

Mandarin Adaptations of Coda Nasals in English

Loanwords*

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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

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phonetic salience is a critical factor in loanword adaptation that can override a phonologically contrastive feature.

Keywords enhancement, salience, phonetics vs. phonology

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.¹ 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

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.

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 ^h ā	t ^h āa	'she'
	tí	t ^h í	t ^h íi	'dam'
	tǔ	t ^h ǔ	t ^{hw} ǔu	'mud'
	tè	t ^h è	t ^h èʔ	'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.²

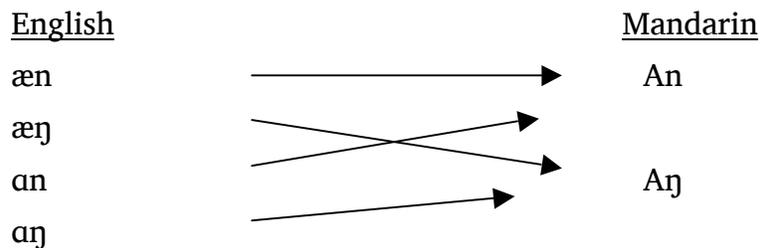
(2)	<u>English</u>		<u>Mandarin</u>
	[æn]	Dan	[an] dan 'egg'
	[æŋ]	dang	
	[ɑn]	Don	[ɑŋ] daŋ 'swing'
	[ɑŋ]	dong	

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 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

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

(1993) and Duanmu (2000, 2007) for details). This scenario is sketched in (3)

(3) phonological mapping

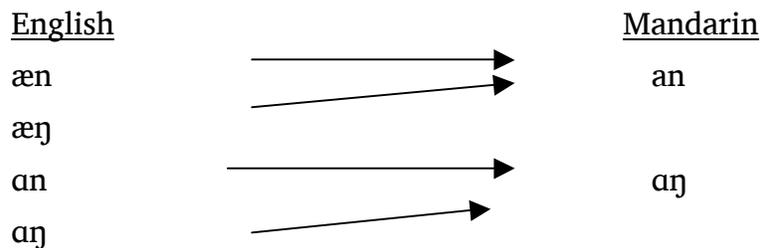


Alternatively, if the adapter is trying to achieve the best phonetic match then in cases of conflict (i.e. English [æŋ] and [an]), additional considerations may come into play to decide the outcome. A priori we might expect variation across different lexical items depending on whether the vowel or the coda nasal is the determining factor.

Alternatively, the adapter might call on other criteria to break the tie. For example, while the [\pm 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 been 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).³ 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).

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.

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 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*.⁴

When the English source consists of a front vowel combined with a dental nasal ([æn]) or a back vowel combined with a velar nasal ([ɑŋ]), we expect the Mandarin adaptation to contain a matching rime--i.e. [an] or [ɑŋ], 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]

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.

<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> [æŋ]		<i>beng.dai</i>	[ʎŋ]
	<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).

(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>gunge</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)

Mandarin

	an	ɑŋ
æŋ	26	4
ɑŋ	2	5

English

$p < 0.008$ (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 [ɑŋ] 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 [ɤŋ].

(8)	<u>English</u>	<u>Mandarin</u>
a.	<i>anon(ym)</i> [aŋ]	a.nang [aŋ]
	<i>ounce</i>	ang.si
	<i>Browning</i>	bai.lang.ning
	<i>pound</i>	bang
	<i>bezant</i>	bie.sang
	<i>radon</i>	dong
	<i>Oregon</i>	e.le.gang
	<i>ergon</i>	er.gang
	<i>concept</i>	gong.si.bu.tuo
	<i>fandango (Sp.)</i>	fang.dange
	<i>geon</i>	ji.ang.ding.sheng
	<i>condenser</i>	kang
	<i>canto (It.)</i>	kang.tuo
	<i>crown</i>	ke.lang

	<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 (Fr.)</i>		<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).⁵ Only four remain faithful to the nasal (9b).

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'.

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.	bank [æŋ]	ban.ke [an]
	Angora	an.gela
	Franklin	fu.lan
	Grange	ge.lan.qi
	Lancashire	lan.kai.xia
	Langley	lan.le
	tango	tan.ge
	tank	tan.ke
	triangle	te.li.an.ge.'er
b.	gangsa [æŋ]	gang.sha [aŋ]
	sarangi	sa.lang.ji
	wankel	wang.ke.er
	Yankee	yang.ji

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

(10) Mandarin

	an	ɑŋ
æŋ	9	4
ɑn	0	24

English $p < 0.000001$ (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 CPl-Coda.

$$(12) \quad \text{Id-[back]}_{\text{E-M}} \gg \text{Id-CPl-Coda} \gg \text{Id-[back]}$$

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] _{E-M}	Id-CPl-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 [ən] (e.g. *sen* [sən] ‘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. [tónŋ] ‘same). Dialects also differ in whether or not [oŋ] is retained after a labial onset: cf. Taiwanese Mandarin [mǒŋ] ‘fierce’ vs. Beijing [mǔŋ]. Finally, there is a more close front vowel allophone after a palatal glide onset [je].⁶

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 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.

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

	<u>F1</u>	<u>F2</u>	
bēn [bēn]	472/9	1476/32	‘run’
bēng [bēŋ]	471/12	1100/68	‘collapse’
sōng [sōŋ]	465/20	857/47	‘loose
bjēn [bjēn]	366/15	2352/31	‘edge’

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)

/bɛn/	Dep-Gl	Id-[back] _{E-M}
[bən]		*
[bjɛn]	*!	

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.⁷

⁷Since 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

(16)	Ländler (Germ)	lian.de.la	*[lən]
	lɛntɔr	lun.tuo	*[lən]
	ɛnʒɪn	yɪn.qɪŋ	*[ən]
	tɛndɛnsi	tiŋ.dɛŋg.sɛ	*[tən], *[tɪn]

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. This suggests that faithfulness for the vowel is broken down into faithfulness for [\pm back] (F2) vs. faithfulness for height [\pm high], [\pm 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).

orthography inhibits the creation of novel combinations of onset, rhyme, and tone. See Bauer (1985) for novel syllables in loans to Cantonese.

(17)

/ten/	Use-Ld-Syll	Id-[back] _{E-M}	Id-[high] _{E-M}	Id-CPI-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)	<u>English</u>	<u>Mandarin</u>
a.	<i>amidone</i> [on]	<i>a.mi.tong</i> [oŋ]
	<i>barbitone</i>	<i>ba.bi.tong</i>

<i>chalone</i>		<i>ka.er.long</i>	
<i>clone</i>		<i>ke.long</i>	
<i>Cologne</i>		<i>ke.long</i>	
<i>hormone</i>		<i>he.er.meng</i>	[ɤŋ]
<i>telephone</i>		<i>de.lu.feng</i>	
<i>microphone</i>		<i>mai.ke.feng</i>	
<i>sousaphone</i>		<i>su.sha.feng</i>	
<i>sarrusophone</i>		<i>sa.luo.suo.feng</i>	
<i>leone</i>		<i>li.ang</i>	[aŋ]
b. <i>scone</i>	[on]	<i>shi.gan</i>	[an]

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

(19)

Mandarin

	Vn	Vŋ
en	14	2
on	1	11

English

$p = 0.000053$ (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]_{E-M} » Id-CPI-Coda ranking established for the low vowels in (12).

(20)

/on/	Rhyme-Harmony	Id-[back] _{E-M}	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 [\pm 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. *uncial* [ʌŋ] *an.se.er* [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> [ɑŋ]

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

	<i>weston</i>		<i>wei.si.dun</i>
	<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).⁸

(25)	<u>English</u>		<u>Mandarin</u>	
a.	amonal	[on]	a.mang.na	[aŋ]
	economy	[aŋ]	ai.kang.nuo.mi	[aŋ]
	anarchy	[æŋ]	an.na.qi	[an]

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.

benadryl	[en]	ben.na.jun	[en]
felony	[ən]	fei.lun.nu	[un]
laudanidine	[æn]	lan.dan.ni	[an]
mana	[æn]	man.na	[an]
monarchy	[an]	meng.ne.'a.ji	[ɤŋ]
perphenazine	[en]	pia.fen.na.xin	[en]
penicilin	[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	[æn]	shi.ban.na	[an]
scammony	[æn]	si.kan.mo.ni	[an]
Tammany	[æm]	tan.mu.ni	[an]
gunny	[ʌn]	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] mɛŋg.ma [ɲŋ]

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 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] _{E-M}	Dep-Place-Coda
ai.kan.nuo.mi	*!	
> ai.kɑŋ.nuo.mi		*

2.3 $Vm \rightarrow Vn, Vŋ$

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).⁹ 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]

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

<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>
<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> [Λm]	<i>sang.bo</i> [aŋ]
<i>gumbo</i> [Λm]	<i>gong.bo</i> [oŋ]
<i>rum</i> [Λm]	<i>lan.mu</i> [an]
<i>calumba</i> [Λm]	<i>ka.lun.ba</i> [un]
<i>yumpies</i> [Λm]	<i>yong.pi.si</i> [oŋ]
<i>carborundum</i> [Λm]	<i>ka.bo.lan.deng</i> [ʁŋ]
<i>trumpet</i> [Λm]	<i>qu.lang.pai.ti</i> [aŋ]

	<i>atom</i>	[əm]	<i>a.tun</i>	[un]
	<i>Edam</i>	[əm]	<i>yi.dun</i>	[un]
b.	<i>shampoo</i>	[æm]	<i>xiang.bo</i>	[aŋ]
	<i>mambo</i>	[am]	<i>man.bo</i>	[an]
	<i>adam</i>	[əm]	<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)

/kampost/	Id-V[back] _{E-M}	*dorsal, labial	*coronal
kan.po.si.te	*!		
> kaŋ.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 [\pm 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)

/ætəm/	Id-V[back] _{E-M}	*dorsal	*coronal
> atun			*
atʉŋ		*!	

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 [ɑŋ] and those spelled with "an" as [ɑn]. 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 [ɑn] 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 [ən] and not [ɑŋ] or [ɑn]. 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" = [ɑŋ], it is the vowel symbol that is the determining factor rather than the consonantal one. Saliency 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.¹⁰ 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>	
	Alexander	[æn]	ya.li.shan.da	[an]
	Amsterdam		a.mu.si.te.dan	
	Anatolia		an.na.tuo.li.ya	
	Atlanta		ya.te.lan.da	
	Birmingham		bo.ming.han	
	Canberra		kan.pei.la	
	Canterbury		kan.te.bo.lei	
	Canton		kan.dun	
	Fanning		fan.ning	

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

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)	<u>English</u>	<u>Mandarin</u>	
a.	Adirondacks	a.di.lang.da.ke	[ɑŋ]
	Bronx	bu.lang.ke.si	
	Cornacht	kang.nuo.te	
	Cornwall	kang.woer	
	Klondike	ke.lang.dai.ke	
	Oregon	e.le.gang	
	Wisconsin	wei.si.kang.xing	
	Longford	lang.fu.de	
	Taunton	tang.dun	
	Tyrone	di.long	[oŋ]
	Yukon	yu.kong	
	Montana	meng.da.na	[ʏŋ]
	Monte Carlo	meng.te.ka.luo	
	Montpelier	meng.bi.liai	
	Vermont	fo.meng.te	

b.	Ontario	[ʌŋ]	an.da.lue	[ʌŋ]
	Tucson		tu.sen	[ən]
	Pondicherry		ben.di.zhi.li	
c.	Anchorage	[æŋ]	an.ke.lei.qi	[ʌŋ]
	Anguilla		an.gui.la	
	Angus		an.ge.si	
	Frankfurt		fa.lan.ke.fu	
	Franklin		fu.lan.ke.lin	
	Lancashire		lan.kai.xia	
d.	Doncaster	[æŋ]	tang.ke.si.te	[ʌŋ]

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>	
	Fundy	[ʌŋ]	fen.di	[en]
	Brunswick		bu.lun.rui.ke	[un] *len
	London		lun.dun	*len, *den

Dunkirk	<i>dun.ke.er.ke</i>	*den
Front	<i>fu.lan.te</i>	[an] *len
Sunderland	<i>sang.de.lan</i>	[aŋ]
Dundee	<i>deng.di</i>	[ɤŋ] *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-CPI-Coda » Id-V[high]) while in the latter the height change is blocked, compelling a change of the nasal coda (Id-V[high] » Id-CPI-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.	Cardigan(shire) [ən]	ka.di.gen [ən]
	Devon	de.wen
	Lincoln(shire)	lin.ken

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

In sum, the adaptations in the place names largely conform to the generalizations uncovered in the analysis of the dictionary loans in

section 2.¹¹ 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 *dāŋ.dǎ* ‘single hit’ (tennis) vs. *fàng.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

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* > *kāng.nai.xin*, *champagne* > *xiāng.bin*, *crayon* > *gu.li.róng*, *hamburger* > *han.bao*, *nylon* > *ni.long*, *sandwich* > *san.ming.zhi*, and *sauna* > *sang.na*.

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).

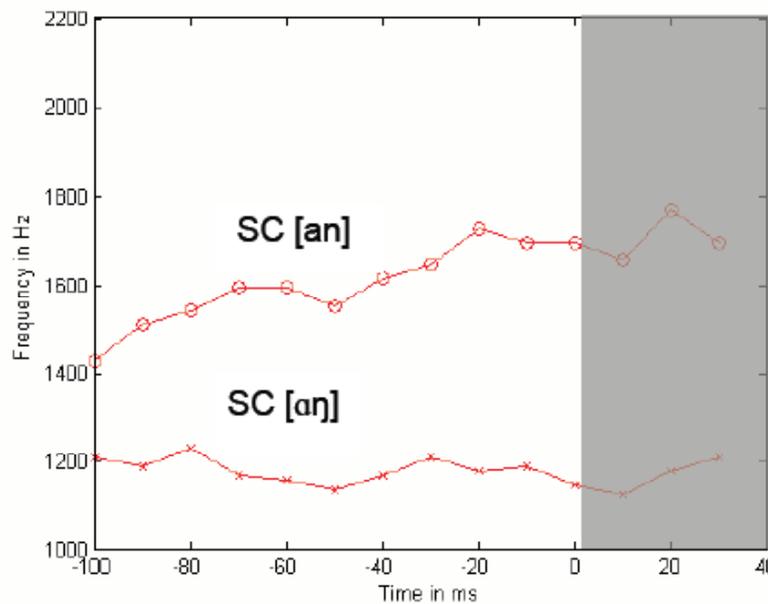


Figure 1. Averaged values of F2 movement for 18 Standard Chinese (Mandarin) vowels from 100 ms. prior to the nasal consonant to 30 ms. into the nasal consonant

Another relevant finding by Mou (2006) was that the average F2 values for predorsal 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.

(33)

		<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 as 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.

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