The /n/-/ŋ/ Asymmetry upon /#/-Suffixation in Beijing and Elsewhere -- A Phonetically Based OT Analysis

The /n/-/ŋ/ Asymmetry upon /ɻ/-Suffixation in Beijing and Elsewhere --A Phonetically Based OT Analysis

Jie Zhang

University of California, Los Angeles

0. Introduction

In many northern Chinese dialects, a suffix /ɻ/ can be added to a monosyllabic noun stem to indicate the diminutive meaning of the noun. This paper focuses on the realization of the coda nasal of the stem--/n/ or /ŋ/--in the /ɻ/-suffixed forms. First, a dialectal survey of the realization patterns of the coda nasals in the suffixed forms is discussed. The survey reveals that the stems closed by /ŋ/ are more inclined to preserve the nasality than the stems closed by /n/ upon /ɻ/-suffixation. A phonetic study on Beijing Mandarin is then documented. The results show that in the unsuffixed forms, the /ŋ/ coda induces a longer nasal flow duration and a greater nasal flow volume than the /n/ coda. Based on the experimental results, I propose an Optimality Theoretic analysis for the surveyed dialects, arguing that the different phonological behavior of /n/ and /ŋ/ is due to a phonetically based universal ranking: $\mathbf{Max([+nas]_{ŋ}) \geq\geq Max([+nas]_{n})}$. Finally, an alternative account for Beijing Mandarin is reviewed, and the advantages of the analysis I propose are outlined.

1. A Dialectal Survey

1.1. Dialects in which /CVŋ/≠/CVn/ upon /ɻ/-Suffixation

In Beijing (Dow 1972, 1984, Lin and Wang 1992), Zhengzhou (Lu 1992), and many other northern Chinese dialects, upon /ɻ/-suffixation, the nasal codas in both /CVn/ and /CVŋ/ stems are lost, but the stem vowel in /CVŋ/+/ɻ/ becomes heavily nasalized while the stem vowel in /CVn/+/ɻ/ stays oral, resulting in neutralization between /CVn/+/ɻ/ and /CV/+/ɻ/. Examples from Beijing are given in (1).[1, 2] Other northern Chinese dialects which have the similar behavior include Juxian (Shi 1995), Changhai (Li 1981), Huojia

[1] In some of the examples given, aside from nasalization, there are also vowel changes that accompany the loss of the nasal coda. These changes, to the best of my knowledge, are not relevant to the current investigation. Readers are advised to ignore these changes for the time being for simplicity reasons. The tones and tone sandhi processes that accompany the /ɻ/-suffixation are not relevant to the issue in question either and are thus not indicated in the examples.

[2] The notations in the original literature are modified to standard IPA.

Pius Tamanji, Masako Hirotani, and Nancy Hall (eds.), NELS 29: 193-208

(He 1982), Harbin (Yin 1995), Wulumuqi (Zhou 1994), Xiangcheng (Liu 1993), Muping (Luo 1995), etc.

(1) Beijing

/CV/+/ɨ/→[CVɻ]:	/pʰa/+/ɻ/→[pʰaɻ]	"rake"
	/sɨˢ/+/ɻ/→[sɨˢɻ][3]	"silk"
/CVn/+/ɨ/→[CVɻ]:	/pʰan/+/ɻ/→[pʰaɻ]	"plate"
	/ɕin/+/ɻ/→[ɕiɻ]	"heart"
/CVŋ/+/ɨ/→[CṼɻ]:	/pʰɑŋ/+/ɻ/→[pʰɑ̃ɻ]	"side"
	/ɕiŋ/+/ɻ/→[ɕiə̃ɻ]	"star"

In a few other dialects, when the stem has a /Vŋ/ rime, the /ɨ/-suffix cannot blend with the stem to form a rhotacized syllable as in Beijing Mandarin. Rather, it is realized as a separate syllable following the stem, leaving the stem unchanged. But when the stem has a /Vn/ rime, the /ɨ/-suffix overlaps with the stem as in Beijing and Zhengzhou, deleting the nasal coda of the stem and leaving the stem vowel nasalized or non-nasalized.

Mancheng, a dialect spoken in Hebei Province, prohibits the /ɨ/-suffix to overlap with a /Vŋ/ rime, but not with a /Vn/ rime. The stem vowel in a /Vn/ rime is left non-nasalized while the nasal coda is deleted upon /ɨ/-suffixation (Chen 1988). Some examples of Mancheng are given in (2).

(2) Mancheng (Chen 1988)

/CV/+/ɨ/→[CVɻ]:	/pa/+/ɻ/→[pɐɻ]	"handle"
	/tɕi/+/ɻ/→[tɕiəɻ]	"chicken"
/CVn/+/ɨ/→[CVɻ]:	/mən/+/ɻ/→[məɻ]	"door"
	/pʰan/+/ɻ/→[pʰɐɻ]	"plate"
/CVŋ/+/ɨ/→[CVŋ]+[ŋəɻ]:	/iaŋ/+/ɻ/→[iaŋ]+[ŋəɻ]	"sheep"
	/ɕiŋ/+/ɻ/→[ɕiŋ]+[ŋəɻ]	"apricot"

Anqing, a dialect spoken in Anhui Province, behaves similarly to Mancheng except that the stem vowel in a /Vn/ rime is nasalized when the nasal coda is deleted upon /ɻ/-suffixation (Hao 1982). Examples from this dialect are given in (3).

(3) Anqing (Hao 1982)

/CV/+/ɨ/→[CVɻ]:	/po/+/ɻ/→[poɻ]	"ball"
	/xa/+/ɻ/→[xaɻ]	"a while"
/CVn/+/ɨ/→[CṼɻ]:	/pan/+/ɻ/→[pã̠ɻ]	"plank"
	/tɕʰien/+/ɻ/→[tɕʰiẽɻ]	"before"
/CVŋ/+/ɨ/→[CVŋ]+[ŋəɻ]:	/noŋ/+/ɻ/→[noŋ]+[ŋəɻ]	"coop"

1.2. Dialects in which /CVŋ/=/CVn/ upon /ɻ/-Suffixation

Dialects in which /CVŋ/ and /CVn/ behave identically in the suffixation process are also attested. A number of dialects do not have nasalization on the stem vowel in either /CVŋ/+/ɨ/ or /CVn/+/ɨ/. Liaocheng (Zhang 1995), Chengdu (Yuan 1989), Nanjing (Liu

[3] The phonetic symbol [ɨˢ] represents the so-called apical vowel or syllabic fricative which occurs after [s] in northern Chinese dialects.

1997), Yinchuan (Gao and Zhang 1997) and Miyang (Li 1996) are cases of this sort. Examples of Liaocheng are given in (4).

(4) Liaocheng (Zhang 1995)

/CV/+/ɨ/→[CVɻ]:	/pa/+/ɻ/→[pɐɻ]	"handle"
	/i/+/ɻ/→[ieɻ]	"one"
/CVn/+/ɨ/→[CVɻ]:	/in/+/ɻ/→[ieɻ]	"sound"
	/uən/+/ɻ/→[ueɻ]	"lines"
/CVŋ/+/ɨ/→[CVɻ]:	/pɑŋ/+/ɻ/→[pɐɻ]	"side"
	/iŋ/+/ɻ/→[iəɻ]	"shadow"

On very rare occasions, the stem vowels in both /CVn/ and /CVŋ/ are nasalized upon suffixation. Only one marginal case of this sort was found in the typological study– Jiyuan (He 1981, Duanmu 1990, Lin 1993). It is marginal because there are two diminutive suffixes in Jiyuan, but as argued in Duanmu (1990) and Lin (1993), neither of them is /ɨ/. Duanmu (1990) claims that the first diminutive suffix is a segment with the feature [+back, +round], and Lin (1993) suggests the feature bundle [-back, +round] for the second diminutive suffix.[4] Some examples of the correspondence between the root rime and the two diminutive rimes is given in (5a) and (5b).

(5) Jiyuan (He 1981, Duanmu 1990, Lin 1993)

a. Diminutive suffix I:

Root Rime	Diminutive Rime
u, uʔ	u
a, au, aʔ, e	ɔ
an	ã
ian	iã
uan	uã
aŋ	ɔ̃
iaŋ	iɔ̃
uaŋ	uɔ̃

b. Diminutive suffix II:

Root Rime	Diminutive Rime
i	iɥ
u	uɥ
a	æ
əw, əy	əɥ
ən, əŋ	ə̃ɥ
in, iŋ	ĩɥ
un, uŋ	ũɥ
yn, yŋ	ỹɥ

1.3. Summary of the Survey

Although how /CVn/ and /CVŋ/ differ in their realization upon /ɻ/-suffixation is not always the same across dialects, the directionality of the difference is the same. Namely, it is always more important to preserve the nasality in /ŋ/ than that in /n/. The difference is shown either by nasalization of the vowel in /CVŋ/+/ɻ/, but not in the other, or by simply requiring the /CVŋ/ rimes to be intact upon /ɻ/-suffixation. The opposite situation where the nasality of /n/ is more prominently preserved than that of /ŋ/ is not attested to the best of my knowledge.

2. A Phonetic Study of Unsuffixed Words in Beijing Mandarin

2.1. Hypothesis and Method

To better understand the nature of the /n/-/ŋ/ asymmetry upon /ɻ/-suffixation, a phonetic study on the unsuffixed words of Beijing Mandarin was conducted. The following hypotheses were to be tested in the experiment:

[4] He (1981) claims that historically, only the second suffix is the /ɻ/ suffix in Jiyuan. The first suffix is the so-called /zi/ suffix in traditional Chinese. Both suffixes are diminutive. But since neither suffix has a close resemblance to its claimed segmentals, we take both suffixes into consideration here.

(6) a. The vowel before /ŋ/ has a longer nasal flow duration than that before /n/.
b. Overall, a /Vŋ/ rime has a longer nasal flow duration than a /Vn/ rime.

The basis for the hypothesis is that if the nasality induced by /ŋ/ involves a longer articulatory gesture and is perceptually more salient than that induced by /n/ in the unsuffixed forms, then the nasality of /ŋ/ being more prominently preserved in the suffixed forms will have a phonetically natural explanation in Beijing Mandarin. Of course, the claim that the perceptual salience plays a role here is made under the assumption that the nasal flow duration is a major correlate of the perception of nasality.

Two male native speakers of Beijing Mandarin--JZ and HL--participated in the study. The first speaker is the author. The test words include six pairs of /CVn/ and /CVŋ/ words. In each pair, C is a matching unaspirated oral stop or affricate and V is a matching vowel. All words have the high-level tone. A sample of the word list is given in (7).

(7)

/tan˥/	"sheet"	/taŋ˥/	"crotch (of pants)"
/ɕin˥/	"heart"	/ɕiŋ˥/	"star"
/sɤn˥/	"forest"	/sɤŋ˥/	"monk"

The test words were read in the carrier sentence in (8).

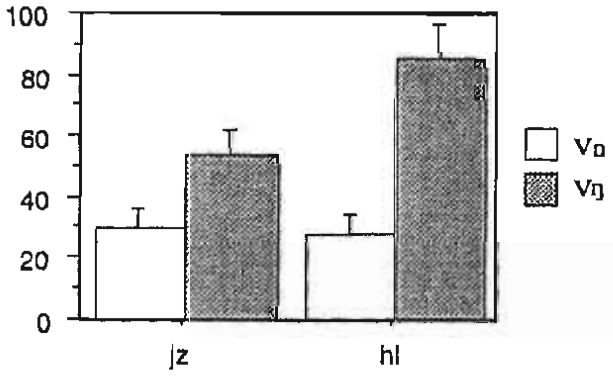
(8) [wo $ʂ^{w}$o ___ tʂɤ kɤ tsi^{s}]
"I say ___ this measure-word character."

Each sentence was read with five repetitions. The order of the sentences was random. Macquirer--an aerodynamic data acquisition system--was used to collect the nasal flow, oral flow and the audio signal of the sentences.

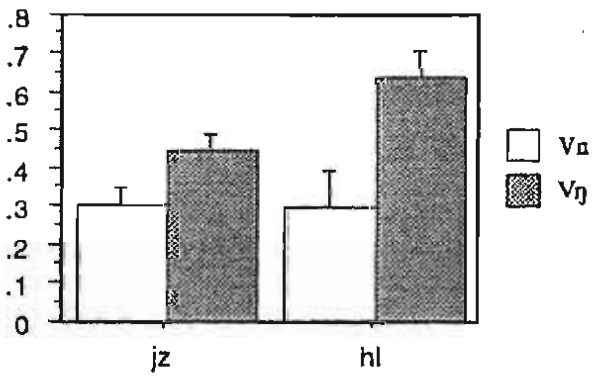
2.2. Results and Discussion

Results of the nasal flow duration measurements for the vowels in the unsuffixed forms /CVn/ and /CVŋ/ are given in (9).

(9) a. Nasal flow duration during the vowel (ms):



b. Nasalized vowel duration: Overall vowel duration

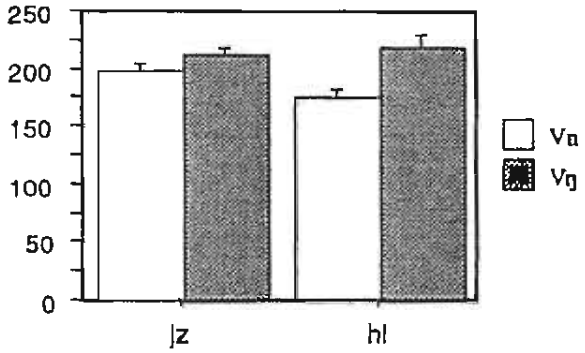


The bar plot in (9a) represents the absolute duration value for the nasal flow within the vowel, while the bar plot in (9b) shows the percentage of the nasalization duration of the vowel to the overall duration of the vowel. The results indicate that for both speakers, there is a significant difference between /Vn/ and /Vŋ/ with respect to the duration of the nasalized portion of the vowel, both in terms of the absolute duration and in terms of the relative percentage ($p<0.0001$). Therefore, hypothesis (6a) is supported by the experiment.

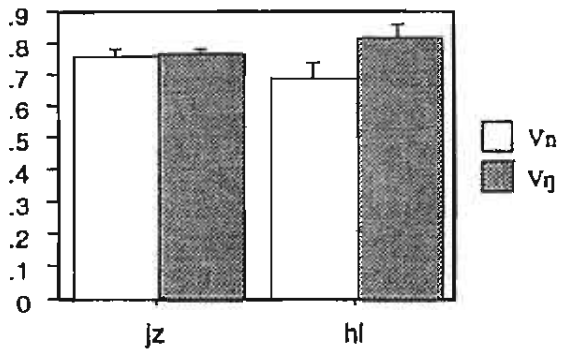
in the unsuffixed forms, the vowel before /ŋ/ has a longer nasal flow duration than the vowel before /n/.

The graphs in (10) show the duration of the nasal flow for the entire rimes /Vn/ and /Vŋ/. Figure (10a) indicates that the absolute nasal flow duration for the /Vŋ/ rimes is significantly longer than that for the /Vn/ rimes for both speakers ($p<0.05$ for JZ, $p<0.0001$ for HL). Figure (10b) shows that there is no consistent difference between /Vn/ and /Vŋ/ in terms of the percentage of the nasal flow duration in the entire rime duration ($p>0.05$ for JZ, $p<0.0001$ for HL). Therefore, we can only claim that hypothesis (6b) is partially supported by the phonetic results: a /Vŋ/ rime has a longer nasal flow duration than a /Vn/ rime in the unsuffixed forms, but only in the sense of the absolute values.

(10) a. Nasal flow duration in the rime (ms):



b. Nasal flow duration in the rime: Overall rime duration



How do the above phonetic results shed light on the /n/-/ŋ/ asymmetry observed in the phonological patterning of Beijing and elsewhere? Articulatorily, we have the result that the velum lowering gesture is longer for the /Vŋ/ rimes than for the /Vn/ rimes (9a, 10a). Perceptually, if we assume that the speakers are more sensitive to unexpected nasalization, namely, the nasalization on the vowel, than they are to expected nasalization, namely, the nasalization of the nasal, then even though there is no significant difference on the percentage of nasalization duration between the entire /Vn/ and /Vŋ/ rimes, the fact that there is a significant difference on the vowels will indicate that the speakers will perceive the /Vŋ/ rimes as being more nasalized than the /Vn/ rimes. I therefore conclude that the [+nas] feature for /Vŋ/ is stronger than that for /Vn/, both articulatorily and perceptually.

In the OT literature, the idea of universal rankings governed by phonetic scales has been entertained by many previous researchers (cf. Steriade 1995, 1997, Jun 1995, Gordon 1998a, b, Beckman 1998, among others). For example, Steriade (1997) argues that the cross-linguistic patterns of laryngeal neutralization can be understood if we employ a series of universally-ranked constraints requiring various perceptual cues for the laryngeal feature to be present and interleave them with the faithfulness constraint. Jun (1995) illustrates the necessity of universal rankings among faithfulness constraints on place features in the account of place assimilation, basing the universal rankings on the production and perception of consonants of different places. Beckman (1998) demonstrates that the input-output correspondence in prosodically strong positions, such as roots, stressed syllables, syllable onsets, should be singled out and outrank the general correspondence constraints, therefore accounting for the wider range of contrasts in these positions, presumably under the assumption that prosodically strong positions offer better perceptual cues for the features in questions. The case under discussion here can be looked at in a similar vein--a feature is more likely to be preserved if it is phonetically stronger. Therefore, the [+nas] feature associated with /ŋ/ is more prominently preserved than that associated with /n/. An important theoretical claim to be made here is that a universal

ranking can be invoked according to the inherent strength of one single feature, even though the difference in strength of a single feature is phonologically non-contrastive, and maybe phonetically very small.

In point of projecting the phonetic results from Beijing to the other Chinese dialects surveyed above, we make the assumption that the results of Beijing Mandarin can be replicated in these dialects as well. Unfortunately, there is not enough phonetic documentation in these dialects that can justify this assumption, and this has to be left as a task for future research. But given the close relation among northern Chinese dialects, an assumption as such does not seem too unreasonable.

Therefore we claim that in the northern Chinese dialects surveyed above, the nasality of /ŋ/ is more prominently preserved than that of /n/ in the suffixed forms because the former is both articulatorily and perceptually stronger in the unsuffixed forms. This idea is formalized in an OT analysis in the following section.

3. An Optimality-Theoretic Account

3.1. Constraints and Universal Ranking

Two types of constraints are crucial in the analysis of the /n/-/ŋ/ asymmetry in these Chinese dialects–faithfulness constraints and phonotactic constraints. The faithfulness constraints require the root and the suffix to be faithfully realized in the surface form, while the phonotactic constraints require the surface form to be phonotactically well-formed. The proposed faithfulness constraints that are relevant to the analyses are given in (11).

(11) a. **Max**($[+\text{nas}]_{\eta}$): preserve the nasality of /ŋ/.
b. **Max**($[+\text{nas}]_{n}$): preserve the nasality of /n/.
c. **RealizeAffix**: affixes must be realized.

The first two constraints require the nasality of /ŋ/ and /n/ to be realized in the suffixed form, respectively. The reason why we need to separate the **Max**([+nas]) constraint into two will become clear in the case studies. **RealizeAffix**, in the cases in question, requires the diminutive suffix to be realized in the suffixed form. This can be deemed as an OT rendition of the Affix Manifestation Principle proposed by Lin (1993).

The key point to the analysis is the universal ranking between the two **Max**([+nas]) constraints, given in (12).

(12) **Max**($[+\text{nas}]_{\eta}$) ≥≥ **Max**($[+\text{nas}]_{n}$)
("≥≥": either outranks or is ranked as high as)

This universal ranking is licensed by the results of the phonetic study discussed above, according to which, we may interpret (11a) as **Max**($[+\text{nas}]_{\textbf{long-gesture}}$), and (11b) as **Max**($[+\text{nas}]_{\textbf{short-gesture}}$). Therefore, the constraint ranking in (12) can be interpreted as a specific rendition of a general ranking schema in (13).

(13) **Max**($[\text{F}]_{\textbf{long-gesture}}$) ≥≥ **Max**($[\text{F}]_{\textbf{short-gesture}}$)

The phonotactic constraints are given in (14).

(14) a. ***ComplexCoda**: no complex coda is allowed.
b. ***NasalVowel**: no nasal vowel is allowed.
c. **MaximumWord**: the suffixed form must be one syllable.

***ComplexCoda** bans syllables with complex codas, and ***NasalVowel** bans syllables with vowels that are nasalized in most of their duration. As for **MaximumWord**, the motivation lies in the common Chinese preference for disyllables—since the suffixed form is usually used with another monosyllabic morpheme to form a compound word, e.g., *paŋ˥*, "side", *pjan˧ pāɻ˥*, "radical (in Chinese writing)", it is preferred to be monosyllabic, thus guaranteeing the disyllabicity of the compound word.

Now we will give analyses for the different dialects we discussed in the survey by appealing to the constraints and their universal ranking I proposed. The dialectal variation is accounted for by different rankings of the constraints.

3.2. Case Studies

3.2.1. Beijing

The relevant data pattern in Beijing Mandarin (as well as Zhengzhou, Juxian, etc.) is recapitulated in (15).

(15) /CVn/+/ɻ/→[CVɻ]; /CVŋ/+/ɻ/→[CṼɻ]

In these dialects, upon /ɻ/-suffixation, both /n/ and /ŋ/ are lost. But only when the stem coda is /ŋ/ is the vowel nasalized after the suffix is added. These facts indicate that **Max([+nas]$_{ŋ}$)** is more highly ranked than ***NasalVowel**, and ***NasalVowel** is in turn more highly ranked than **Max([+nas]$_{n}$)**. ***ComplexCoda**, **RealizeAffix** and **MaximumWord** are never violated, and I assume that they are all undominated in the grammar. Therefore, the constraint ranking that accounts for the data pattern in Beijing Mandarin is revealed as in (16). The relevant tableaux are shown in (17).

(16) ***ComplexCoda, RealizeAffix, MaximumWord, Max([+nas]$_{ŋ}$)**
⇓
***NasalVowel**
⇓
Max([+nas]$_{n}$)

(17) a. /CVn/+/ɻ/→[CVɻ]

CVn+ɻ	*Comp Coda	Realize Affix	Maxim Word	Max ([+nas]$_{ŋ}$)	*Nasal Vowel	Max ([+nas]$_{n}$)
☞CVɻ						*
CṼɻ					*!	

b. /CVŋ/+/ɻ/→[CṼɻ]

CVŋ+ɻ	*Comp Coda	Realize Affix	Maxim Word	Max ([+nas]$_{ŋ}$)	*Nasal Vowel	Max ([+nas]$_{n}$)
CVɻ				*!		
☞CṼɻ					*	

3.2.2. Mancheng

The relevant data pattern in Mancheng is repeated in (18). In Mancheng, when the stem is closed by /n/, the nasal is dropped entirely upon /ɻ/-suffixation, but when the stem

is closed by /ŋ/, the /ɻ/-suffix is realized in a different syllable, and the vowel remains oral, or at most partially nasalized.

(18) /CVn/+/ɻ/→[CVɻ]; /CVŋ/+/ɻ/→[CVŋ]+[ŋəɻ]

To account for this data pattern, we need to make the following modification to the evaluation of the faithfulness constraints regarding the nasals: the constraints are only satisfied when the nasal itself is fully preserved in the output. They receive one violation if the nasality is only preserved on the vowel, and they receive two violations if the nasality is completely lost. This is illustrated in (19).

(19) **Max([+nas]$_N$)**: /CVN/ → [CVN] √
/CVN/ → [CṼ] *
/CVN/ → [CV] ** (N=n or ŋ)

The above modification can be deemed as perceptually based. Under the assumption that the perception of nasality is directly related to the nasal flow duration, an oral opening can significantly weaken the nasal perception, because a considerable portion of the overall airflow will be vented out through the oral cavity. Therefore, we consider the nasal segment--/n/ or /ŋ/--to render a better nasal perception than a nasalized vowel. Hence it is reasonable to posit in this case that only the complete preservation of the nasal segment satisfies the nasal faithfulness constraints, while preserving the same velum lowering gesture on the vowel incurs one violation of the constraints.

The following ranking arguments can be given to Mancheng. For /CVn/+/ɻ/, since the oral vowel wins over the nasal vowel, ***NasalVowel** must outrank **Max([+nas]$_n$)**; and since the oral vowel wins over the disyllabic form, **MaximumWord** must outrank **Max([+nas]$_n$)**. For /CVŋ/+/ɻ/, since the disyllabic form wins over both of the monosyllabic forms, **Max([+nas]$_ŋ$)** must outrank **MaximumWord**. ***ComplexCoda** and **RealizeAffix** are again never violated and are therefore deemed as undominated. The complete constraint ranking for Mancheng is given in (20).

(20) ***ComplexCoda**, **RealizeAffix**, **Max([+nas]$_ŋ$)**
⇓
MaximumWord , ***NasalVowel**
⇓
Max([+nas]$_n$)

The relevant tableaux for Mancheng are shown in (21). In both (21a) and (21b), the candidate that fully preserves the nasal coda does not violate ***NasalVowel**, since we assume that the vowel preceding the nasal segment is oral, or is partially nasalized at most.[5]

[5] It can be argued that in Mancheng and Anqing (discussed in the next section), the candidate [CVŋ+ŋəɻ] for /CVŋ/+/ɻ/ (or [CVn+nəɻ] for /CVn/+/ɻ/, for that matter), violates both **Integrity** and **Dep-IO** for the gemination of the nasal and the insertion of [ə] respectively. Then a candidate without [ŋ]-gemination will actually win. I would like to entertain two possible explanations. In my own experience with a Hebei dialect closely related to Mancheng, the suffixed form for [CVŋ] sounds like a disyllabic word [CVŋəɻ], or even [CVŋɻ], without [ŋ]-gemination. So the forms with [ŋ]-gemination could be due to the original fieldworker's mistranscription. Secondly, if the suffixed form does have [ŋ]-gemination, it could be due to the result of an **Onset** constraint which requires syllables to have an onset and a **Syllable Correspondence** constraint which requires the coda of a syllable in the allomorph μ of a morpheme to remain coda of the syllable in the allomorph μ' of the same morpheme (Steriade 1995). If both of these constraints outrank **Integrity**, then the form with [ŋ]-gemination will surface as the correct output. As for

(21) a. /CVn/+/ĭ/→[CVɻ]

CVn+ĭ	*Comp Coda	Realize Affix	Max ([+nas]$_{ŋ}$)	Maxim Word	*Nasal Vowel	Max ([+nas]$_{n}$)
☞ CVɻ						**
CV̄ɻ					*!	*
CVn+nəɻ				*!		

b. /CVŋ/+/ĭ/→[CVŋ]+[ŋəɻ]

CVŋ+ĭ	*Comp Coda	Realize Affix	Max ([+nas]$_{ŋ}$)	Maxim Word	*Nasal Vowel	Max ([+nas]$_{n}$)
CVɻ			*!*			
CV̄ɻ			*!			
☞CVŋ+ŋəɻ				*		

3.2.3. Anqing

Anqing differs from Mancheng in only one respect: in a stem closed by /n/, upon r-suffixation, the vowel becomes nasalized instead of staying oral, as shown in (22).

(22) /CVn/+/ĭ/→[CV̄ɻ]; /CVŋ/+/ĭ/→[CVŋ]+[ŋəɻ]

Therefore, the only ranking difference between Anqing and Mancheng is that in Anqing, **Max([+nas]$_{n}$)** outranks ***NasalVowel** rather the opposite in Mancheng. The constraint ranking in (23) can account for the Anqing data. The relevant tableaux are shown in (24).

(23) ***ComplexCoda, RealizeAffix, Max([+nas]$_{ŋ}$)**

⇓

MaximumWord

⇓

Max([+nas]$_{n}$)

⇓

***NasalVowel**

(24) a. /CVn/+/ĭ/→[CVɻ]

CVn+ĭ	*Comp Coda	Realize Affix	Max ([+nas]$_{ŋ}$)	Maxim Word	Max ([+nas]$_{n}$)	*Nasal Vowel
CVɻ					*!*	
☞ CV̄ɻ					*	*
CVn+nəɻ				*!		

Dep-IO, we may consider that it is violated in order to satisfy an undominated constraint **Nucleus**, which requires all syllables to have a nucleus.

b. /CVŋ/+/ɨ/→[CVŋ]+[ŋəɻ]

CVŋ+ɨ	*Comp Coda	Realize Affix	Max ([+nas]$_{ŋ}$)	Maxim Word	Max ([+nas]$_{n}$)	*Nasal Vowel
CVɻ			*!*			
CṼɻ			*!			*
☞CVŋ+ŋəɻ				*		

As we can see from above, dialects in which there is a /n/-/ŋ/ asymmetry upon /ɻ/-suffixation can be accounted for by appealing to the universal ranking **Max([+nas]$_{ŋ}$) >> Max([+nas]$_{n}$)** and inserting phonotactic constraints between these two constraints in the hierarchy.

For dialects in which /n/ and /ŋ/ behave identically upon /ɻ/-suffixation, we rank **Max([+nas]$_{ŋ}$)** and **Max([+nas]$_{n}$)** in the same stratum of the constraint hierarchy. Thus the constraint hierarchy will not make any distinction between the preservation of a velar nasal and that of an alveolar nasal, resulting in identical behavior of the two nasal codas. This can be seen in the Liaocheng and Jiyuan dialects below.

3.2.4. Liaocheng

In Liaocheng, both the velar and alveolar nasal codas are deleted upon /ɻ/-suffixation, and the vowels in both cases stay oral, as shown in (25).

(25) /CVn/+/ɨ/→[CVɻ]; /CVŋ/+/ɨ/→[CVɻ]

This data pattern indicates that the phonotactic wellformedness constraints ***ComplexCoda**, **MaximumWord*** and ***NasalVowel**, as well as the faithfulness constraint **RealizeAffix**, are undominated, and they outrank the faithfulness constraints regarding the nasal codas. This constraint ranking is shown in (26).

(26) ***ComplexCoda, RealizeAffix, MaximumWord , *NasalVowel***

⇓

Max([+nas]$_{ŋ}$), Max([+nas]$_{n}$)

The relevant tableaux for Liaocheng are shown in (27). The evaluation of the faithfulness constraints regarding the nasals is back to being binary like in Beijing. Namely, it is only violated if the nasal information is completely lost in the suffixed form.

(27) a. /CVn/+/ɻ/→[CVɻ]

CVn+ɻ	*Comp Coda	Realize Affix	Maxim Word	*Nasal Vowel	Max ([+nas]$_{ŋ}$)	Max ([+nas]$_{n}$)
☞CVɻ						*
CṼɻ				*!		

b. /CVŋ/+/ɻ/→[CVɻ]

CVŋ+ɻ	*Comp Coda	Realize Affix	Maxim Word	*Nasal Vowel	Max ([+nas]$_{ŋ}$)	Max ([+nas]$_{n}$)
☞CVɻ					*	
CṼɻ				*!		

3.2.5. Jiyuan

The relevant data pattern in Jiyuan is shown again in (28).

(28) /CVn/+/F/→[CṼF]; /CVŋ/+/F/→[CṼF]

Since for both /n/ and /ŋ/, the nasality is preserved upon suffixation by nasalization on the stem vowel, we infer that both of the nasal faithfulness constraints--**Max([+nas]$_{ŋ}$)** and **Max([+nas]$_{n}$)**--outrank ***NasalVowel**. ***ComplexCoda, RealizeAffix**, and **MaximumWord** are again undominated in the grammar. Therefore, the constraint ranking in (29) accounts for the data pattern in Jiyuan. The tableaux are shown in (30).

(29) ***ComplexCoda, RealizeAffix, MaximumWord**
Max([+nas]$_{ŋ}$), Max([+nas]$_{n}$)
⇓
***NasalVowel**

(30) a. /CVn/+/F/→[CṼF]

CVn+F	*Comp Coda	Realize Affix	Maxim Word	Max ([+nas]$_{ŋ}$)	Max ([+nas]$_{n}$)	*Nasal Vowel
CVF					*!	
☞CṼF						*

b. /CVŋ/+/F/→[CṼF]

CVŋ+F	*Comp Coda	Realize Affix	Maxim Word	Max ([+nas]$_{ŋ}$)	Max ([+nas]$_{n}$)	*Nasal Vowel
CVF				*!		
☞CṼF						*

The analyses of Liaocheng and Jiyuan crucially depend on ranking **Max([+nas]$_{ŋ}$)** and **Max([+nas]$_{n}$)** on a par in the constraint hierarchy. To this end, we must acknowledge the two possible phonetic scenarios that may give rise to this ranking. One is that, as we have assumed, these dialects have the similar phonetic behavior as Beijing Mandarin. Namely, /ŋ/ induces a longer nasal flow duration than /n/. But the grammar of these dialects chooses not to encode this fine phonetic difference in it. But it is possible that in these dialects, there is no significant difference between /ŋ/ and /n/ in terms of the nasal gesture duration. Logically, it is also conceivable that in these dialects, there is a significant effect between the two nasals in the opposite direction from Beijing, i.e., longer and stronger nasal flow for /n/ than for /ŋ/. But again, the grammar chooses not to represent this difference. We do not recognize this scenario as a possibility because if we did, then we would expect this phonetic pattern to be found in other dialects, and we would further expect that in at least some of these dialects, the phonetic differences would be picked up by the grammar, and thus create a suffix pattern like (31).

(31) /CVn/+/i/→[CṼi]; /CVŋ/+/i/→[CVi]

But this pattern is never attested. Regarding the first two hypotheses, without the support of empirical phonetic data, we can only lay them out at this point and hope to test them in future research.

So far, we have accounted for all the data patterns we have observed in the survey of northern Chinese dialects regarding the phonetic realization of /CVn/ and /CVŋ/ syllables upon /ɻ/-suffixation. The analyses crucially depend on the universal ranking between the two faithfulness constraints on nasality--**Max([+nas]$_{ŋ}$)** either outranks or is ranked as high as **Max([+nas]$_{n}$)**. The opposite data pattern in which the nasality of /n/ is more prominently preserved than /ŋ/ is not attested because the ranking **Max([+nas]$_{n}$)** >> **Max([+nas]$_{ŋ}$)** is claimed to be universally implausible on phonetic grounds.

3.3. Further Discussion of the Analysis

If we look at the phonetic results closely, we may notice that although the differences in nasal flow duration and volume between /n/ and /ŋ/ in Beijing Mandarin are statistically significant, they are very small in absolute values. But in terms of the phonological behavior of these two nasals, they are categorically different. In the analysis I proposed, I made the assumption that these differences are the major cause, or at least one of the major causes, of the perception of nasality. Then the striking fact is, not only can very small (though statistically significant) phonetic differences be saliently perceived, but they can also incur phonological consequences. Another possibility we need to entertain is that there are other greater differences between /n/ and /ŋ/ that the phonetic study did not cover, e.g., vowel nasalization, oral flow during the nasal consonant (Wang 1997b, based on a split-mask aerodynamic study, claims that the nasal codas in Beijing Mandarin are nasal glides), etc. Therefore, the phonetic study documented here can only serve as the preliminary for a series of phonetic studies aiming to reveal the real differences between /n/ and /ŋ/ in these Chinese dialects. Moreover, a perception experiment is needed to test the hypothesis that whatever differences revealed by the aerodynamic or acoustic studies are the direct correlates of the nasal perception.

Another issue that should be raised is whether or not the analysis is best interpreted synchronically. We may imagine that historically, there were greater differences between /n/ and /ŋ/ in terms of nasality in Chinese, and they caused /n/ and /ŋ/ to behave differently phonologically. While these differences have diminished over time, their phonological consequence has not. Under this assumption, the difference between /n/ and /ŋ/ in their phonological behavior in the modern-day Chinese dialects is better explained from a historical perspective. But even so, if a perception study reveals that speakers can perceive the small phonetic differences in nasality, we cannot deny the synchronic relevance of the analysis proposed here.

4. An Alternative for Beijing

Duànmu (1990) offers an account based on syllable structure for the /ɻ/-suffixation in Beijing and elsewhere. The basic idea for Beijing is that there is only one coda slot in the syllable structure, and it will be taken by the /ɻ/-suffix in the diminutive form. To account for the difference in vowel nasalization between the two nasals upon suffixation, he suggests that the vowel in the unsuffixed form is nasalized before a velar nasal. The derivations for a /CVn/ stem and a /CVŋ/ stem are given in (32a) and (32b) respectively.

(32) a. /gən/→[gən] /gən/+/ɻ/→[gəɻ]

b. /gəŋ/→[gə̃ŋ] /gəŋ/+/ɻ/→[gə̃ɻ]

Under the assumption that the vowel before /n/ is categorized as oral and the vowel before /ŋ/ is categorized as nasalized, Duanmu (1990)'s analysis can be reinterpreted as the interaction of the following constraints in an OT framework:

(33) a. **Ident[nas]$_V$**: the vowel in the suffixed form must agree in nasality with the vowel in the stem.
b. **MaxSeg**: don't delete segment.

Assuming the same constraints ***ComplexCoda, RealizeAffix, MaximumWord** and ***NasalVowel** as above, the ranking in (34) renders the correct outputs for Beijing. The crucial ranking is **Ident[nas]$_V$ >> MaxSeg**.

(34) ***ComplexCoda, RealizeAffix, MaximumWord, Ident[nas]$_V$**
⇓
MaxSeg, *NasalVowel

The tableaux that illustrate the correct outputs are given in (35).

(35) a. /CVn/+/ĩ/→[CVɻ]

CVn+ĩ	*Comp Coda	Realize Affix	Maxim Word	Ident [nas]$_V$	*Nasal Vowel	Max Seg
☞CVĩ					*	*
CVn		*!			*	*
CṼɻ				*!	*	*

b. /CṼŋ/+/ĩ/→[CṼɻ]

CṼŋ+ĩ	*Comp Coda	Realize Affix	Maxim Word	Ident [nas]$_V$	*Nasal Vowel	Max Seg
CVĩ				*!	*	*
CṼŋ		*!			*	*
☞CṼɻ					*	*

Duanmu's analysis is similar in spirit to the analysis proposed in this paper in that it acknowledges the difference in nasality between /n/ and /ŋ/. But the story seems to be more complicated than he assumes. For example, his analysis cannot be easily extended to Mancheng and Anqing in which /ŋ/ has to be completely preserved, thus resulting in disyllables for the suffixed forms, while /n/ is simply replaced by the /ɻ/-suffix. Futhermore, for Anqing and Jiyuan, it does not seem to be able to explain why a nasalized vowel results upon suffixation to the /CVn/ forms, if the vowel in /CVn/ is treated as oral as in Beijing. Lastly, analysis in this line runs into serious problems with Jinan, a dialect spoken in Shandong, which displays the following behavior as in (36) (Qian 1995).

(36) Jinan (Qian 1995)

a.	/CṼ/+/ɻ/→[CVɻ]:	/pʰã/+/ɻ/→[pʰɛɻ]	"plate"
		/pʰẽ/+/ɻ/→[pʰeɻ]	"(wash)basin"
b.	/CVŋ/+/ɻ/→[CṼɻ]:	/ʐaŋ/+/ɻ/→[ʐãɻ]	"pulp"
		/ɕiŋ/+/ɻ/→[ɕiãɻ]	"star"

In this case, Duanmu's proposal runs into a ranking paradox: the data in (36a) requires that ***NasalVowel** >> **Ident[nas]**$_V$, while the data in (36b) requires the exact opposite: **Ident[nas]**$_V$ >> ***NasalVowel**. But the OT analysis I proposed in section 3 does not have the problems mentioned above. It appeals to **Max** rather than **Ident** constraints, therefore where the nasality shows up in the suffixed form is not crucial. Mancheng, Anqing and Jiyuan are accounted for by the different interaction among the **MaximumWord**, **Max**([+nas]$_{\eta}$) **Max**([+nas]$_n$) and ***NasalVowel** constraints. For the case of Jinan, if we assume that the nasality for a nasalized vowel is weaker than the nasality of a real nasal, then a universal constraint ranking--**Max**([+nas]$_{\eta}$) >> **Max**([+nas]$_V$)--with the phonotactic constraint ***NasalVowel** ranked in between will generate the correct suffixed forms in (36).

5. Theoretical Implications

Two theoretical implications can be drawn from the analysis of the /n/-/ŋ/ asymmetry discussed in this paper. Regarding the nature of correspondence constraints **Max**, not only can they refer to features, as suggested by McCarthy and Prince (forthcoming), Lombardi (1998) and Pulleyblank (1996), but they can also be distinguished by small and non-contrastive phonetic differences, for example, the nasality difference between /n/ and /ŋ/. Regarding phonetically governed universal constraint rankings, not only can they be posed on faithfulness constraints regarding different prosodic positions (Beckman 1998) or on different places of articulation (Jun 1995), but they can also be posed on a single feature with different degree of phonetic strength. Specifically, the cases under discussion here illustrate that it is more important to preserve the nasal feature when it is articulatorily longer in duration and perceptually more salient. It is the universal ranking between **Max**([+nas]$_{\eta}$) and **Max**([+nas]$_n$) that delivers the explanation to the /n/-/ŋ/ asymmetry upon /ɻ/-suffixation in northern Chinese dialects.

References

Beckman, J. (1998). *Positional Faithfulness.* Ph.D. dissertation. University of Massachusetts, Amherst.

Chen, S.-J. (1988). "Hebei Mancheng Fangyan de Tedian" (Idiosyncrasies of the Mancheng Dialect of Hebei Province). *Fangyan* (Dialects) 1988: 103-112.

Dow, F. D. M. (1972). *An Outline of Mandarin Phonetics.* Australian National University Press.

Dow, F. D. M. (1984). *An Introduction to the Pronunciation of Chinese.* Dept. of Chinese, University of Edinburgh.

Duanmu, S. (1990). *A Formal Study of Syllable, Tone, Stress and Domain in Chinese Languages.* Ph.D. dissertation, MIT.

Gao, B.-T. and A.-S. Zhang (1997). *Yinchuan Hua Yindang* (A Record of the Yinchuan Dialect). In J.-Y. Hou (ed.), *Xiandai Hanyu Fangyan Yinku* (Records of Modern Chinese Dialects). Shanghai Jiaoyu Zhubanshe (Shanghai Education Publishing House).

Gordon, M. (1998a). *Syllable Weight: Phonetics, Phonology and Typology.* Ph.D. dissertation, UCLA.

Gordon, M. (1998b). The Process Specific Nature of Weight: The Case of Contour Tone Restrictions. *Proceedings of WCCFL-17.*

Hao, N. (1982). "Anqing Fangyan Cihui" (The Vocabulary of the Anqing Dialect). *Fangyan* (Dialects) 1982: 297-313.

He, W. (1981). "Jiyuan Fangyan Jilüe" (A Brief Record of the Jiyuan Dialect). *Fangyan* (Dialects) 1981: 5-26.

He, W. (1982). "Huojia Fangyan Yunmu de Fenlei" (The Rime Categories of the Huojia Dialect). *Fangyan* (Dialects) 1982: 22-36.

Hou, J.-Y. (1989). "Erwei, Erhua, Ziwei" ("Er" Suffix, "Er" Coloring, "Zi" Suffix). In J.-Y. Hou, *Jinyu Yanjiu* (Studies of the Jin Dialects). Institute for the Studies of Languages and Cultures of Asia and Africa, Tokyo University of Foreign Studies.

Jun, J (1995). *Perceptual and Articulatory Factors in Place Assimilation: An Optimality Theoretic Approach.* Ph.D. dissertation, UCLA.

Li, B. (1981). "Changhai Fangyan de Erhua yu Ziwei" (The "Er" and "Zi" Suffixes of the Changhai Dialect). *Fangyan* (Dialects) 1981: 93-103.

Li, Y.-M. (1996). "Miyang Fangyan de Erhua ji Erhua Shanyin" (The "Er" Suffix and the "Er" Tap in the Miyang Dialect). *Fangyan* (Dialects) 1996: 302-305.

Lin, T. and L.-J. Wang (1992). *Yuyinxue Jiaocheng* (A Course in Phonetics). Beijing: Beijing Daxue Chubanshe (Beijing University Press).

Lin, Y.-H. (1993). Degenerate Affixes and Templatic Constraints: Rime Change in Chinese. *Language* 69: 649-682.

Liu, D.-Q (1997). *Nanjing Hua Yindang* (A Record of the Nanjing Dialect). In J.-Y. Hou (ed.), *Xiandai Hanyu Fangyan Yinku* (Records of Modern Chinese Dialects). Shanghai Jiaoyu Zhubanshe (Shanghai Education Publishing House).

Liu, S.-H. (1993). "Xiangcheng Fangyan Yinxi" (The Sound System of the Xiangcheng Dialect). *Fangyan* (Dialects) 1993: 284-294.

Lombardi, L. (1998). *Evidence for MaxFeature Constraints from Japanese.* Ms., University of Maryland, College Park.

Lu, J.-W. (1992). *Zhengzhou Fangyan Zhi* (A Record of the Zhengzhou Dialect). Beijing: Yuwen Chubanshe (The Philology Publishing House).

Luo, F.-T. (1995). "Muping Fangyan Cidian Yinlun" (Introduction to the "Muping Dialect Dictionary"). *Fangyan* (Dialects) 1995: 1-16.

McCarthy, J. & A. Prince (1995). Faithfulness and Reduplicative Identity. In J. Beckman, L. W. Dickey & S. Urbanczyk (ed.), *University of Massachusetts Occasional Papers in Linguistics 18: Papers in Optimality Theory*: 249–384. Amherst: GLSA.

McCarthy, J. and A. Prince (forthcoming). Faithfulness and Identitiy in Prosodic Morphology. In René Kager, Harry van der Hulst and Wim Zonneveld (ed.), *The Prosody Morphology Interface.* Cambridge University Press, Cambridge.

Pulleyblank, D. (1996). Neutral Vowels in Optimality Theory: A Comparison of Yoruba and Wolof. *Canadian Journal of Linguistics* 41: 295-347.

Qian, Z.-Y. (1995). "Jinan Fangyan Cidian Yinlun" (Introduction to the "Jinan Dialect Dictionary"). *Fangyan* (Dialects) 1995: 242-256.

Shi, M.-Y. (1995). *Juxian Fangyan Zhi* (A Record of the Juxiang Dialect). Beijing: Yuwen Chubanshe (The Philology Publishing House).

Steriade, D. (1995). Lecture notes for the proseminar on syllable structure, Fall 1995, UCLA.

Steriade, D. (1997). *Phonetics in Phonology: The Case of Laryngeal Neutralization.* Ms, UCLA.

Wang, Z.-J. (1993). *The Geometry of Segmental Features in Beijing Mandarin.* Ph.D. dissertation, University of Delaware.

Wang, Z.-J. (1997a). Erhuayun de Tezheng Jiagou (The Feature Geometry of R-Rimes). *Zhongguo Yuwen* (Chinese Philology), 1997: 2-10.

Wang, Z.-J. (1997b). Ying-Han Biyunwei de Butong Xingzhi (The Quality Differences in Nasal Codas between English and Mandarin).

Yin, S.-C. (1995). "Harbin Fangyan Cidian Yinlun" (Introduction to the "Harbin Dialect Dictionary"). *Fangyan* (Dialects) 1995: 17-25.
Yuan, J.-H. (1989). *Hanyu Fangyan Gaiyao* (An Overview of Chinese Dialects), 2nd Edition. Beijing: Wenzi Gaige Chubanshe (Writing-System Reformation Publishing House).
Zhang, H.-Q. (1995). *Liaocheng Fangyan Zhi* (A Record of the Liaocheng Dialect). Beijing: Yuwen Chubanshe (The Philology Publishing House).
Zhou, L. (1994). "Wulumuqi Fangyan Cidian Yinlun" (Introduction to the "Wulumuqi Dialect Dictionary"). *Fangyan* (Dialects) 1994: 241-251.

Department of Linguistics
UCLA
405 Hilgard Ave.
Los Angeles, CA 90095

zhang@ucla.edu