as evidence for constituency, associating $[m_5]$ to the second mora might be a better choice (see discussion under item (20)).

BI-σ RU/CSE is really a simplistic version of other general constraints that conspire to produce effects of binarity at a level higher than the mora (see Downing 2006, in particular Chapter 3, for discussion of binarity at different prosodic levels). Its effect is to ensure that given a trisyllabic input, a disyllabic output would be preferred and that each syllable would be mapped to 2 moras.[22]

BI-σ RU together with HD-RT and IDENT-HD, this would ensure that when CSE applies, the final syllable in a trisyllabic string remains intact, forcing the initial and medial syllables to merge. I am using ad hoc the PT-σ which is really shorthand for a bunch of constraints that would derive the phonotactic requirements with the Tianjin syllable. The role of PT-σ here is to dictate that when syllables merge, ill-formed syllables do not surface. I shall not pursue the details here for fear of confusing detours, but instead simply state the crucial properties of such phonotactics in (27).

(27)   Some Tianjin phonotactics
        a.   Given VVX in a syllable, the second V must be more sonorant.[23]
        b.   For a syllable containing, uVN, N cannot be velar nasal.

If one looks at the data in Tianjin presented so far, one would notice that (27) has no exceptions, not even under CSE such as those in (24). Below, (28) provides tableaux demonstrating how the CSE cases may be correctly predicted.

(28)   a.   pau kuŋ tʰou   → pɔŋ tʰou "foreman" (cf. (25a))

Input: Casual speech + pau kuŋ tʰou	BI-σ RU/CSE	PT-σ	MAX[f]	*MULTI-X	*MULTI-μ
i. pau kuŋ tʰou	*!				
ii. pauŋ tʰou		*!	**		*
iii. ☞pɔŋ tʰou			**	*	

        b.   tɕau tai xuɛ → tɕɔɛ xuɛ "teachers' representatives meeting" (cf. (25a))

Input: Casual speech + tɕau tai xuɛ	BI-σ RU/CSE	PT-σ	MAX[f]	*MULTI-X	*MULTI-μ
i. tɕau tai xuɛ	*!				
ii. tɕaui xuɛ		*!	**		*
iii. tɕɔi xuɛ			**!	*	
iv. ☞tɕɔɛ xuɛ			*	**	

---

[22] I have refrained from using "foot", but instead appeal to Chen's (2000) idea of a Rhythmic Unit to avoid confusion; in Tianjin, monosyllables are minimal words, making each monosyllable a binary (moraic) foot (Yip 2002:182-186). The exact nature of the RU is an important question for any research into the nature of Chinese prosody (from as early as Shih 1986, notions like foot, superfoot, etc have all served as potential contenders for the nature or RU), but it is only tangential to the concerns of this paper.

[23] This appears to be contrary to the constraint SONFALL appealed to in Yip (2003). The contradiction is only apparent, since Yip uses SONFALL to force the first V to be a glide G. I am not making a G/V distinction here; whether one treats such sequences as GV of VV, the second V is more sonorant.

Input: Casual speech + kuŋ tsʰan taŋ	BI-σ RU/CSE	PT-σ	MAX[f]	*MULTI-X	*MULTI-μ
i. kuŋ tsʰan taŋ	*!				*
ii. ☞ kuan taŋ			**		*
iii. kɔn taŋ			**	*!	

In (28), cases where elision has applied to the final syllable are not considered since HD-RT and IDENT-HD would have easily ruled out any such candidates. Candidates (28ai, bi, ci) are faithful, but under casual speech conditions BI-σ RU/CSE would have ruled it out because there are three syllables and six moras.

In (28a), candidate (ii) fulfills BI-σ RU/CSE but the [auŋ] rime violates Tianjin's phonotactics on where the sonority should peak. MAX[f], though important in normal speech to preserve input phones is now sacrificed under the pressures of BI-σ RU/CSE. The only recourse would be for [a] and [u] to be both mapped into one timing unit, like (22) and also (17), triggering vowel coalescence (akin to Schane 1984; Archangeli and Pulleyblank 1994, and similarly in Hsu 2003b).[24] This is done at the expense of the constraints that forbid multiple associations.

In (28b), the situation is similar, except that candidate (iv) would be most harmonic because the maximum number of melodies are preserved through coalescence, whereas candidate (iii) has deleted [t] and [a]. In (28c) again, one sees that the correct output is predicted even though there is no vowel coalescence this time. As may be seen in candidate (iii), coalescence would produce extraneous violations of *MULTI-X. It should be clear that all the cases in (24) can be correctly derived by this model.

The logic in the above analysis is really quite simple. BI-σ RU/CSE forces the loss of phonological material, and MAX[f] together with sonority requirements ensures that the least sonorous material at Window I are the ones targeted for elision so that merging would produce a well-formed syllable under PT-σ. This creates a sort of edge-in mapping of the material from initial and medial syllables to form the merged syllable.

Now, there are two complications to the story of CSE in Tianjin. Firstly, as noted earlier, medial onsets which are [+sonorant] are faithfully preserved under CSE, though secondly, even these are deleted when there is alliteration (cf. (7), repeated here as (29)).

(29) a.   pa liŋ tɕhi   → pa liŋ tɕhi   "8-0-7"[25]
      b.   xuaŋ liaŋ ɕi   → xuaŋ liaŋ ɕi   name of the present author
      c.   li liaŋ i   → liaŋ i   "Li Liangyi" (a name)

Suffice to say that some kind of faithfulness constraint would preserve those [+sonorant] onsets by virtue of their melodic content, outranking BI-σ RU/CSE. Since

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[24] Recall also the [y] as derived from a combination of [u] and the [+front] feature of alveolopalatals in section 3.2.

[25] Li Wenxin (personal communication) reports that he has heard a CSE version when used as a bus number. The fieldwork recordings of Wee, Yan and Lu (2005) also gives /tɕa lɤ fu /→[tɕaɤ fu] "Carrefour" where /l/ is elided. It is likely that the set of segments susceptible to CSE is expanding to include /l/, but this issue would have to be left aside for the moment until the pattern is more stable.

the exact nature of this faithfulness constraint is irrelevant here, I am simply going to refer to it as FAITH [son, cons]. However, it would be overridden by *ALLIT.

(30)   *ALLIT
        Do not allow adjacent syllables to have identical onsets.
        FAITH [son, cons]
        Do not delete [+sonorant, +consonant] segments.

        Admittedly, the constraints in (30) do not look like universals. *ALLIT appears ad hoc, though it can be more easily appreciated as a convenient package of OCP-related constraints at the consonantal-tier (in non-linear phonological frameworks such as autosegmental phonology Goldsmith 1976 and with special references to consonants and vowels in McCarthy's 1979 account on Semitic languages). Alliteration involves identity of consonants. In any case, the constraint has appeared in Yip (1999, 2001) and in other names such as *ECHO, *REPEAT-C and OCP-STEM in Yip (1995a, 1998, 1999, 2001). For Tianjin trisyllabic CSE, it would mean adjacency of identical elements at the consonantal plane.

2.4.   Preservation of medial onsets in CSE

Recall in (4b) that there is another type of CSE where the onset of the medial syllable is preserved. The relevant cases are repeated here.

(31)   Onset Preserving CSE (from (4b))
        i.   jən min pi   → jəm pi   Renminbi
        ii.   kuo min taŋ   → kom taŋ   Kuo Min Tang
        iii.   tʰai pʰiŋ tɕiɛ   → tʰam tɕiɛ   "Peace Street"
        iv.   tʰai piŋ iaŋ   → tʰam iaŋ   "the Pacific Ocean"
        v.   tsu pa tɕɛ   → tsup tɕɛ   "Piggy"
        vi.   pai rən li   → pər li   name "Bai Renli"
        vii.   pa li tʰai   → pal tʰai   place name "Balitai"
        viii.   sou liu tan   → sol tan   "hand grenade"

Except for (31iii, iv), the rest involves the simple deletion of the coda segment of the initial syllable, the deletion of the rime of the medial syllable and a merger. In (31iii, iv), the [m] is very likely the nasalization of the labial stop, triggered by the nasal in from the medial coda. In any case, (31) can be accounted for by the same Bɪ-σ RU/CSE which removes two moras. However, (31) must be special in that this time, it is the medial onset that gets mapped to the remaining moras, something like (32).

(32)   Possible mapping for Onset Preserving CSE
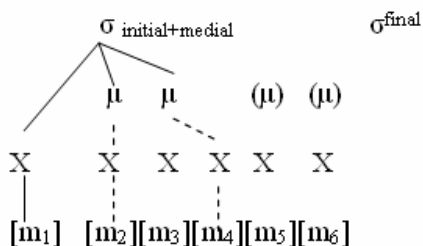
        The basic CSE described in the earlier section is obtained by the combined effects of two constraints: BI-σ RU/CSE which reduces the mora count, and MAX[f] so that it is the coda of the initial syllable and the onset of the medial syllable that gets elided to produce a merged syllable that obeys sonority peak requirements. However, BI-σ RU/CSE could also be satisfied by the removal of the rime of the medial syllable, though MAX[f] would disprefer that option. As can be seen in (32), this involves the removal of [m₃], [m₅] and [m₆], which is one more faithfulness violation than (25). To see this in action, consider the following tableau using (28a) as an example.

(33)   pau kuŋ tʰou → pɔŋ tʰou "foreman"

Input: Casual speech + pau kuŋ tʰou	BI-σ RU/CSE	MAX[f]
i. pau kuŋ tʰou	*!	
ii. ☞pɔŋ tʰou		*ᵤ*ₖ
iii. pak tʰou		*ᵤ*ᵤ*ₙ!

        In (33), the subscript for the violations under MAX[f] indicates the melodies that are elided. It should be evident how the two constraints combine to create the basic CSE at Window I. Thus in order for a pattern like (32) to surface, there must be a constraint that outranks MAX[f]. In the cases of (31i-v), what is common about [p, pʰ, m] is that they are all [+labial, -continuant]. Likewise, in (31vi-viii), what is preserved is the liquids. Constraint that requires faithfulness to [+labial, -continuant] and liquids would suffice to get the necessary effect.

(34)   MAX[+labial,-continuant]
        [+labial, -continuant] segments in the input must be preserved in the output.
        MAX[liquid]
        [+coronal, +sonorant] segments in the input must be preserved in the output.

With (34), now consider the case of (31i) and (31viii) in the tableaux below.

(35).   a.   jən min pi → jəm pi   Renminbi

Input: Casual speech + jən min pi	MAX [+labial,-cont]	BI-σ RU/CSE	MAX[f]
i. jən min pi		*!	
ii. jəin pi	*!		**
iii. ☞jəm pi			***

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b.　　　sou liu tan → sol tan "hand grenade"

Input: Casual speech + sou liu tan	MAX [liquid]	Bɪ-σ RU/CSE	MAX[f]
i. sou liu tan		*!	
ii. soiu tan	*!		**
iii. ☞ sol tan			***

The final piece of the puzzle is with (31iii,iv) where p → m. Again this is not a major problem and can in fact be fixed by MAX[f] itself without any additional constraints. This is because p → m only when there is a nasal coda in the medial syllable. That nasality can be preserved for better satisfaction of MAX[f] by associating with the labial segment, as below (see Cohn 1993a,b for more on such nasal associations).

(36)
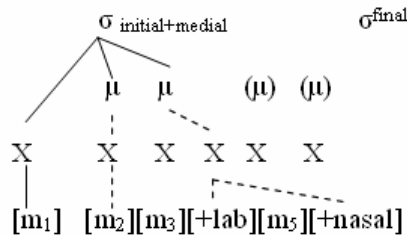
2.5.　　Interim summary

The main idea in this section's discussion of CSE is that the Tianjin syllable is bimoraic, given that it is also a minimal word. Markedness of multiple associations between the mora and timing units and the melodic content would prefer a CVX type of syllable, though faithfulness may sometimes prevail to produce a CVVX type or a CVX type that involves coarticulation. The latter accounts of certain derived vowels like [y], offering a potential resolution to the long standing debate on the status of medial glides in Mandarin syllables. It offers also the possibility of vowel sandhi under CSE when the initial and medial syllables of trisyllabic strings merge to form a new bimoraic syllable. The account for CSE is that in general, trisyllabic strings reduce to disyllabic ones. This falls out easily when a CSE triggering constraint such as Bɪ-σ RU/CSE is allowed to interact with the constraints that derive the Tianjin syllable structures. With an account of the basic CSE in place, the next section takes a look at the tone sandhi patterns before CSE and tone sandhi are put together for a full account.

3.　　Tianjin Tone

3.1.　　Inventory and Tone Sandhi

Tianjin has an inventory of four basic tones: Low, High, Rising and Falling, such that ditonal combinations produce six sandhi patterns. Thus out of 16 (= 4^2) possible ditonal combinations, only ten ditonal outputs are attested (Wee, Yan and Chen 2005:7). The sandhi patterns are:

(37)   Ditonal Sandhi in Tianjin
       a.   LL → RL   e.g. [fei.tɕi]   "air plane"
       b.   RR → HR   e.g. [mai.mi]   "buy rice"
       c.   FF → LF   e.g. [pau.kau] "report"
       d.   RH → LH   e.g. [tsu.rən]   "master/owner"
       e.   RF → LF   e.g. [xau.ta]   "very big"
       f.   FL → HL   e.g. [tsʰaŋ.kɤ] "sing a song"

(37a-c) are clearly instances of OCP, though one would note that /HH/ inputs do not trigger alternation. This effect can be easily achieved using a typical set of OCP and faithfulness constraints, such as those listed in (38).

(38)   OCP [T]
       Do not allow adjacent tone T.
       IDENT-HD
       Head syllable must have an identical correspondence between input and output.
       IDENT[T]
       Input tonal contour must have an identical correspondence in the output.
       HD-RT
       For any branching node N, the element from the rightmost branch is the head.

       OCP[T] is a generalized OCP constraint on tones where T is variable. IDENT[T] forbids unmotivated input~output mismatches, except where triggered by OCP[T]. When that happens, IDENT[T]-HD and HD-RT[26] would target the alternation at the initial syllable, demonstrated in (39).

(39)   Deriving Tianjin Ditonal Sandhi

| /LL/	OCP [L,R,F]	IDENT-HD	IDENT[T]	OCP[H]	HD-RT
i. LL	*!				
ii. ☞XL			*		
iii. LX		*!	*		
/HH/	OCP [L,R,F]	IDENT-HD	IDENT[T]	OCP[H]	HD-RT
i. ☞HH				*	
ii. XH			*!		
iii. HX		*!	*		

       In (39), I have used "X" to indicate the tone that has undergone sandhi, and have used /LL/ as a representative of /RR/ and /FF/ sequences. OCP [L,R,F] is really a convenient cluster of the OCP[T] constraints, all three of which rank above OCP [H]. The separation of these constraints is motivated typologically in that different languages appear to tolerate different kinds of adjacency more than others. In many of the Chinese languages, HH is tolerated by not LL, but African ones appear to prefer

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[26] One could in principle collapse HD-RT and IDENT[T]-HD into IDENT[T]-RT. However, it has been shown in Nelson (1998, 2003) that positing positional faithfulness constraints that make direct reference to the element of the right branch would have pathological typological consequences. As such all prima facie right-faithfulness must be the combination of headship and faithfulness to head positions.

LL over HH.[27] The choice of X would become clearer only when one takes a composite view of tone contours: contours are made up of sequences of tone features such as [low] and [high] (Yip 1980, 1995, Bao 1990; Duanmu 1990; with roots in the autosegmental representation of tone in Leben 1973, Williams 1976 and Goldsmith 1976). Thus, R and F are respectively (40a, b).

(40)   Compositionality of contour tones
        a.   F   b.   R

             high   low   low   high
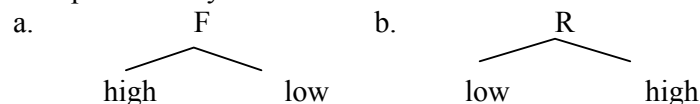
Simplex contours like L and H would have only one feature, so that a tonal template would be something like (41).

(41)   Tone Contour   or   Tone Contour

        tone feature   tone feature   tone feature
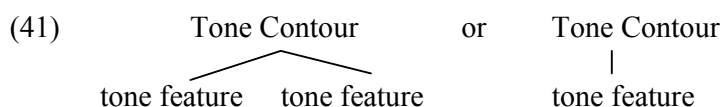
An account for F → L; L→ R and R → H in (3a-c) is then simply the effect of MAX[t] and DEP[t] under the influence of OCP[T]. F → L and R → H by the loss of the first tone feature, [low] and [high] respectively for the two cases above, violate MAX[t]. L → R is accounted for by the insertion of a [high] tone feature, violating DEP[t].[28] These constraints are presented in (42) (see also Yip 2002 for discussions on such general constraints on tones).

(42)   MAX[t]
        Do not delete tone features
        DEP[t]
        Do not insert tone features

With (37d-f), Chen (2000) proposes that they are special instances of OCP applying at a tone featural level suggesting OCP[t] with the effect of forbidding adjacent identical tone features.

(43)   OCP[t] [29]
        Do not allow adjacent identical tone features

To get F → H and R → L for (37d-f), all one needs to do is remove the offending element, which is the second tone feature of each composite tone. Thus, F

---

[27] I do not know if there are languages that prefer FF or RR adjacency over HH or LL, which if existent would complete the factorial typology. However, since contour tones are more marked than level tones anyway, such languages may be hard to find.
[28] Similarly for (3d-f), the second tone feature is deleted for R and F to produce R→ L and F→ H respectively.
[29] One may query if OCP can apply to contour tones when such tones are composed of more basic non-OCP violating units. The applicability of OCP on two levels have been made explicit in Yip (1989, 2002) and Bao (1990:208ff; 1999). OCP applying at different levels is not peculiar to tones, such patterns are also found in treatments on geminates and adjacent homorganic segments. Diagrammatically, a contour tone as represented in (40) has two levels, and phonological processes can apply to both.

becomes H when the [l] element is removed and similarly for R when the [h] element is removed.

(44)   Resolving OCP[t] violations

T   T_head

...   t   t   ...
             ↓
             ∅
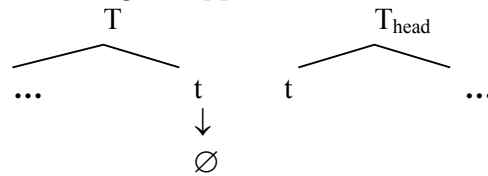
It should be noted that the OCP[t] account would erroneously predict that the FR tonal sequence should undergo sandhi to become HR since FR would also incur an OCP[l] violation. Not only that, HH does not incur tone sandhi either, but OCP[t] which triggers the RF → LF and RH → LH alternations would force HH to undergo sandhi even if OCP[H] is lowly ranked. Both these situations are not supported by the facts reported in Li and Liu (1985) or any of the subsequent investigations of Tianjin ditonal sandhi. Chen (2000), Wee (2004), Wee, Yan and Chen (2005) and even as recently as Lin (2008) have remained largely silent about these problems, as there appears to be no better solution than to stipulate them. After all, the OCP account works very nicely for all the other tone sandhi cases. I will return to these issues in section 4 when CSE facts are taken into consideration.

Tonal patterns of longer strings are derivable from the rudimentary rules in (37) and require little elaboration except for two remarks. Firstly as noted in Chen (2000, following Yip 1989), OCP[T] offences must be resolved before OCP[t], exemplified below in (45).

(45)   a.   /FFL/ → [LHL]
                i.   tsan saŋ fəŋ   "gain the upperhand"
                ii.   tsau ɕaŋ tɕi   "camera"
                iii.   sɿ sɿ san   "4-4-3"
                Derivation:
                FFL
                | by FF→ LF (cf. OCP[T])
                LFL
                  | by FL → HL (cf. OCP [t])
                LHL

        b.   /FLL/ → [FRL]
                i.   suŋ ɕɛn xua   "give fresh flowers"
                ii.   wai tɕau kuan   "diplomat"
                iii.   sɿ san san   "4-3-3"
                Derivation:
                FLL
                  | by LL → RL (cf. OCP[T])
                FRL   FL not applicable, no further sandhi applies

In (45,a b), underlining indicates the site of tone sandhi with vertical shafts connecting tones to their sandhied outcome. In these cases, one sees the competition between OCP[T] and OCP[t], and in order to obtained the attested results, OCP[T] must be resolved first. In (11b), the resolution of OCP[T] bleeds OCP[t] type sandhi.

Secondly when resolving OCP[T] offences, tone sandhi applies from left to right unless such an order of sandhi application produces derived OCP[T] violations in the process. This property becomes clear when one considers the cases of /LLL/ and /RRR/ simultaneously.

(46)   a.   /RRR/ → [HHR]

            i.   tsʅ y san   "paper umbrella"
            ii.   tsan lan kuan   "exhibition hall"
            iii.   tɕou wu tɕou   "9-5-9"

            Derivation:
            RRR
            | by RR → HR (cf. OCP[T])
            HRR
             | by RR → HR
            HHR

      b.   /LLL/ → [LRL]

            i.   kʰai fei tɕi   "fly an air plane"
            ii.   kuŋ tsʅ kau   "high salary"
            iii.   san pa san   "3-8-3"

            Derivation:
            LLL
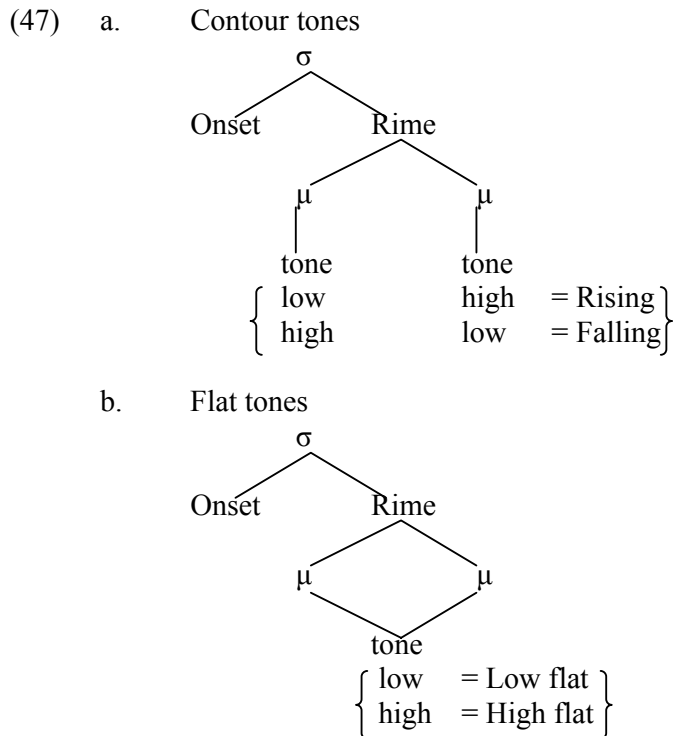 | by LL → RL (cf. OCP[T])
            LRL

As may be seen in (46a), the derivation of /RRR/ → [HHR] requires the rule to apply in counterbleeding order, creating what McCarthy (1998, 2003) would call non-surface apparent opacity since the RR→ HR rule has applied more than necessary to resolve all OCP[T] offending collocations. In this case, the order is from left to right. However, the reverse is true for (46b), where LL→ RL has applied in the bleeding order, removing both OCP[T] offending collocations in one alternation. The reason, according to Chen (2000), is that a left to right order for /LLL/ would create RRL as an intermediary, with an OCP[T] offending collocation interim. This preemptive clause that OCP[T] resolution cannot create interim OCP[T] offending sequences would account for the difference in directionality between (46a) and (46b).

       The points made in (45) and (46) do not lend themselves easily to a classical OT approach by nature of their derivational character. This does not concern us here, but an attempt at how OT can account for these patterns is available in Wee (2004) and Lin (2008). For the purpose of understanding Tianjin CSE, it would suffice for us to note the basic patterns of tone sandhi as triggered by OCP[T/t] and their interaction with the faithfulness constraints as illustrated in (39).

3.2.   *Tones from Syllable Mergers*

Following the above discussion of tones, and the earlier patterns of CSE, a natural question would be what happens to tones when syllables lose segmental material under CSE. Of particular relevance would be the compositionality of tones presented in (41). In Tianjin, this turns out to be quite straightforward. Since every syllable (apart from the toneless ones, see Wang 2002) is bimoraic, and contour tones are

compositional, it follows that the Tianjin tonal inventory could be derived by associating high or low tone features to each of the mora, as in (47).

(47) a.   Contour tones

```
                σ
             /     \
        Onset       Rime
                   /     \
                  μ       μ
                  |       |
                tone    tone
              {  low     high   = Rising }
              {  high    low    = Falling}
```

    b.   Flat tones

```
                σ
             /     \
        Onset       Rime
                   /   \
                  μ     μ
                   \   /
                   tone
              {  low   = Low flat  }
              {  high  = High flat }
```

Since the Tianjin syllable is bimoraic, the representations in (47) predict that the Tianjin dialect should have a tonal inventory of four: Low, High, Rising and Falling, as each tone feature [low] and [high] are associated to moras.[30] This prediction is clearly correct.

Another prediction of (47) is that for basic CSE at Window I, tones or merged syllables would be formed from the tones associated to the residue moras. This prediction is borne out, as can be seen in the examples in (48), relevant syllables underlined.

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[30] See also Morén and Zsiga (2006) for a similar discussion in Thai that contour tones are the result of different tone features associated to different moras of a syllable. Unlike Tianjin where level tones are not multiply-linked to two moras, Thai level tones are singly linked to the final mora so that L or H begin somewhere in the mid-tone then falls or rises respectively. In the phonetic studies of Li and Liu (1985) and Shi (1990), Tianjin level tones are generally quite leveled across the entire syllable.

(48)   Tones from merged syllables

```
            σ_initial              σ_medial          σ_final
          ┌──────┐            ┌──────┐
          μ        μ          μ        μ
          |        |          |        |
     I.   h       l/h        l/h       h     →    H
     II.  h       l/h        h/l       l     →    F
     III. l       h/l        l/h       h     →    R
     IV.  l       h/l        h/l       l     →    L
```

a.   Type I: H/F +R/H → H
    i.   liouH yR xuɛL → lyH xuɛL   name "Liu Yuhui"
    ii.   miH xouH tʰauH → mioH tʰauH   "peach"
    iii.   tsɔF pənR sanL → tsɔmH sanL   name " Zhao Benshan"
    iv.   taF xuŋH tɕʰauH → tɔŋH tɕʰauH   "Dahong Bridge"[31]

b.   Type II: H/F + F/L → F
    i.   puɔH uF kuanR → pouF kuanR   "museum"
    ii.   tɕyH xuaL tsʰaH → tɕyaF tsʰaH   "chrysanthemum tea"
    iii.   luF xuanF liŋH → luanF liŋH   name "Lu Huanling"
    iv.   iɛF tsauL ɕaH → iɛɔF ɕaH   name "Ye Zhaoxia"

c.   Type III: R/L + R/H → R
    i.   liR kuR iL → liuR iL   name "Li Guyi"
    ii.   ɕauR ɕuŋR maul → ɕɔŋR maul   "little panda"
    iii.   tsaŋL yR sənL → tsãĩR sənL   name "Zhang Yusheng"
    iv.   tsuŋL ɕyɛH sənL → tsuẽR sənL   "secondary school student"

d.   Type IV: R/L + F/L → L
    i.   tɕaŋR tɕɛF sʅH → tɕaɛL sʅH   "Chiang Kai Shek"
    ii.   liR tɕaL tsʰəŋH → liaL tsʰən   name "Li Ka Shing"
    iii.   tʰunL ɕynF yɛnH → tʰunL yɛnH   "correspondent"
    iv.   pauL kuŋL tʰouH → pɔŋL tʰou   "foreman"

To see exactly how this works, consider an illustration given in (49) below.

---

[31] For reasons totally mysterious to me, many speakers (Li Wenxin, personal communication) perceive the merged syllable as a F tone rather than H. However, in the pitch tracks I obtained for this utterance, the merged syllable is almost identical to the final syllable (H), and is distinct from the F of the (48b) cases.

(49) luF xuanF liŋH → luanF liŋH   name "Lu Huanling" (from 48biii)
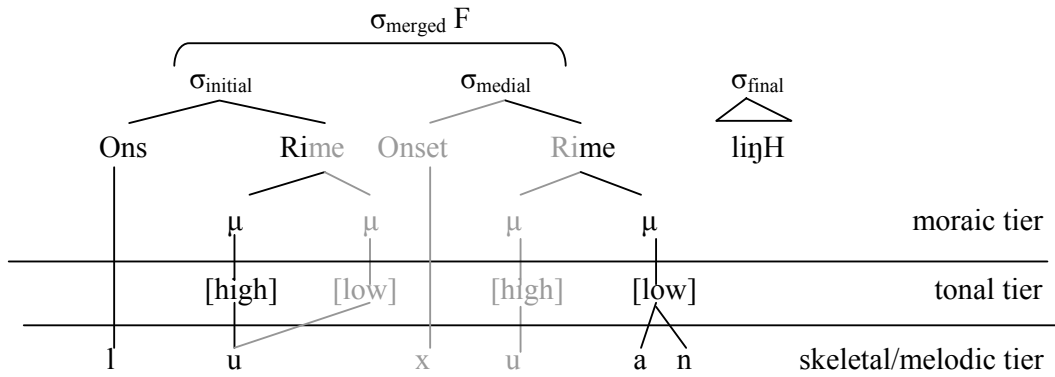
In (49), the resultant tone after merger is F, indicated as σ$_{merged}$F. Items in light grey are removed due to CSE, which include the medial onset, the second mora of the initial syllable, the first mora of the medial syllable and various segments removed by stray erasure for failure to be mapped. Tones and melodies are represented as autosegments on their respective tiers. It should be clear that this would work for all the examples in (48).

The model in (47) would likewise account for the second type of CSE where the onset of the medial syllable is preserved. The account in (32) would predict that for such cases, it is the tone of the initial syllable that would remain intact since those are the moras that stay after CSE (recall the representation in (36)). This is clearly seen in the data in (50).

(50) Onset Preserving CSE (from (31))

i.   t^{h}aiF piŋH iaŋH → t^{h}amF iaŋH   "the Pacific Ocean" (cf. (31iv))
ii.   paL liR t^{h}aiH → palL t^{h}aiH   place name "Balitai" (cf. (31vii))
iii. souR liuH tanF → solR tanF   "hand grenade" (cf. (31viii))

In (50), the underlined items on the left side of the arrow correspond to those on the right. It should be clear that the tone from the second syllable plays no role in what appears at the merged syllable.

The matter on post CSE tones supports the view that the mora is the tone bearing unit (TBU) in Tianjin, though earlier papers have variously argued for the syllable as TBU (Odden 1990; Clements 1984; Yip 1995b), or the mora as TBU (Clements 1986, Pulleyblank 1994; Duanmu 1990, 1994). As evidence for both positions grows, it is unsurprising when Yip (2002:73-76) suggests that TBU differs across languages, but the TBU must be a prosodic entity such as the syllable or the mora.

4.   Interaction between CSE and Tone Sandhi

4.1.   Ordering paradox in CSE and Tone Sandhi

Since elision and syllable mergers affect tones, it would be natural to wonder if one is ordered before the other. The clearest way to illustrate this would be to consider trisyllabic strings that have HLF and RLL tonal sequences which undergo Window I CSE. If CSE applies before sandhi, then HLF would surface as LF via FF when the

initial and medial syllables merge to form an F. Likewise, if CSE precedes sandhi, RL should merge to form an L, which then undergoes LL sandhi to emerge as RL. This is tested out in (51) and (52).

(51)   tɕiŋR kaŋL sanL → tɕiaŋR sanL   "Mt. Jinggang"
        a.   CSE first:

input		tɕiŋR kaŋL sanL	
Step 1	Elision	tɕiaŋL	sanL
Step 2	Tone sandhi	tɕiaŋR	sanL
output		tɕiaŋR	sanL

(LL→ RL)

        b.   Tone sandhi first:

input		tɕiŋR kaŋL sanL	
Step 1	Tone sandhi	tɕiŋH kaŋR sanL	
Step 2	Elision	tɕiaŋH	sanL
output		*tɕiaŋH	sanL

(LL→ RL; RR → HR)

(52)   ɕyɛH sənL tsʰuF → ɕyŋF tsʰuF   "Students Office"
        a.   CSE first:

input		ɕyɛH sənL tsʰuF	
Step 1	Elision	ɕyŋF	tsʰuF
Step 2	Tone sandhi	ɕyŋL	tsʰuF
output		*ɕyŋL	tsʰuF

(FF→ LF)

        b.   Tone sandhi first:

input		ɕyɛH sənL tsʰuF	
Step 1	Tone sandhi	n/a	
Step 2	Elision	ɕyŋF	tsʰuF
output		ɕyŋF	tsʰuF

The results in (51) and (52) present and ordering paradox. (51) shows that CSE should apply first followed by tone sandhi, but (52) requires the reverse ordering to get the counterfeeding effect of allowing a FF (sandhi-triggering) adjacency) to surface. Had CSE applied before tone sandhi consistently, one would have a very cozy picture of transparency, where the outcome of CSE either feeds or bleeds tone sandhi, what McCarthy (1998, 2003) describes as surface true and surface apparent). Little more needs to be said since OT would handle transparent situations very nicely. In this case, things appear to be very complicated since both (51) and (52) point in opposite directions. [32]

        A survey of other types of CSE indicates that generally, elision precedes tone sandhi. Consider (53), a case of onset preserving CSE, and (54), a case of total deletion of the medial syllable.

---

[32] Li (2006) reports similar difficulties with ordering of CSE and tone sandhi..

(53) tʰaiF pʰiŋH tɕiɛL → tʰamH tɕiɛL   "Peace Street"

a.   CSE first:

input		tʰaiF pʰiŋH tɕiɛL		
Step 1	Elision	tʰamF	tɕiɛL	Onset preserving CSE
Step 2	Tone sandhi	tʰamH	tɕiɛL	(FL→ HL)
output		tʰamH	tɕiɛL	

b.   Tone sandhi first:

input		tʰaiF pʰiŋH tɕiɛL		
Step 1	Tone sandhi	n/a		
Step 2	Elision	tʰamF	tɕiɛL	Onset preserving CSE
output		*tʰamF	tɕiɛL	

(54) tɕʰyɛnF iɛF tsʰaŋR → tɕʰyɛnF tsʰaŋR   name of a mall

a.   CSE first:

input		tɕʰyɛnF iɛF tsʰaŋR		
Step 1	Elision	tɕʰyɛnF	tsʰaŋR	Medial syllable
Step 2	Tone sandhi	n/a		
output		tɕʰyɛnF	tsʰaŋR	

b.   Tone sandhi first:

input		tɕʰyɛnF iɛF tsʰaŋR		
Step 1	Tone sandhi	tɕʰyɛnL iɛF tsʰaŋR		FF → LF
Step 2	Elision	tɕʰyɛnL	tsʰaŋR	Medial syllable
output		*tɕʰyɛnF	tsʰaŋR	

Given these facts, one way of resolving the paradox would be to assume that elision does precede sandhi, and the cases where sandhi fails to apply after elision are cases of tolerance or blocking of some kind. The non-application of sandhi to cases like (52) would have to be attributed to certain blocking mechanisms either along the lines Comparative Markedness (McCarthy 2002) or Phonological Blocking (Hall 2006). This issue would be taken up in the next subsection.

4.2.   Tolerance of sandhi-triggering sequences

Exploring into the the elision-sandhi interaction paradox, the corpus and recordings of Wee, Yan and Lu (2005) reveals that after merging, sandhi-triggering sequences FF, RF and RR are tolerated, as in (55).

(55)   a.   Merging produces FF
            i.   ɕyɛH səŋL tsʰuF → ɕyŋF tsʰuF   "Students Office"
            ii.   taF tsɻF pauF → taɻF pauF   "poster"
        b.   Merging produces RF
            i.   tsuŋL wənH ɕiF → tsuənR ɕiF   "Department of Chinese"
            ii.   souR_liuH tanF → solR tanF   "hand grenade"
        c.   Merging produces RR
            i.   xauR liɛnH tɕouR → xɔɛnR tɕouR   name "Hao Lianjiu"
            ii.   tɕaL xaiH iouR → tɕaeR iouR   "there's more at home"

There are, however, no cases of such tolerance for derived LL, FL or RH sequences, as shown in (56).

(56)　a.　Merging produces LL → RL
　　　　　i.　tɕɛR faŋF tɕynL → tɕaŋR tɕynL　　"People's Liberation Army"
　　　　　ii.　ɕinL tɕaL pʰuɔL → ɕiaR pʰuɔL　　"Singapore"
　　　b.　Merging produces RH → LH
　　　　　i.　tsaŋL xuŋH miŋH→ tsɔ̃ŋL miŋH name "Zhang Hongming"
　　　　　ii.　tsuŋL ɚR iɛnH → tʂũɚL iɛnH　　　"middle ear infection"
　　　c.　Merging produces FL → HL
　　　　　i.　xuH tɕaL tsuŋL → xuaH tsuŋL　　　name "Hu Jiazhong"
　　　　　ii.　uənH xuaF tɕɛL → uãH tɕɛL　　　"Culture Road"

In (56), the surface tones come about after sandhi has applied to the new merged tones. For example, in (56ai), *tɕɛR* and *faŋF* merge to first form *tɕaŋL*, which then undergoes sandhi triggered by the final *tɕynL* to become *tɕaŋR tɕynL* in the CSE form.

　　　What (51-55) show is that a transparent interpretation (elision before sandhi in rule-ordering terms) to the orders of tone sandhi and elision is more viable than an opaque one (sandhi before elision). Firstly, the transparent interpretation could appeal to an account for the cases in (52), (54) and (55) in terms of tolerance, but the opaque ordering would have no explanation to the cases in (56). So this is the case of choosing the lesser evil of two problematic accounts to the elision-sandhi ordering paradox. Secondly, a transparent interpretation is simpler to account for, both in OT and derivational terms. The next question is of course how one can account for the tolerance of RR, FF and RF sandhi-triggering sequences in CSE outputs.

　　　A simple solution would be to appeal to McCarthy's (2002) Comparative Markedness, so that derived RF, FF and RR are less marked than their underived counterparts. For LL, FL and RH, the derived sequences would be just as marked so that these sequences undergo sandhi whether or not they are produced by CSE. Constraint ranking typology certainly allows for this since each sandhi-triggering OCP [T/t] constraint and their "derived" counterparts must be allowed to be ranked with respect to each other. If such an approach is taken, the ranking for Tianjin would look something like (57).

(57)　Comparative Markedness Approach to the Ordering Paradox (preliminary)
　　　$OCP_O[T/t]$; $OCP_N[L/l]$ » M_{AX} [t] » $OCP_N[R/F]$ $OCP_N[h]$
　　　, where subscript O indicates underived; subscript N indicates derived
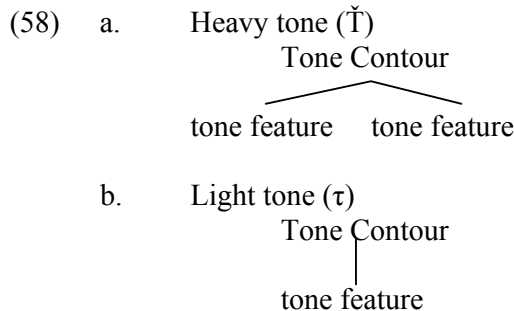
In (57), OCP[T/t] is a convenient collapse of OCP [T] and OCP[t], though where relevant, I have indicated exactly which tones are involved.

　　　(57) would produce the right results and the insight in making a distinction between derived sandhi-triggering sequences and underived ones is probably right. However, it does look weird that $OCP_N[L/l]$ should behave so differently from the other OCP_N constraints. Also, recall in section 3.1 that there is a similar sequence FR that is expected to trigger sandhi, but does not. The problem then was that FR is an OCP[h] violation which had to be ranked highly to trigger FL → HL. Though at first blush somewhat unrelated to the elision-sandhi paradox, there is one thing in common about the post elision sandhi-triggering sequences that are tolerated: the triggering tones (i.e. the tone on the right) are bi-featural, either [hl] =F or [lh] =R. With the

exception of LL→ RL, all other sandhi cases would yield monofeatural (level) tone on the left of a ditonal sequence.

4.3.   Tone weights, constraint conjunction and a reanalysis of ditonal sandhi

If one construes of bifeatureal tones as tonally heavy and monofeatural ones as tonally light (analogous to branching and non-branching rimes), then it would appear that tone sandhi seems to be producing tonally iambic cases. The cases where sandhi-triggering sequences are tolerated are precisely those where the head is at least tonally as heavy as the non-head.

(58)   a.   Heavy tone (Ť)
                      Tone Contour

                 tone feature   tone feature

        b.   Light tone (τ)
                      Tone Contour

                 tone feature

With (58), we see that ŤŤ and τŤ sequences are tolerated after CSE even if they are expected to undergo sandhi. Suppose one assumes that tonally, Tianjin is iambic, with a constraint that punishes Ťτ sequences, like *Ťτ.

(59)   *Ťτ
        Do not have ditonal sequences that are Ťτ.

The constraint in (59) is analogous to those that forbid feet that have the non-head syllables heavier than the head. In this case, the claim in (59) is that Tianjin is tonally iambic. Though such a claim may strike one as novel at first blush, strong substantiation comes from the fact that all ditonal sandhi in Tianjin applies only to the initial tone. The stability of the final tone suggests headship. Head finality is also supported by the CSE facts where the final syllable remains intact in all cases. Since there is nothing by way of vowel length to identify the meter of Tianjin, tone appears to be a very reliable source for figuring out Tianjin's prosody.

        With (59), it is necessary to see how it would be ranked with respect to the other constraints. The relevant cases in point are the following ditonal patterns.

(60)   a.   Sandhi cases
                 i.   /RF/ → [LF]
                 ii.   /RH/ → [LH]
                 iii.   /FL/ → [HL]
                 iv.   /LL/ → [RL]
        b.   Cases without sandhi
                 i..   /FR/ → [FR]
                 ii.   /HH/ → [HH]
                 iii.   /RL/ → [RL]
                 iv.   /FH/ → [FH]

Beginning with the cases in (60), it should be obvious that *Ťτ would disprefer [FH] and [RL], implying that MAX[t] » *Ťτ, shown below as (61a). Likewise, MAX[t] » OCP[l] because FR, which does not violate *Ťτ, remains unchanged even though it would violate OCP[l], shown as (61b). However, the case of /FL/→HL would show that OCP[l] and *Ťτ can gang up to overcome MAX[t] (constraint conjunction, Mohanan 1993, Smolensky 1993, 1997)

(61) a. Tolerance of *Ťτ violation

Input: RL	MAX[t]	*Ťτ
i. ☞ RL		*
ii. HL	*!	

b. Tolerance of OCP[l] violation

Input: FR	MAX[t]	OCP[l]
i. ☞ FR		*
ii. HR	*!	

c. Ganging-up effect of *Ťτ & OCP[l]

Input: FL	*Ťτ & OCP[l]	MAX[t]	*Ťτ	OCP[l]
i. FL	*!		*	*
ii. ☞ HL		*		

With (61), one now has a piece of the puzzle of the Tianjin ditonal sandhi patterns that was left out in the earlier analyses. The next piece would lie in the RF→LF and HH cases, where the strong influence of OCP[h] mysteriously does not apply to HH. The solution would again lie in the accurate placement of DEP[t] with respect to the OCP constraints, (62).

(62) a. Strong OCP[h]

Input: RF	OCP[h]	MAX[t]	*Ťτ
i. RF	*!		
ii. ☞LF		*	

b. Effects of DEP[t]

Input: HH	DEP[t]	OCP[h]	MAX[t]	*Ťτ
i. ☞HH		*		
ii. LH	*!		*	
iii. FH	*!			*

c. The strength of OCP[L]

Input: LL	OCP[L]	DEP[t]	OCP[l]	*Ťτ
i. ☞LL	*!		*	
ii. RL		*		*

In (62a), the powerful effect of OCP[h] can be seen as it overrides the requirements of MAX[t]. This power would have to be restrained for the HH cases, and that can be easily achieved with DEP[t]. The only case where DEP[t] is violated in Tianjin is in satisfaction of OCP[L], (62c). It is important to bear in mind the distinction between

OCP[T] and OCP[t] which apply to different levels in a compositional tonal representation such as that given earlier in (47) and (58).

With (61) and (62), all the pieces of Tianjin ditonal sandhi would be in place. The earlier analyses that accounted for Tianjin ditonal sandhi in terms of OCP[t/t] are right but incomplete, the missing piece is simply *Ťτ, with which a complete account can then be found with the right ranking of DEP[t] and a constraint conjunction with OCP[l]. Combined with the other patterns of ditonal sandhi given in section 3:(37), a ranking hierarchy would be as given in (63).

(63)   A Consistent Ranking Hierarchy for Tianjin Ditonal Sandhi

```
    OCP [L]    OCP [F]      OCP [R]
        \         |        /
              DEP[t]
                            *Ťτ & OCP[l]
           OCP[h]
                      \        /
                   MAX [t]
                   /        \
        *Ťτ    OCP[l]   OCP[H]
```
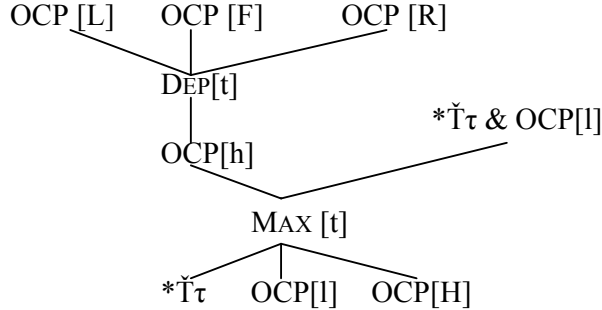
4.4.   Derived sandhi-triggering ditonal sequences

With *Ťτ, it is now possible to return to the issue of sandhi-triggering sequences derived from CSE outlined in section 4.2. The main difference between the CSE derived cases and the regular ditonal ones lies in the tolerance of RF, FF and RR. With the comparative markedness approach, all that is needed is for OCP$_N$[h] to rank below MAX[t]. This would account for why CSE derived RF stays unchanged, (64a). However, CSE derived RH→ LH. The earlier appeal in section 4.2 to *Ťτ would not be adequate since *Ťτ is ranked below MAX[t]. However, this can again be resolved by constraint conjunction, (64b).

(64)   a.   tsuŋL wənH ɕiF → tsuənR ɕiF   "Department of Chinese"

Input: Casual speech + tsuŋL wənH ɕiF	*Ťτ & OCP$_N$[h]	MAX[t]	*Ťτ	OCP$_N$[h]
i. ☞ tsuənR ɕiF				*
ii. tsuənL ɕiF		*!		

b.   tsaŋL xuŋH miŋH→ tsɔ̃ŋL miŋH   name "Zhang Hongming"

Input: Casual speech + tsaŋL xuŋH miŋH	*Ťτ & OCP$_N$[h]	MAX[t]	*Ťτ	OCP$_N$[h]
i. tsɔ̃ŋR miŋH	*!		*	*
ii. ☞ tsɔ̃ŋL miŋH		*		

The account for derived FL→HL and the lack of sandhi for derived FR is similar, only this time, involving OCP$_N$[l].

(65)　a.　puɔH uF kuanR → pouF kuanR　　　"museum"

Input: Casual speech + puɔH uF kuanR	*Ťτ & OCP_N[l]	MAX[t]	*Ťτ	OCP_N[l]
i. ☞ pouF kuanR				*
ii. pouH kuanR		*!		

　　b.　uənH xuaF tɕɛL → uãH tɕɛL　　　"Culture Road"

Input: Casual speech + uənH xuaF tɕɛL	*Ťτ & OCP_N[l]	MAX[t]	*Ťτ	OCP_N[l]
i. uãF tɕɛL	*!		*	*
ii. ☞ uãH tɕɛL		*		

CSE derived FF and RR sequences are tolerated too, and following the discussion in section 4.2, this is attributed to low-ranking OCP_N[R] and OCP_N[F]. But since CSE derived LL is not tolerated, OCP_N[L] must remain highly ranked.

(66)　a.　ɕyɛH sənL tsʰuF → ɕyŋF tsʰuF　　　"Students' Office"

Input: Casual speech + ɕyɛH sənL tsʰuF	*Ťτ	MAX[t]	OCP_N[F]
i. ☞ɕyŋF tsʰuF			*
ii. ɕyŋL tsʰuF		*!	

　　b.　tɕaL xaiH iouR → tɕaeR iouR　　　"there's more at home"

Input: Casual speech + tɕaL xaiH iouR	*Ťτ	MAX[t]	OCP_N[R]
i. ☞ tɕaeR iouR			*
ii. tɕaeH iouR		*!	

　　c.　tɕɛR faŋF tɕynL → tɕaŋR tɕynL　　"People's Liberation Army"

Input: Casual speech + tɕɛR faŋF tɕynL	OCP_N[L]	DEP[t]	*Ťτ
i. tɕaŋL tɕynL	*!		
ii. ☞ tɕaŋR tɕynL		*	*

　　　The complete ranking hierarchy that would produce the full range of ditonal sandhi in Tianjin across both regular speech and CSE is thus as given in (67).

(67)　Tianjin Ditonal Sandhi (regular speech and CSE)

OCP_O/N[L]　　　　　OCP_O[F]　　　　　　OCP_O[R]

DEP[T]

*Ťτ&OCP_O[l]　　　　　　　　　*Ťτ & OCP_N[t]

OCP_O[h]

MAX [t]

*Ťτ　OCP_O[l]　　OCP_O/N[H]　OCP_N[t]　　OCP_N[F]　　OCP_N[R]
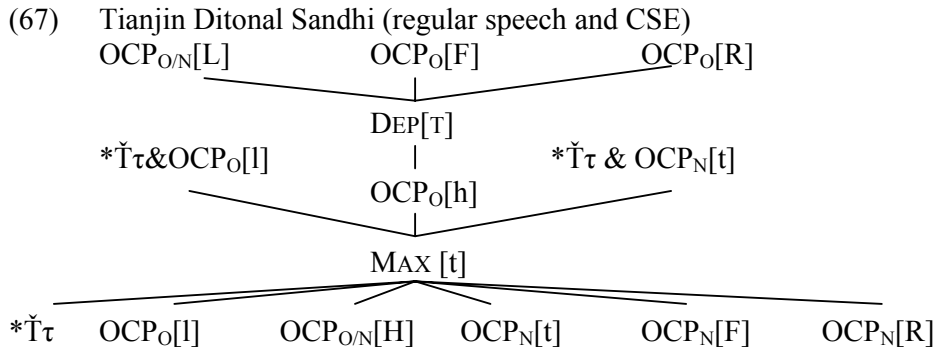
5.   Conclusion

This paper studies Casual Speech Elision (CSE) of Tianjin, and how an account of it must incorporate the facts of tone sandhi. The key to understanding CSE lies in a bimoraic syllable architecture and how vowels coalesce when residue moras from the initial and medial syllables merge to form a new syllable. Because moras are the tone-bearing units of Tianjin, such a merger also brings about a new tone based on the tones associated to the residue moras, which are then subject to possible tone sandhi.

To see how CSE interacts with tone sandhi, it is first necessary to see how tone sandhi works in Tianjin, an area well researched since the 1980s (Li and Liu 1985; Chen 1986, 2000; Tan 1987; Zhang 1987; Miliken et al 1997; Wang 2002). While all of them converge on the relevance of two levels of OCP (Yip 1989, one at the level of the full tone contour, OCP[T]; and another at the level of compositional tone features, OCP[t]), there were persistent gaps that remained unexplained: (i) why did FR not undergo sandhi when FL→HL? (ii) Even if OCP[H] is ranked low, why does HH not undergo tone sandhi when OCP[h] must be ranked high as evidenced by RF→LF and RH→LH? Together with the puzzle on why some sandhi-triggering sequences derived from CSE are allowed to surface unaltered, this brought about an account that appealed to tonal complexity for prosodic headship. In so doing, it became apparent that the OCP[T/t] constraint family has to be carefully teased apart so that each OCP constraint is allowed to interact with the faithfulness constraints that preserve tonal features and the prosodic constraints on tonal complexity.

Thus, not only does one arrive at an account for CSE that takes care of tone sandhi, one would also have successfully addressed the long standing puzzling gaps in basic Tianjin ditonal alternation patterns.

Appendix: Gestural Overlap and Tianjin CSE

Given the casual nature of CSE, it would be surprising if gestural overlap has no role to play in a full account. After all, this can be clearly seen in examples where vowels are nasalized after elision, such as (A-1).

(A-1) ɕiŋ xua tsʰuən → ɕy ã tsʰuən "gingko blossom village" (cf. (24v)

       Following Cohn (1993a,b), this can easily be accounted for since lowering of the velum to allow nasal airflow does not interfere in anyway with the movement of the other articulators, except for the production of plosives. In fact, such an account would explain why certain segments are capable of blocking nasal spreading but not others. However, as Zsiga (1997) clearly demonstrated in her treatment of Igbo, not all phonological processes are amendable to a gestural account. In fact, cases where there are categorical shifts must be largely phonological, though it is possible to provide a framework for mapping the gestural overlaps to the phonological (abstract) features. The cases in Tianjin CSE by and large support this view. Consider first of all the loss of obstruent onset segments of the medial syllable in cases like (A-2).

(A-2) pei tsʰən tɕʰy → pen tɕʰy   "Beichen area" (cf. (24vi))

       For a gestural overlap account to work, one would expect at least some traces of [i] or [tsʰ]. It is particularly telling that neither the [-continuant] nature of [t] nor the fricative nature of [s] and [h] are found in the output, nor is there any trace of coronality, at least not acoustically.

(A-3)   Waveform and spectrogram of CSE form: pen tɕʰy "Beichen area"


[p   e   n   tɕ ʰ   y   ]
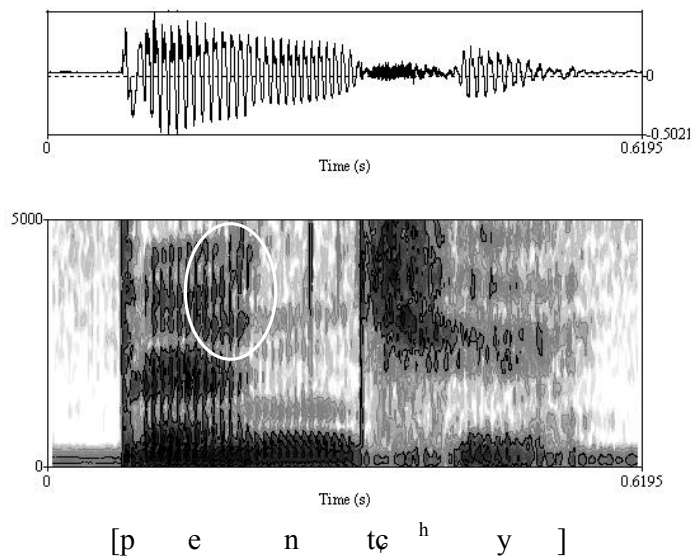
Spectrographic analyses such as (A-3) may obscure articulatory gestures since it is certainly possible to gesture in such a way that acoustic effects may be masked. However, if gestures are to be linguistically relevant, then it must also have some acoustic manifestation, without which the gesture is plainly vacuous.

As such, while it is not impossible to conceive of (A-3) as gestural overlap, it would require so much overlap as to make quite a few segments hidden from obvious detection (unlike the case of nasality given in Cohn 1993a,b where traces of the overlapping elements, i.e. the nasality of vowels and other phones, remain visible). This is possible along the lines of Davidson (2006), where total elision may still be possibly attributed to overlap, though Davidson's account dealt only with schwa, and there is a lot more at stake here. In any case, an account would still be needed for how far the overlap would have to go, consequently being not too different from a phonological account of segmental elision.

A second thing to consider would be with respect to vowel coalescence, which too can be conceived as gestural overlap of adjacent vowels, this time primarily in the tongue positions. In the case of (A-3) above, ignoring the [n.tɕʰ] that are lost, overlapping of tongue gestures would involve [e, i] and possibly [ə].In the formant profile between [e] and [n] in (A-3), there is a fairly prominent transition (circled in white) that might suggest the overlapping of [e] and [i]. However, it would still be necessary to explain why much of the nucleus of the first syllable is [e] and not [i], which presumably falls back on theories of syllabification and sonority. In any case, there are cases like (A-4).

(A-4)   tuŋ faŋ xuŋ   → tɔŋ xuŋ   "The east is red" (cf. (24iv))

[t   ɔ   ŋ   x   u   ŋ]
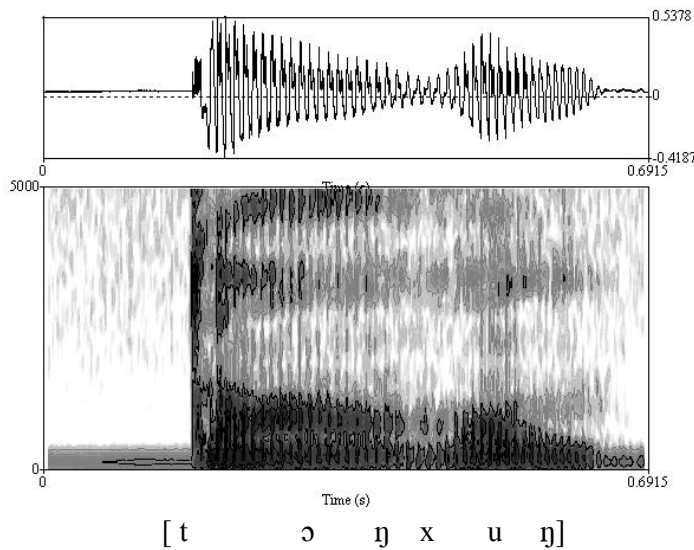
Though in (A-4) there is a transition between [t] and [ɔ], the fact that it is [ɔ] and not [a] even towards the beginning of [ŋ] shows that a purely gestural overlapping account would a require [labiality] of [u] to go so far as to make overlapping identical to categorical shifts (though Flemming 2001 would argue that these stem from the same constraints in the same system). In an overlapping account (a case of timing gestural movements, Zsiga 1997, 2000), one would expect an [a]-like presence before [ŋ]. This is not so clearly supported by the phonetic facts.

A third consideration is with regards to tone. Given a gestural overlap account, an /FLL/ input would under CSE produce an FL output where the F is a matter of tonal interpolation between the initial high point of F and the end point of the medial L or (ii). The fall that stretches across the residue segments of the initial and medial

syllables could be gradual or it could fall sharply followed by an extended L of the final syllable. (A-5) presents one such case in point.

(A-5)   xuH tɕaL tsuŋL → xuaH tsuŋL name "Hu Jiazhong" (cf. (56ci))
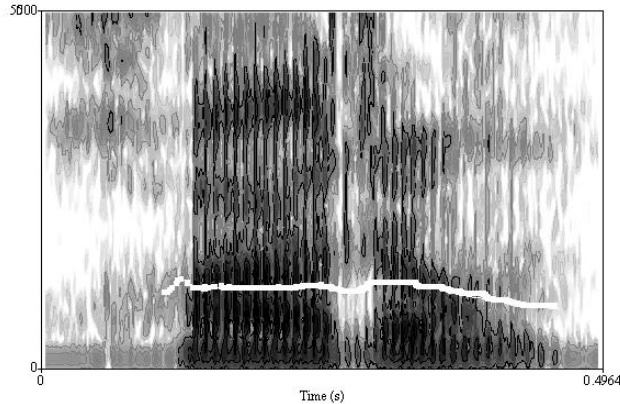
The thing about (A-5) is that the CSE output simply has a H tone for the merged syllable as can be seen in the pitch tracks superimposed on the spectrograms. In fact, the approach to the final L starts only after the beginning of final syllable. The H tone of the merged syllable is easily explained by the tone sandhi rule FL → HL, which involves a categorical shift not easily amendable to gestural overlap under CSE.

In summary, though gestural overlap would be necessary for a full phonetic description of the CSE patterns in Tianjin, much of the explanation to the key patterns remain within the domain of phonological features (echoing the conclusions dawn in Zsiga 2000). There is no conflict between the account presented in this paper and gestural overlap, in fact, both ideas would be needed for a detailed understanding. What this appendix hopes to show is that there is a phonological aspect that must be addressed even in something like CSE where gestural overlap would seem to be an obvious answer. This would seem like a trivial point to anyone who makes a distinction between how a grammar is organized in the mind and how that grammar must be executed by the physical human articulatory apparatus. After all, is it not equally obvious that our bodies may not execute what our minds demand (let's say in trying to draw a perfectly straight line)?

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