

# Mandarin adaptations of coda nasals in English loanwords\*

Feng-fan Hsieh, Michael Kenstowicz & Xiaomin Mou  
Massachusetts Institute of Technology

The paper documents and analyzes the ways in which English loanwords into Mandarin are adapted to conform to the Rhyme Harmony constraint that requires the front vs. back quality of a nonhigh vowel to agree with the coronal vs. dorsal character of a nasal coda. The principal finding is that the backness of the English vowel determines the outcome and can force a change in the place of articulation of the nasal coda. This is attributed to the phonetic salience of the vowel feature in comparison to the relative weakness of the nasal place feature. It is concluded that phonetic salience is a critical factor in loanword adaptation that can override a phonologically contrastive feature.

## 1. Background and motivation

In the recent theoretical literature on loanword phonology two competing models have emerged. The first, championed by Paradis & LaCharité (1997, 2005) and others, holds that loanword adaptation is executed primarily by bilinguals who draw on their phonological competences in both the donor (L2) and recipient (L1) languages to discern segmental equivalences at an abstract, phonological (phonemic) level. When an exact phonemic match is not found then the closest available phoneme is chosen, with distance measured in terms of the distinctive features operative in the native, L1 grammar. An alternative view, typically couched within the OT model, sees loanword adaptation as based on the phonetic output of the donor language—either in the form of a raw acoustic signal (Silverman 1992) or more usually in a UG-based phonetic transcription of varying degrees of detail and abstraction.<sup>1</sup>

---

\*An earlier version of this paper was read at the third Theoretical East Asian Linguistics (TEAL-3) Workshop held at Harvard University, July 2005. We thank the audience as well as Andrea Calabrese, François Dell, San Duanmu, and Moira Yip for helpful comments.

1. Under standard conceptions, OT grammars lack an intermediate, phonemic (word-level) level of representation, making the kind of mapping envisioned by Paradis & LaCharité (1997, 2005) unavailable.

The adapter can take a variety of factors into account in order to make the loan sound like a word of the native language while still remaining as faithful as possible to the source of the loan. These include orthography as well as phonetic properties that are salient to an L1 speaker—regardless of their contrastive status in the L1 or L2 grammars. See Kenstowicz & Suchato (2006) and Yip (2006) as well as cited references for discussion of this alternative.

Mandarin Chinese presents us with the possibility of an interesting test of these two alternative models of loanword adaptation. According to most analyses (e.g. Duanmu 2000, 2007), Mandarin has five vowel phonemes: /i/, /y/, /u/, /ə/, and /a/. The high vowels contrast for [back] and [round] while the mid and low vowels do not. Stressed syllables are subject to a bimoraic constraint. There are no complex syllable margins. Codas are restricted to the nasals /n/ and /ŋ/ (modulo r-suffixation in the formation of the diminutive) and the glides/semivowels /j/, /w/. The canonical lexical item has the shape C(Gl)VX (X = V, Gl, N). The vowels take on a variety of allophonic guises depending on the surrounding consonants. In (1) we illustrate several generic CVV syllables. The first column is the Pinyin transliteration, the second is the underlying phonemicization, and the third is a broad phonetic transcription (Duanmu 2000).

(1)	<u>Pinyin</u>	<u>UR</u>	<u>PR</u>	
	tā	t <sup>h</sup> ā	t <sup>h</sup> āa	'she'
	tí	t <sup>h</sup> í	t <sup>h</sup> íi	'dam'
	tǔ	t <sup>h</sup> ǔ	t <sup>h</sup> wǔu	'mud'
	tè	t <sup>h</sup> è	t <sup>h</sup> èγ	'special'

In the context of nasal codas the low vowel takes a relatively front allophone before the dental nasal (typically transcribed as [an]) and a relatively back, unrounded allophone before the velar nasal (transcribed as [aŋ])—a distribution termed Rhyme Harmony in Duanmu (2000, 2007). By contrast, in English front and back low vowels freely combine with the dental and velar nasal phonemes to give four possible combinations.<sup>2</sup>

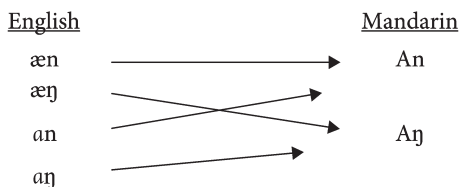
(2)	<u>English</u>		<u>Mandarin</u>	
	[æŋ]	Dan	[an]	dan 'egg'
	[æŋ]	dang		
	[aŋ]	Don	[aŋ]	dan 'swing'
	[aŋ]	dong		

If loanword adaptation abstracts away from the phonetic details in both L1 and L2 grammars, then we expect that in cases of conflict between faithfulness to the English vowel or to the nasal coda, the Mandarin adaptation should be determined

2. Before the velar nasal the vowel is rounded [ɔ] or [ɔ̃] for many English speakers.

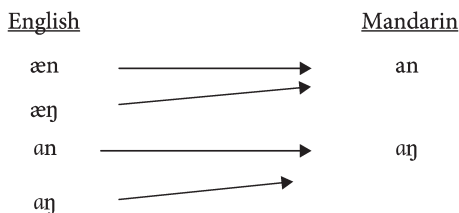
by the nasal consonant. This is because the nasal coda is the only point of similarity at the phonological level, given that the vowel is unspecified or noncontrastive for [back] in Mandarin (indicated by the archiphoneme A; see Wang (1993) & Duanmu (2000, 2007) for details). This scenario is sketched in (3)

(3) phonological mapping



Alternatively, if the adapter is trying to achieve the best phonetic match then in cases of conflict (i.e. English [æ̃ŋ] and [an]), additional considerations may come into play to decide the outcome. A priori we might expect variation across different lexical items depending on whether the vowel or the coda nasal is the determining factor. Alternatively, the adapter might call on other criteria to break the tie. For example, while the [±back] vowel difference is phonologically predictable, it is more salient phonetically and hence could provide a better overall match than the nasal coda consonant—a segment whose place features are relatively faint and highly susceptible to neutralization cross-linguistically. The latter scenario predicts the correspondences in (4).

(4) phonetic (auditory) mapping



In the absence of a well-developed theory of loanword adaptation, it is unclear which of these two alternatives is more likely to be true. Hence the empirical study of such conflicting cases is an important step towards such a theory.

Whether (3) or (4) is the correct scenario turns out to be a question that is not so easily answered. It is well known that in comparison to Japanese and Korean, Mandarin Chinese is highly resistant to phonological loans, preferring loan translations or calques (Novotná 1967). Furthermore, it appears that many of the phonological loans that entered the language in the Early Modern period (c. 1900–1940) have become obsolete or been replaced. Contemporary Mandarin vocabulary thus lacks a substantial body of loanwords that we can easily consult in order to

answer our question. We are thus forced to fall back on more meager resources. We are aware of two sources with relevant data. First, there is the *Dictionary of Loanwords and Hybrid Words in Chinese* (Liu et al. 1984).<sup>3</sup> We analyze material drawn from this source in Section 2. Second, there is the Website of the Chinese Ministry of Foreign Affairs, which has a listing of the preferred transcriptions and pronunciations for many foreign place names. We analyze data drawn from the latter in Section 3. Section 4 reviews the phonetic basis of the front-back vowel enhancement of the coda nasal contrast to provide independent support for our analysis. Section 5 is a brief summary and conclusion.

## 2. Analysis of loanwords from the dictionary

Our study's loanword corpus consists of c. 600 items drawn from Liu et al. (1984) that contain a VN sequence in the loan source (typically English). The discussion here focuses on items where the vowel of the source word is low or mid since this is where the vowel is phonologically unspecified or noncontrastive for front vs. back in Mandarin and the resolution of the conflict between faithfulness to the vowel vs. faithfulness to the coda nasal of the English word can be studied. We organize the data into several subcategories. The first consists of English VN rimes where V is nonhigh, N is a dental or velar nasal, and the syllable bears some degree of stress. Our main finding is that it is the front vs. back category of the vowel that determines the outcome. We then look at VN sequences drawn from final unstressed syllables in English. Here we find competition between strategies based on approximation to the English reduced vowel vs. those based on the orthographic representation. The next category consists of loans in which a nasal has been inserted into the coda to achieve a bimoraic syllable. Our data indicate that the front vs. back quality of the vowel in English determines the substitution as [n] or [ŋ], respectively. In the last group, the coda nasal of the English loanword is [m], which must be repaired—typically by changing the [m] to [n] or [ŋ]. Once again, we find that the vowel of the source word decides the outcome.

### 2.1 VN

When the vowel is low there is a partial correlation between its front vs. back status in the English source word and its orthographic form. Front vowel [æ] (RP [a]) is

---

3. The authors state that the dictionary was constructed in the period 1960–64 from material in dictionaries, monographs, Chinese translations of foreign classics, academic journals, newspapers, magazines, as well as other sources such as import-export catalogs, customs declaration forms, etc. The dictionary contains c. 10,000 items.

represented with the letter *a* (e.g. *hat*) while the back, unrounded [ɑ] (or rounded [ɒ] in RP) is typically represented with *o* (e.g. *hot*). However, sometimes [ɑ] is also spelled with the letter *a* (e.g. *class*). Since we cannot always rely on English spelling, we have checked all examples with the OED.<sup>4</sup>

When the English source consists of a front vowel combined with a dental nasal ([æn]) or a back vowel combined with a velar nasal ([aŋ]), we expect the Mandarin adaptation to contain a matching rime—i.e. [an] or [aŋ], respectively. For English [æn] there are 31 loans in our corpus; all but five support this hypothesis.

(5)	<u>English</u>	<u>Mandarin</u>	
a.	<i>anchovy</i> [æn]	<i>an.chou</i> [an]	
	<i>angel</i>	<i>an.qi.er</i>	
	<i>antecedent</i>	<i>an.ti.xi.deng</i>	
	<i>flange</i>	<i>fa.lan.(-pan)</i>	
	<i>Vandyke</i>	<i>fan.tai.ke</i>	
	<i>van de graaf</i>	<i>fan.de.ge.la.fu</i>	
	<i>furan</i>	<i>fu.ran</i>	
	<i>candelilla</i>	<i>kan.te.li.la</i>	
	<i>clan</i>	<i>ke.lan</i>	
	<i>cotangent</i>	<i>kou.tan.jin</i>	
	<i>lancers</i>	<i>lan.sa.si</i>	
	<i>rand</i>	<i>lan.te</i>	
	<i>lanthanium</i>	<i>lan</i>	
	<i>Levant</i>	<i>li.fan.de</i>	
	<i>romantic</i>	<i>luo.man.di.ke</i>	
	<i>romance</i>	<i>luo.man.si</i>	
	<i>mantle</i>	<i>man.tuo</i>	
	<i>pandora</i>	<i>pan.duo.la</i>	
	<i>saraband</i>	<i>sa.la.ban.de</i>	
	<i>sandal</i>	<i>shan.da.li</i>	
	<i>Sudan</i>	<i>su.dan</i>	
	<i>tangent</i>	<i>tan.jin</i>	
b.	<i>bandage</i> [æn]	<i>beng.dai</i> [ɲŋ]	
	<i>phalanstery</i>	<i>fa.lang.ji.si.te</i> [aŋ]	
	<i>scandium</i>	<i>kang</i>	
	<i>lantum</i>	<i>lang.tang</i>	
	<i>vandal</i>	<i>wang.da.er</i>	

For English [aŋ] rimes there are seven examples in the corpus; five are adapted as expected with a velar nasal and back vowel allophone (6a).

4. For the period of the early 20th century the British presence in China was much stronger than the American one and thus British English is the more likely source for the English loanwords.

- (6)
- |    | <u>English</u>  |      | <u>Mandarin</u>  |      |
|----|-----------------|------|------------------|------|
| a. | <i>Congo</i>    | [aŋ] | <i>gang.guo</i>  | [aŋ] |
|    | <i>franc</i>    |      | <i>fa.lang</i>   |      |
|    | <i>furlong</i>  |      | <i>lang</i>      |      |
|    | <i>pingpong</i> |      | <i>ping.pang</i> |      |
|    | <i>mongoose</i> |      | <i>meng.ge</i>   | [ʎŋ] |
| b. | <i>encore</i>   | [aŋ] | <i>an.ge</i>     | [an] |
|    | <i>gong</i>     |      | <i>gun.ge</i>    | [un] |

The matrix in (7) summarizes the adaptation of the harmonic rhymes. Mandarin preserves the front vs. back quality of the rhyme to a significant degree.

- (7) English

	an	aŋ
æŋ	26	4
aŋ	2	5

Mandarin  $p < 0.008$  (two-tailed Fisher's exact test)

In loans where the English vowel and coda nasal do not agree as front vs. back, there are two ways in which the adaptation can be brought into alignment with the Mandarin [an] and [aŋ] codas required by Rhyme Harmony. Either the front vs. back character of the vowel can be preserved and the nasal changed; or alternatively the nasal coda can be held constant and the vowel adjusted. The data overwhelmingly evidence the first strategy. The corpus contains 24 loans where the English source consists of a low, back vowel and a dental nasal. In all of the corresponding Mandarin loans, it is the nasal consonant that is changed, giving an [aŋ] rhyme in the majority of cases (8a). In a few (8b), the vowel is mid [oŋ] or [ʎŋ].

- (8)
- |    | <u>English</u>        |      | <u>Mandarin</u>       |      |
|----|-----------------------|------|-----------------------|------|
| a. | <i>anon(ym)</i>       | [an] | <i>a.nang</i>         | [aŋ] |
|    | <i>ounce</i>          |      | <i>ang.si</i>         |      |
|    | <i>Browning</i>       |      | <i>bai.lang.ning</i>  |      |
|    | <i>pound</i>          |      | <i>bang</i>           |      |
|    | <i>bezant</i>         |      | <i>bie.sang</i>       |      |
|    | <i>radon</i>          |      | <i>dong</i>           |      |
|    | <i>Oregon</i>         |      | <i>e.le.gang</i>      |      |
|    | <i>ergon</i>          |      | <i>er.gang</i>        |      |
|    | <i>concept</i>        |      | <i>gong.si.bu.tuo</i> |      |
|    | <i>fandango (Sp.)</i> |      | <i>fang.dange</i>     |      |

<i>geon</i>			<i>ji.ang.ding.sheng</i>	
<i>condenser</i>			<i>kang</i>	
<i>canto</i> (It.)			<i>kang.tuo</i>	
<i>crown</i>			<i>ke.lang</i>	
<i>marathon</i>			<i>ma.la.song</i>	
<i>monsoon</i>			<i>mang.xun</i>	
<i>pontificate</i>			<i>pang.ti.fei.jia.te</i>	
<i>pontoon</i>			<i>pang.tong</i>	
<i>plante</i> (Fr.)			<i>pu.lang.te</i>	
<i>samba</i>			<i>sang.ba</i>	
<i>sonnet</i>			<i>shang.lai-ti</i>	
b.	<i>gondola</i>	[an]	<i>gong.duo.la</i>	[oŋ]
	<i>neon</i>		<i>ni.hong</i>	
	<i>cellon</i>		<i>se.long</i>	
	<i>mont</i>		<i>meng</i>	[ɤŋ]

The number of loanwords with a velar nasal coda and front vowel nucleus is again smaller (13).<sup>5</sup> Only four remain faithful to the nasal (9b). The rest (9a) change the [ŋ] to [n] so as to remain faithful to the English vowel.

(9)	<u>English</u>		<u>Mandarin</u>	
a.	<i>bank</i>	[æŋ]	<i>ban.ke</i>	[an]
	<i>Agora</i>		<i>an.ge.la</i>	
	<i>Franklin</i>		<i>fu.lan</i>	
	<i>Grange</i>		<i>ge.lan.qi</i>	
	<i>Lancashire</i>		<i>lan.kai.xia</i>	
	<i>Langley</i>		<i>lan.le</i>	
	<i>tango</i>		<i>tan.ge</i>	
	<i>tank</i>		<i>tan.ke</i>	
	<i>triangle</i>		<i>te.li.an.ge.er</i>	
b.	<i>gangsa</i>	[æŋ]	<i>gang.sha</i>	[aŋ]
	<i>sarangi</i>		<i>sa.lang.ji</i>	
	<i>wankel</i>		<i>wang.ke.er</i>	
	<i>Yankee</i>		<i>yang.ji</i>	

The matrix in (10) summarizes the resolution of the conflicting English rimes.

5. The word *mu.si.deng* [dɤŋ] < *mustang* [æŋ] has an unexpected mid rather than low vowel. We are not able to explain this change in height. Given that it is treated as mid, the expected [den] syllable is rare in Modern Mandarin and is avoided in loans. See discussion of mid vowels below. The *Yankee* > *yang.ji* loan might arise from semantic contamination since the character used to represent it means 'western'.

(10)

English

	an	aŋ
æŋ	9	4
an	0	24

Mandarin  $p < 0.000001$  (two-tailed)

In sum, our hypothesis is supported—the more salient vowel normally determines the adaptation even though the nasal coda is the site of the phonological contrast.

Adopting the approach to loanword phonology taken in Kenstowicz (2005) and Yip (2006) where faithfulness to the loanword source is expressed as an OT Output-Output faithfulness constraint that may be ranked differently from the corresponding Input-Output constraint of native grammar, we can express the adaptation of the low vowel+nasal coda words into Mandarin as follows. First, we assume an undominated markedness constraint of RHYME HARMONY (Duanmu 2000, 2007) that requires a front vs. back low vowel to co-occur with a dental vs. velar nasal coda, respectively (see Flemming 2003 for discussion of the phonetic basis for such a constraint). Second, we assume that the nasal codas are the site of the lexical contrast in Mandarin (F » M) while the [ $\pm$ back] low vowel allophones [a] and [a] are distributed by Rhyme Harmony (M » F). Given the OT premise of Richness of the Base, native grammar inputs in which the nucleus and coda violate Rhyme Harmony are repaired by faithfulness to the coda, as in (11) below.

(11)

/an/	Rhyme Harmony	Id-CPI-Coda	Id-[back]
[an]	*!		
>[an]			*
[aŋ]		*!	
/aŋ/			
[aŋ]	*!		
>[aŋ]			*
[an]		*!	



But in the loanword phonology, in order to be faithful to the vowel of the source language, the adapter calls on the otherwise submerged Id-[back] constraint which is “cloned” as an Output-Output constraint between English and Mandarin and ranked above Faithfulness to CPI-Coda.

(12) Id-[back]<sub>E-M</sub> » Id-CPI-Coda » Id-[back]

Given this ranking, the input-output adaptation mapping is diverted towards faithfulness to the otherwise redundant vowel, as shown below.

(13)

/an/	Rhyme Harmony	Id-[back] <sub>E-M</sub>	Id-CPI-Coda
[an]	*!		
[an]		*!	
>[aŋ]			*
/æŋ/			
[aŋ]	*!		
[aŋ]		*!	
>[an]			*

Let us now consider examples where the English source word consists of a mid vowel followed by a nasal coda. In Mandarin there are four surface mid vowels whose distribution is determined by the surrounding onset and coda consonants (Duanmu 2000, 2007). The basic allophone, found in open syllables, is back unround [ɤ]. As with the low vowel, a dental nasal requires a more fronted vowel nucleus [əŋ] (e.g. *sen* [səŋ] ‘forest’) while a velar nasal requires a back vowel nucleus [ɤ] or [o]. In some varieties of Mandarin the latter derives from earlier [uŋ] by lowering (e.g. [tóŋ] ‘same’). Dialects also differ in whether or not [oŋ] is retained after a labial onset: cf. Taiwanese Mandarin [mǒŋ] ‘fierce’ vs. Beijing [mǒŋ]. Finally, there is a more close front vowel allophone after a palatal glide onset [je].<sup>6</sup>

6. In order to have some sense of the location of these allophones in phonetic space, we recorded five tokens for each from a male Taiwanese Mandarin speaker (the first author). The results showing the average first and second formant measures and standard deviations from the mid point of the vowel are shown below. We see that the [ə] is a relatively central vowel

Turning to the loanwords, there are three cases to consider depending on whether the English vowel is [ɛ], [o], or [ʌ]. We examine each of these in turn. First, when the mid vowel is [ɛ] and the coda is [n] in the English source, Mandarin offers the choice between [je] and [ən]. Neither option is particularly close. It is therefore of some interest that the former is systematically rejected in favor of the latter (14).

(14)	<u>English</u>		<u>Mandarin</u>
	amen	[ɛn]	a.men [ən]
	pentyl		ben.ti.er
	benzene		ben
	benzocaine		ben.zuo.ka.yin
	Enfield		en.fei.er
	phen(ol)		fen
	phosgene		fu.su.zhen
	convention		kang.wen.xin
	pimento		pi.men.ta
	cement		shui.men.ting

The choice of central [ə] over diphthongal [je] for English [ɛ] indicates that Dep-Glide dominates faithfulness for [back].

(15)

/ben/	Dep-Gl	Id-[back] <sub>E-M</sub>
[bən]		*
[bjen]	*!	

The few exceptions to this correspondence occur when the C[ən] syllable is either not attested in the existing inventory of Mandarin syllable types or is rare (16). In this case an adjustment must be made—changing the vowel or the nasal.<sup>7</sup>

falling roughly midway between the front [je] and the back rounded [o] in F2. The nucleus of the [je] is more close, showing the influence of the onglide.

		<u>F1</u>	<u>F2</u>	
bēn	[bən]	472/9	1476/32	'run'
bēng	[bɤŋ]	471/12	1100/68	'collapse'
sōng	[sɔŋ]	465/20	857/47	'loose'
bjēn	[bjən]	366/15	2352/31	'edge'

7. Since the data in the dictionary are all transcribed with Chinese characters, a syllable containing a novel combination of CVC cannot be easily represented. It is not clear to us to what extent this fact about orthography inhibits the creation of novel combinations of onset, rhyme, and tone. See Bauer (1985) for novel syllables in loans to Cantonese.

- (16) *Ländler* (Germ) *lian.de.la* \**[lən]*  
*lentor* *lun.tuo* \**[lən]*  
*engine* *yin.qing* \**[ən]*  
*tendency* *ting.deng.se* \**[tən]*, \**[tin]*

Curiously, it is the vowel height that is changed while the front vs. back property of the vowel in the source word is largely maintained. Lin (2008) reports a similar finding. This suggests that faithfulness for the vowel is broken down into faithfulness for  $[\pm\text{back}]$  (F2) vs. faithfulness for height  $[\pm\text{high}]$ ,  $[\pm\text{low}]$  (F1), as indicated in the tableau in (17). (We assume the undominated constraint USE-LISTED-SYLLABLE: A syllable in the adapted loanword must have a precedent in the native inventory).

(17)

/ten/	Use-Ld-Syll	Id-[back] <sub>E-M</sub>	Id-[high] <sub>E-M</sub>	Id-CPL-Coda
ten	*!			
tin	*!			
>tiŋ			*	*
toŋ		*!		*

Our corpus contains 12 examples of conflicting English rimes in [on]. In the corresponding Mandarin adaptations, they change the [n] to velar [ŋ] in order to remain faithful to the vowel (18a). The lone exception is shown in (18b). When the onset is a labial consonant then the vowel [o] is blocked by the labial disharmony constraint that bans the combination of a labial onset and rhyme in the Beijing dialect. The back unrounded vowel [ɤ] (Pinyin *eng*) or the low [a] is substituted in this case.

- (18) English                      Mandarin
- a. *amidone* [on]      a.mi.tong [oŋ]  
*barbitone*              ba.bi.tong  
*chalone*                ka.er.long  
*clone*                    ke.long  
*Cologne*                ke.long  
*hormone*                he.er.meng [ɤŋ]  
*telephone*              de.lu.feng  
*microphone*            mai.ke.feng  
*sousaphone*            su.sha.feng  
*sarrusophone*        sa.luo.suo.feng  
*leone*                    li.ang [aŋ]
- b. *scone* [on]            shi.gan [an]

The contingency table in (19) summarizes the outcome of the competing changes for the [±back] feature of the vowel and the corresponding coronal vs. dorsal place feature of the nasal coda.

(19) English

	V <sub>n</sub>	V <sub>ŋ</sub>
en	14	2
on	1	11

Mandarin  $p = 0.000053$  (two-tailed)

As the tableau in (20) shows, in the case of the conflicting back vowel + coronal coda the correct adaptation is made by the Id-[back]<sub>E-M</sub> » Id-CPI-Coda ranking established for the low vowels in (12).

(20)

/on/	Rhyme-Harmony	Id-[back] <sub>E-M</sub>	Id-CPI-Coda
[on]	*!		
> [oŋ]			*
[əŋ]		*!	

The behavior of the English rimes composed of the centralized, wedge vowel [ʌ] suggests that it is not salient enough on the crucial [±back] F2 dimension to force a change in the nasal coda. Faithfulness to the coda obtains in all but one case (21). The vowel receives a range of adaptations as high, mid, or low.

- (21)
- |    | English              |  | Mandarin                     |  |
|----|----------------------|--|------------------------------|--|
| a. | <i>uncial</i> [ʌŋ]   |  | <i>an.se.er</i> [an]         |  |
|    | <i>punch</i>         |  | <i>pan.qu</i>                |  |
|    | <i>hundredweight</i> |  | <i>han.jue.huai.tuo</i>      |  |
|    | <i>carborundum</i>   |  | <i>ka.bo.lan.deng</i>        |  |
|    | <i>Brunswick</i>     |  | <i>bu.lun.si.wei.ke</i> [un] |  |
|    | <i>sundae</i>        |  | <i>sheng.dai</i> [ʏŋ]        |  |
| b. | <i>Young</i> [ʌŋ]    |  | <i>yang</i> [aŋ]             |  |

To summarize the adaptation of English VN rimes with a mid vowel, we find [ɛŋ] and [oŋ] primarily rendered as faithful to vowel quality at the expense of change in the nasal consonant. The adaptation of [ʌŋ] and [ʌŋ] is determined by the nasal

coda, indicating that the wedge vowel is not decisive and reflecting its intermediate position on the [±back] F2 dimension.

Before turning to reduced vowels, we note a minor pattern. Seven items in our corpus terminate in the graph *-oon*. Since [dun], [tun], [sun] and [lun] are valid Mandarin syllables, it is puzzling why these adaptations are rejected in five of the seven items—primarily in favor of C[ong]. Possibly in these cases the adapter was following a graphic rule that interprets the *-oon* as if it terminated in a tense mid vowel, (i.e. [on]) rather than the phonetic [un].

(22)	<u>English</u>		<u>Mandarin</u>	
	<i>cardoon</i>	[un]	ha.dun	[un]
	<i>monsoon</i>		mang.xun	[yn]
	<i>cartoon</i>		ka.tong	[oŋ]
	<i>pantaloon</i>		pa.ta.long	
	<i>pontoon</i>		pang.tong	
	<i>shalloon</i>		xia.long	
	<i>simoon</i>		xi.meng	[ʃŋ]

English loans with final syllables containing unstressed, reduced vowels exhibit two competing adaptation strategies. The primary one substitutes *en* [ən]—arguably Mandarin’s best phonetic match to the schwa-like, reduced vowel of English (23a). This practice is followed unless an illegal or rare syllable such as *len* [lən] or *den* [tən] results, in which case a high vowel is typically substituted (23b) instead. In a few cases (23c), the adapter has based the choice on the spelling.

(23)	<u>English</u>		<u>Mandarin</u>	
a.	<i>Addision</i>	[ən]	a.di.sen	[ən]
	<i>eikonogen</i>		ai.ke.nu.zhen	
	<i>Bremen</i>		bu.le.men	
	<i>predicament</i>		bu.li.di.jia.men	
	<i>cushion</i>		gu.chen	
	<i>claisen</i>		ke.lai.sen	
	<i>co.se.cant</i>		kou.xi.gen	
	<i>li.nen</i>		lian.ren	
	<i>mammon</i>		ma.men	
	<i>Mormon</i>		mo.men	
	<i>bacon</i>		pei.gen	
	<i>pullman</i>		pu.er.men	
	<i>salmon</i>		sa.men	
	<i>cinchophen</i>		xin.ke.fen	
	<i>union</i>		yu.ren	
b.	<i>Appleton</i>	[ən]	a.pu.dun	[un] [dən] (rare)
	<i>dal.ton</i>		dao.er.dun	
	<i>weston</i>		wei.si.dun	

	<i>baron</i>		<i>ba.lun</i>	*lən
	<i>per.lon</i>		<i>bei.lun</i>	
	<i>gallon</i>		<i>jia.lun</i>	
	<i>carron</i>		<i>ka.lun</i>	
	<i>Corbillon</i>		<i>kao.bi.lun</i>	
	<i>chaldron</i>		<i>qiao.te.lun</i>	
c.	<i>satan</i>	[ən]	<i>sa.dan</i>	[an]
	<i>ti.tan</i>		<i>tai.tan</i>	
	<i>Zion</i>		<i>xi.an</i>	
	<i>harmattan</i>		<i>ha.ma.dan</i>	

These data can be analyzed by assuming that the schwa of the source word is not salient enough to determine the outcome and the decision is passed on to the coda nasal. Since all the examples have coda [n], no change is required. Our corpus contains no unstressed syllables with a coda dorsal nasal, which in any case are rare with nonhigh vowels in English. The tableau below illustrates the adaptation *baron* > *ba.lun*. The adaptations with the high vowel in (23b) indicate that [+high] is preferred to [+low] as a match for the unstressed schwa of English, probably because high vowels are phonetically shorter than low vowels cross-linguistically.

(24)

/bærən/	Use-Ld-Syll	Id-[back]	Id-CPL-Coda	Id-duration
lən	*!			
loŋ		*	*!	
lan		*		*!
> lun		*		

In sum, the adaptations analyzed in this section indicate that when the vowel of the English source word is front or back then it determines the way in which the loan accommodates the Rhyme Harmony constraint. Nonsalient schwa or wedge seem to pass the decision on to the nasal coda.

In the next two sections we review a couple of other places in the loanword grammar where the place feature of a nasal coda is determined by the vowel of the source word.

## 2.2 V.NV → VN.NV

In (25) we list examples in which a nasal consonant is added to the coda before a following nasal onset in order to satisfy the bimoraic requirement on stressed

syllables. Interestingly, the choice between [n] and [ŋ] is determined, not by geminating the nasal of the source word, but rather by the vowel of the augmented syllable (25a). For example, in the adaptation of *economy* the English stressed syllable is augmented in the Mandarin loan by insertion of a velar rather than a dental nasal: *ai.kang.nuo.mi*. The handful of exceptions to this generalization is shown in (25b).<sup>8</sup>

(25)	<u>English</u>		<u>Mandarin</u>	
a.	amonal	[on]	a.mang.na	[aŋ]
	economy	[an]	ai.kang.nuo.mi	[aŋ]
	anarchy	[æŋ]	an.na.qi	[an]
	benadryl	[en]	ben.na.jun	[en]
	felony	[ən]	fei.lun.nu	[un]
	laudanidine	[æŋ]	lan.dan.ni	[an]
	mana	[æŋ]	man.na	[an]
	monarchy	[an]	meng.ne.a.ji	[ɤŋ]
	perphenazine	[en]	pia.fen.na.xin	[en]
	penicillin	[en]	pan.ni.xi.lin	[an]
	thiram	[æm]	qiu.lan.mu	[an]
	seneca	[en]	sen.ni.jia	[en]
	penny	[en]	pen.ni	[en]
	arsphenamine	[en]	shen.fan.na.ming	[an]
	spanner	[æŋ]	shi.ban.na	[an]
	scammony	[æŋ]	si.kan.mo.ni	[an]
	Tammany	[æm]	tan.mu.ni	[an]
	gunny	[ʌŋ]	gong.ni	[oŋ]
	Tony	[on]	tang.ni	[aŋ]
	Downing	[aun]	tang.ning	[aŋ]
b.	afghani	[an]	a.fu.han.ni	[an]
	memory	[em]	meng.mo.li	[ɤŋ]
	mammoth	[æm]	meng.ma	[ɤŋ]

The data in (25) show that faithfulness to the backness of the vowel–redundant in Mandarin but contrastive in English—is an active constraint of the loanword grammar that overrides homorganicity for the NC cluster that might otherwise be expected since it does not require the insertion of a place feature in the coda but

8. The OED indicates a back vowel for the medial syllable of *Afghani* in (25b). For this reason we classify it as an exception. Also the loan *mammoth* > *meng.ma* is represented with the character for *meng* ‘fierce’, perhaps for semantic reasons.

merely anticipates the place feature of the following onset. We illustrate this aspect of the Mandarin loanword grammar in (26).

(26)

e/kan/omy	Id-V[back] <sub>E-M</sub>	Dep-Place-Coda
ai.kan.nuo.mi	*!	
>ai.kan̩.nuo.mi		*

### 2.3 Vm → Vn, Vŋ

Finally, in (27) we list loans where the English source word contains a labial nasal in the coda. Since Mandarin bars [m] from the coda, the nasal coda must alter its place of articulation. The data indicate that the choice between [n] and [ŋ] is determined primarily by the front vs. back nature of the preceding vowel in the English source word (27a). The more centralized wedge vowel is once again less decisive, occurring with both dorsal and well as coronal nasal codas. Exceptions are shown in (27b).<sup>9</sup> Here as well we find that the adaptation has recourse to the more salient vowel rather than substituting a default consonant such as [n] that might otherwise be expected under a \*Dorsal » \*Labial » \*Coronal ranking for consonantal place (de Lacy 2006).

(27)

	<u>English</u>		<u>Mandarin</u>	
a.	<i>ambersite</i>	[æm]	<i>an.bu.rui.te</i>	[an]
	<i>ambroise</i>	[æm]	<i>an.bu.luo.si</i>	
	<i>ampul</i>	[æm]	<i>an.bu</i>	
	<i>samsonite</i>	[æm]	<i>san.suo.na.te</i>	
	<i>Gram</i>	[æm]	<i>ge.lan</i>	
	<i>jam</i>	[æm]	<i>zhan</i>	
	<i>compost</i>	[am]	<i>kang.po.si.te</i>	[aŋ]
	<i>combination</i>	[am]	<i>kang.bai.na.xiong</i>	
	<i>compost</i>	[am]	<i>kang.po.si.te</i>	
	<i>compote</i>	[am]	<i>kang.bo.te</i>	
	<i>communism</i>	[am]	<i>kang.men.ni.si.mu</i>	
	<i>commons</i>	[am]	<i>kang.men.si</i>	
	<i>combiner</i>	[am]	<i>kang.ping.na</i>	
	<i>commission</i>	[am]	<i>kang.mi.xiong</i>	

9. The *shampoo* > *xiang.bo* loan is represented with the character for 'fragrance' and so may be a case of semantic contamination.



<i>Tom</i>	[am]	<i>tang.mu</i>	
<i>Thompson</i>	[am]	<i>tang.mu.sheng</i>	
<i>samba</i>	[am]	<i>sang.ba</i>	
<i>quinoform</i>	[om]	<i>kui.nuo.fang</i>	
<i>embelin</i>	[em]	<i>en.bei.lin</i>	[ən]
<i>sumbul</i>	[ʌm]	<i>sang.bo</i>	[aŋ]
<i>gumbo</i>	[ʌm]	<i>gong.bo</i>	[oŋ]
<i>rum</i>	[ʌm]	<i>lan.mu</i>	[an]
<i>calumba</i>	[ʌm]	<i>ka.lun.ba</i>	[un]
<i>yumpies</i>	[ʌm]	<i>yong.pi.si</i>	[oŋ]
<i>carborundum</i>	[ʌm]	<i>ka.bo.lan.deng</i>	[ʃŋ]
<i>trumpet</i>	[ʌm]	<i>qu.lang.pai.ti</i>	[aŋ]
<i>atom</i>	[ə̃m]	<i>a.tun</i>	[un]
<i>Edam</i>	[ə̃m]	<i>yi.dun</i>	[un]
b. <i>shampoo</i>	[æ̃m]	<i>xiang.bo</i>	[aŋ]
<i>mambo</i>	[am]	<i>man.bo</i>	[an]
<i>adam</i>	[ə̃m]	<i>ya.dang</i>	[aŋ]
<i>empire</i>	[em]	<i>ying.bai.er</i>	[iŋ]
<i>emperor</i>	[em]	<i>ying.bai.li.re.er</i>	[iŋ]

The tableau in (28) shows the effect of  $\text{Ident-V}[\text{back}]_{\text{E-M}}$  in the adaptation of *compost*.

(28)

/kɑ̃mpost/	Id-V[back] <sub>E-M</sub>	*dorsal, labial	*coronal
kan.po.si.te	*!		
> kɑ̃ŋ.po.si.te		*	

The adaptations of the unstressed syllables of *atom* and *Edam* ([atun] and [yidun]) with a coronal support the idea that [n] is the default nasal. If the [±back] quality of the schwa vowel of English is indeterminant (as seems plausible—cf. Flemming & Johnson 2007) then the choice between the coronal and dorsal coda is resolved by the markedness hierarchy that substitutes coronal as the default oral place.

(29)

/ætə̃m/	Id-V[back] <sub>E-M</sub>	*dorsal	*coronal
>atun			*
atunŋ		*!	

Before concluding this section we briefly address the possible role of orthography in the coda nasal adaptation process. The vast majority of loans spelled with “on” are adapted as [aŋ] and those spelled with “an” as [an]. Could orthography be the basis of the adaptation pattern rather than reference to the salience of the vowel on the F2 dimension? We think not. First, the few words in our corpus with an [an] sequence from Romance languages such as *franc* and *canto* are adapted with a back rhyme in accord with the back vowel in the source. Second, “on” and “an” words where the corresponding syllable in English is unstressed such as *cushion* are by and large adapted with [əŋ] and not [aŋ] or [oŋ]. Since stress is not orthographically recorded, the adaptation must be based on the spoken form of the word to explain this distinction. In our view the adapters use their knowledge of the spelling regularities of the source languages to guide them in the correct pronunciation of the source word vowel, which in turn determines the adaptation. This is evident in occasional mistaken interpretations such as *satan* > [sa.dan] where the final syllable is treated as stressed. Finally, even if we were to grant that orthography is the basis of the adaptation, it does not help to explain why in the orthographic equivalence of “on” = [aŋ], it is the vowel symbol that is the determining factor rather than the consonantal one. Salience in the phonetics provides a more plausible basis for understanding the adaptation, especially when it is combined with the observation that the less salient central vowels wedge and schwa do not determine the outcome. Here it is the nasal consonant that appears to do so. If the Mandarin adaptation of nasal codas is based on spelling, then if “n” determines the outcome for syllables with wedge and schwa, why not for “an” and “on” as well?

### 3. Another corpus

The list of place names on the Chinese Ministry of Foreign Affairs website provides another opportunity to study the adaptation of nasals into Mandarin.<sup>10</sup> These data largely corroborate the generalizations found in the data from the dictionary discussed in Section 2. First, source words with a front [æ] followed by a nasal ([m] or [n]) uniformly have the [an] correspondence in Mandarin.

(30)	<u>English</u>	<u>Mandarin</u>
	<i>Alexander</i> [æŋ]	ya.li.shan.da [an]
	<i>Amsterdam</i>	a.mu.si.te.dan
	<i>Anatolia</i>	an.na.tuo.li.ya
	<i>Atlanta</i>	ya.te.lan.da

10. We thank Ross Foo for providing us with a transcribed list of such words.

Birmingham	bo.ming.han
Canberra	kan.pei.la
Canterbury	kan.te.bo.lei
Canton	kan.dun
Fanning	fan.ning
Flanders	fo.lan.de
Grampian	ge.lan.ping
Hampshire	han.pu
Indiana	yin.di.an.na
Kansas	kan.sai.shi
Manchester	man.che.si.te
Manhattan	man.ha.dun
Mansfield	man.si.fe.ier.de
Nancy	nan.xi
Nantucket	nan.ta.ji.te
Nottingham	nuo.ding.han
Stamford	si.tan.fu

In cases where the loan source contains a conflicting combination of vowel nucleus and nasal coda, the vowel is the determining factor in the adaptation in the vast majority of cases (31). For [an] *Ontario* and *Tucson* (31b) are the exceptions where we find an unexpected front vowel. Perhaps the latter is based on a false parsing *Tuc+son* (cf. *Addison* > *adisen*). For [æŋ] the only exception is *Doncaster* (31d), for which the OED provides a [dæn] transcription despite the spelling.

(31)	English		Mandarin	
a.	<i>Adirondacks</i>	[an]	a.di.lang.da.ke	[aŋ]
	<i>Bronx</i>		bu.lang.ke.si	
	<i>Connacht</i>		kang.nuo.te	
	<i>Cornwall</i>		kang.wo.er	
	<i>Klondike</i>		ke.lang.dai.ke	
	<i>Oregon</i>		e.le.gang	
	<i>Wisconsin</i>		wei.si.kang.xing	
	<i>Longford</i>		lang.fu.de	
	<i>Taunton</i>		tang.dun	
	<i>Tyrone</i>		di.long	[oŋ]
	<i>Yukon</i>		yu.kong	
	<i>Montana</i>		meng.da.na	[ɤŋ]
	<i>Monte Carlo</i>		meng.te.ka.luo	
	<i>Montpelier</i>		meng.bi.liai	
	<i>Vermont</i>		fo.meng.te	
b.	<i>Ontario</i>	[an]	an.da.lue	[an]
	<i>Tucson</i>		tu.sen	[əŋ]
	<i>Pondicherry</i>		ben.di.zhi.li	

c.	<i>Anchorage</i>	[æŋ]	<i>an.ke.lei.qi</i>	[an]
	<i>Anguilla</i>		<i>an.gui.la</i>	
	<i>Angus</i>		<i>an.ge.si</i>	
	<i>Frankfurt</i>		<i>fa.lan.ke.fu</i>	
	<i>Franklin</i>		<i>fu.lan.ke.lin</i>	
	<i>Lancashire</i>		<i>lan.kai.xia</i>	
d.	<i>Doncaster</i>	[æŋ]	<i>tang.ke.si.te</i>	[aŋ]

We have seven examples for [ʌŋ]. Five are faithful to the nasal, recapitulating the behavior seen earlier in (21). The syllable gaps *\*len* and *\*den* motivate the changes in vowel height.

(32)	<u>English</u>		<u>Mandarin</u>	
	<i>Fundy</i>	[ʌŋ]	<i>fen.di</i>	[en]
	<i>Brunswick</i>		<i>bu.lun.rui.ke</i>	[un] *len
	<i>London</i>		<i>lun.dun</i>	*len, *den
	<i>Dunkirk</i>		<i>dun.ke.er.ke</i>	*den
	<i>Front</i>		<i>fu.lan.te</i>	[an] *len
	<i>Sunderland</i>		<i>sang.de.lan</i>	[aŋ]
	<i>Dundee</i>		<i>deng.di</i>	[ʌŋ] *den, *din

Finally, when the final syllable in the English loan is unstressed, the expected [Cən] is found in many cases (33a). (33b) and (33c) reflect two alternative responses to the Mandarin syllable gaps against the otherwise expected [ən] rime. In the former the vowel is adapted as high (Id-CPL-Coda » Id-V[high]) while in the latter the height change is blocked, compelling a change of the nasal coda (Id-V[high] » Id-CPL-Coda). The adaptations in (27d) appear to be based on the orthographic representations in which the vowels are treated as full rather than reduced.

(33)	<u>English</u>		<u>Mandarin</u>	
a.	<i>Cardigan(shire)</i>	[ən]	<i>ka.di.gen</i>	[ən]
	<i>Devon</i>		<i>de.wen</i>	
	<i>Lincoln(shire)</i>		<i>lin.ken</i>	
	<i>Logan</i>		<i>luo.gen</i>	
	<i>New Haven</i>		<i>niu.hei.wen</i>	
	<i>Saxony</i>		<i>sa.kr.sen</i>	
	<i>Solomon</i>		<i>suo.luo.men</i>	
b.	<i>Boston</i>	[ən]	<i>bo.shi.dun</i>	[un] *den
	<i>Eton</i>		<i>yi.dun</i>	*den
	<i>Lachlan</i>		<i>la.ke.lun</i>	*len
	<i>Lawrence</i>		<i>lao.lun.si</i>	*len

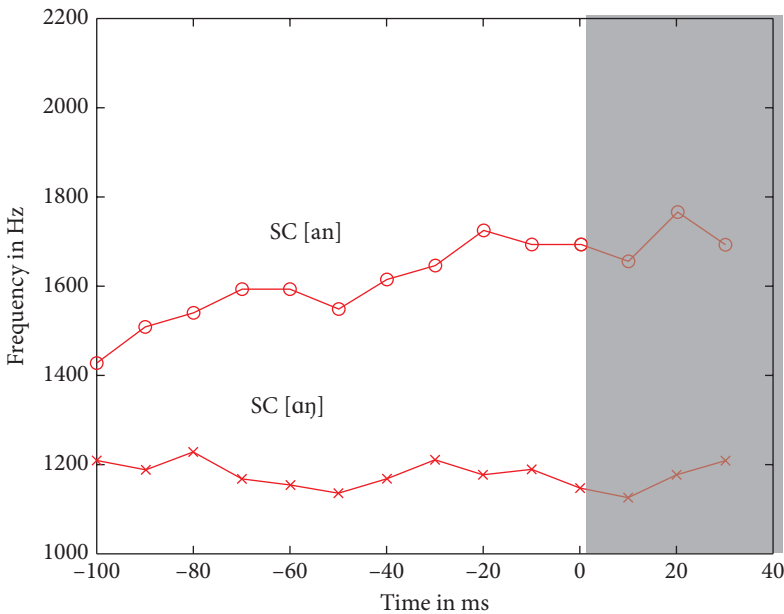
c.	Croyden		ke.luo.yi.deng	[ʎŋ]	*den
	Wimbledon		wen.bu.er.deng		*den
d.	Akron	[ən]	a.ke.long	[oŋ]	
	Cro-Magnon		ke.lu.mai.nong		
	Birmingham		bo.ming.han	[an]	
	Evans		ai.fan		
	Michigan		mi.zhi.an		
	New Orleans		niu.ao.er.liang	[aŋ]	

In sum, the adaptations in the place names largely conform to the generalizations uncovered in the analysis of the dictionary loans in Section 2.<sup>11</sup> The adaptation of the coda nasal is determined by the position of the vowel in the source word on the front-back, F2 dimension. When the vowel occupies an intermediate position on this dimension, as in the case of wedge [ʌ], or is indeterminant, as in the case of schwa, the nasal place of the coda is largely preserved.

#### 4. Phonetic basis

The surface phonetic contrast in vowels before the alveolar vs. dorsal codas has been studied in a number of phonetic investigations of Mandarin. For example, Chen (2000) reports F2 differences of c. 500 Hz. in [an] vs. [aŋ] rhymes when they appear before a stop such as *dān.dǎ* ‘single hit’ (tennis) vs. *fàn.dà* ‘magnify’. They are located in the interior of the vowel and are not just a coarticulatory effect at the VC transition. Crucially, she also finds that these differences persist—at a lower (c. 250 Hz) but still significant ( $P < 0.001$ ) magnitude—in the wake of the deletion of an intervocalic nasal in casual speech *shā(n).ào* ‘cove’. The magnitude of the F2 differences in Mandarin [an] vs. [aŋ] rhymes was further documented by Mou (2006), who found a c. 400 Hz difference at the mid point of the vowel for her Beijing subjects (see Figure 1).

11. The appendix to Hall-Lew’s (2002) study of more recent western loanwords into Mandarin drawn from the area of popular culture contains c. 130 items including the following that conform to the generalizations seen in Sections 2 and 3: *carnation* > *kang.nai.xin*, *champagne* > *xiang.bin*, *crayon* > *gu.li.rong*, *hamburger* > *han.bao*, *nylon* > *ni.long*, *sandwich* > *san.ming.zhi*, and *sauna* > *sang.na*.



**Figure 1.** Averaged values of F2 movement for 18 Standard Chinese (Mandarin) vowels from 100 ms. prior to the nasal consonant to 30 ms. into the nasal consonant

Another relevant finding by Mou (2006) was that the average F2 values for pre-dorsal low and mid vowels are relatively close to the values found in syllables lacking a coda while the pre-coronal nuclei are more distant from such open syllables.

(34)

		<u>F2 in Hz</u>	
Ca	1111	Ce	1440
Caŋ	1172	Ceŋ	1448
Can	1330	Cen	1578

This difference makes sense under Flemming's (2003) interpretation of the relation between coronal consonants and vocalic tongue body features as one of fronting the tongue body to accommodate a consonantal constriction at the alveolar ridge. The relatively steady rise in F2 for [an] in Figure 1 in comparison to the largely flat trajectory in [aŋ] also makes sense in these terms. Finally, Mou (2006) reports gating experiments in which her subjects could reliably guess the presence and identity of the upcoming coda nasal when they heard less than half of a low or mid vowel. On the other hand with high vowels, where there is a contrast among [i], [y], and [u], speakers could not reliably identify the following nasal—especially after [i] where there may even be neutralization of the [n] vs. [ŋ] contrast. In sum, Rhyme Harmony is a genuine process of Mandarin grammar—an enhancement

effect (Keyser & Stevens 2006) that speakers can utilize to identify the place of articulation of the nasal coda.

## 5. Summary and conclusion

This study utilized the Mandarin nasal codas to probe the phonological vs. phonetic bases of loanword adaptation. Nonhigh vowels are assigned different allophones along the front–back dimension in order to enhance a phonemic contrast between coronal and dorsal nasal codas. Our principal finding is that when the adapter is presented with conflicting choices to satisfy this phonotactic constraint of native grammar, it is the information found in the phonetically more salient vowel that determines the outcome. This result is in line with other cases of such conflict in loanword adaptation reported in Kenstowicz (2003). Coupled with the observation that stressed syllables are often the site of cyclic transfer (Kenstowicz 1997; Steriade 1999), it suggests that perceptual salience constitutes an alternative dimension of phonological faithfulness.

Tasks for future research include more extensive documentation and analysis of current loanword adaptation patterns in Mandarin as well as a more quantitative analysis of the Rhyme Harmony process along the lines of Flemming (2008). More generally, our study raises the question of whether enhancements which play a role in speech perception couple together features or cues that have a natural, cross-linguistically recurrent relation such F0 and duration cues to consonantal laryngeal contrasts (Hsieh & Kenstowicz 2008); or can they involve more phonetically arbitrary connections that are rooted in the accidents of the history of individual languages? This is of course a fundamental question that has emerged in the field of phonology more generally in the past decade. We believe that continued study of loanword adaptation may provide crucial evidence to help resolve this matter.

## References

- Bauer, Robert. 1985. "The expanding syllabary in Hong Kong Cantonese". *Cahiers de linguistique Asie orientale* 14.99–111.
- Chen, Marilyn. 2000. "Acoustic Analysis of Simple Vowels Preceding a Nasal in Standard Chinese". *Journal of Phonetics* 28.43–67.
- De Lacy, Paul. 2006. *Markedness: Reduction and Preservation in Phonology*. (=Cambridge Studies in Linguistics 112.) Cambridge: Cambridge University Press.
- Duanmu, San. 2000. *The Phonology of Standard Chinese*. Oxford: Oxford University Press. (2007, 2nd edition.)

- Flemming, Edward. 2003. "The Relation Between Coronal Place and Vowel Backness". *Phonology* 20.335–73.
- Flemming, Edward & Sarah Johnson. 2007. "Rosa's Roses: Reduced Vowels in American English". *Journal of the International Phonetic Association* 37.83–96.
- Flemming, Edward. 2008. "The Grammar of Coarticulation". To appear in *La Coarticulation: Indices, Direction et Representation*, ed. by M. Embarki & C. Dodane.
- Hall-Lew, Lauren Asia. 2002. *English Loanwords in Mandarin Chinese*. BA Honors Thesis, University of Arizona, Tucson.
- Hsieh, Feng-fan & Michael Kenstowicz. 2008. "Phonetic Knowledge in Tonal Adaptation: Mandarin and English Loanwords in Lhasa Tibetan". *Journal of East Asian Linguistics* 17.279–97.
- Kenstowicz, Michael. 1997. "Base-identity and Uniform Exponence: Alternatives to Cyclicity". *Current Trends in Phonology: Models and Methods* ed. by Jacques Durand & Bernard Laks, vol. 1, 363–94. Salford: University of Salford.
- Kenstowicz, Michael. 2003. "Salience and Similarity in Loanword Adaptation: a Case Study from Fijian". *Language Sciences* 29.316–40.
- Kenstowicz, Michael. 2005. "The Phonetics and Phonology of Korean Loanword Adaptation". *Proceedings of the First European Conference on Korean Linguistics* ed. by S-J. Rhee, 17–32. Seoul: Hankook Publishing Co.
- Kenstowicz, Michael & Atiwong Suchato. 2006. "Issues in Loanword Adaptation: a Case Study from Thai". *Lingua* 116.921–49.
- Keyser, Jay Samuel & Kenneth Noble Stevens. 2006. "Enhancement and Overlap in the Speech Chain". *Language* 82.33–63.
- LaCharité, Darlene & Carole Paradis. 2005. "Category Preservation and Proximity vs. Phonetic Approximation in Loanword Adaptation". *Linguistic Inquiry* 36.223–58.
- Lin, Yen-hwei. 2008. "Variable Vowel Adaptation in Standard Mandarin Loanwords". *Journal of East Asian Linguistics* 17. 363–380.
- Liu Zhengtan, Gao Mingkai, Mai Yongqian, & Shi Yowei. 1984. *Dictionary of Loanwords and Hybrid Words in Chinese*. Shanghai cishu chubanshe, Shanghai.
- Mou, Xiaomin. 2006. *Nasal Codas in Standard Chinese: a Study in the Distinctive Feature Theory*. Ph.D. dissertation, Massachusetts Institute of Technology.
- Novotná, Zdenka. 1967. "Linguistic Factors of the Low Adaptability of Loan-words to the Lexical System of Modern Chinese". *Monumenta Serica* 26.103–18.
- Paradis, Carole & Darlene LaCharité. 1997. "Preservation and Minimality in Loanword Adaptation". *Journal of Linguistics* 33.379–430.
- Silverman, Daniel. 1992. "Multiple Scansions in Loanword Phonology: Evidence from Cantonese". *Phonology* 9.289–328.
- Steriade, Donca. 2000. "Paradigm Uniformity and the Phonetics-Phonology Boundary". *Acquisition and the Lexicon* ed. by Michael Broe & Janet Pierrehumbert (=Papers in Laboratory Phonology 5.), 313–34. Cambridge: Cambridge University Press.
- Wang, Jenny Zhijie. 1993. *The Geometry of Segmental Features in Beijing Mandarin*. Ph.D. dissertation, University of Delaware.
- Yip, Moira. 2006. "The Symbiosis Between Perception and Grammar in Loanword Phonology". *Lingua* 116.950–75.