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Phonetic Knowledge in Tonal Adaptation: Mandarin and English Loanwords in Lhasa Tibetan*

In this paper we present the results of a study of the tonal adaptation of a corpus of c. 300 Mandarin and 40 English loanwords in Lhasa Tibetan drawn from Yu *et al.*'s (1980) *Colloquial Lhasa Tibetan-Chinese Dictionary*. Our principal finding is that no equivalence is drawn between the tones of Mandarin/English stress and Lhasa Tibetan. Instead, tones are assigned by a combination of default rules of Tibetan grammar and UG enhancement processes familiar from the tonogenesis literature.

1. Introduction

The loanword literature contains many studies of segmental adaptation. There are also several investigations of how the stress and associated F0 peaks and valleys of English and French loans are interpreted and adapted in such tonal languages as Cantonese (Silverman 1992), Hausa (Leben 1996), Yoruba (Kenstowicz 2005), and Thai (Kenstowicz & Suchato 2006). But aside from Maddieson (1977), we are not aware of studies focusing on how the lexical tones of one language are adapted by another tone language. This study helps to fill that gap. It is organized as follows. First we review the tonal contrasts of Mandarin and Lhasa Tibetan (henceforth LT). Then we present the results of our analysis of the Mandarin data in the loanword corpus. Next we consider the implications of these data from the perspective of various models of loanword adaptation. We then present our interpretation followed by corroborating evidence in the more limited corpus of English loans. The paper closes with discussion of another example of

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the same phenomenon noted by Wu (2006) for English loanwords in Taiwanese Mandarin followed by a summary and suggestions for future research.

2. Background

Mandarin (or Standard Chinese) has the familiar four contrasting tones seen in (1), with the contours described in terms of the five-point scale devised by Chao (1930).

(1)	Tone 1	High	[55]	H	mā	'mother'
	Tone 2	Rise	[35]	LH	má	'hemp'
	Tone 3	Concave	[21(4)]	L(H)	mǎ	'horse'
	Tone 4	Fall	[51]	HL	mà	'scold'

LT tones are customarily reduced to a binary H vs. L phonological contrast, with the surface pitch contours a function of the syllable rime shape. These are tabulated and illustrated in (2), based on the acoustic analyses and pitch plots in Hsieh (2007) (cf. Hu (1980) and Hu *et al.* (1982)). The data (10 to 20 tokens for each rime type) were produced in isolation by one male speaker of LT and were extracted from a cassette recording accompanying Zhou's (1983) *A Pronunciation Guide to Lhasa Tibetan*. Measurements of the normalized F0 contours were made with the help of Yi Xu's Praat script (TimeNormalizeF0.Praat).

(2)	Rime type		H-register	L-register
	Short	V	[54]	[23]
	Long	V:/VN/V̰:	[44]	[113]
	Glottalized	VP/V̰	[52]	[132]
		VN/V̰:	[52]	[132]

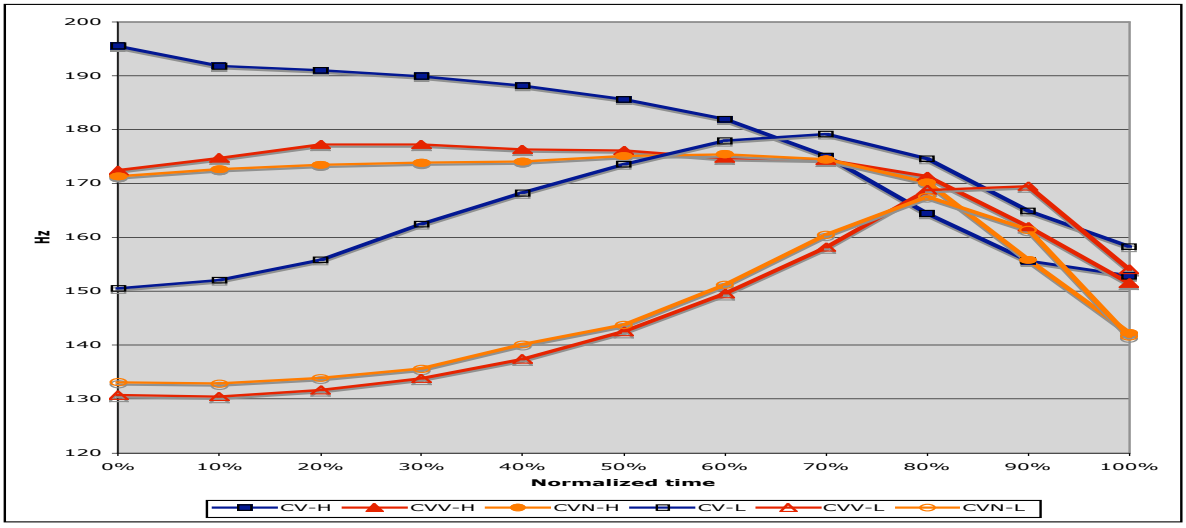


Fig. 1 Monosyllabic tones in Lhasa Tibetan (where V=short vowel, VV=long vowel, H=H-register, L=L-register[1]) tones on glottalized rimes are not included)

As we can see, the cutoff point between the two registers is around 160 Hz (at least for the first 30% portion). The F0 contours converge at around the 80% point of normalized time in the upper pitch space, followed by a fall to a low boundary tone in these citation forms. Shorter syllables begin at a higher point in the F0 space. The H-register tones are relatively flat until the fall to the boundary tone while the L-register tones begin in the lower pitch space and then rise toward the upper register. These F0 contours reflect the fact that the H-L register distinction arose diachronically from voicing distinctions in the onset consonants that no longer appear on the phonetic surface in the present-day language--a tonogenesis phenomenon found throughout (South)East Asian languages. See Svantesson and House (2006) for recent discussion of the phenomenon in Kammu.

When monosyllables are combined to form compounds, a tone sandhi process occurs in which the underlying tones on noninitial syllables are replaced by H (see Fig. 2 below

[1] Tones on glottalized rimes are not included due to the difficulty of obtaining reliable pitch tracing on creaky voiced vowels.

for pitch tracks). The influence of rime shape on the syllable's surface F0 contour depends on the location of the syllable (initial, medial, final) in the compound. See Meredith (1990), Duanmu (1992), Sun (1997), Yip (2002) and Hsieh (2007) for recent generative analyses.

One other important point is that both Mandarin and LT lack a (surface) voicing contrast among obstruents as well as sonorants. Both languages have an aspiration contrast for stops.

3. Tonal Adaptations: Mandarin

Since Lhasa Tibetan has surface F0 contours that approximate most of the Mandarin tones (1,3,4), one might expect the latter to be more or less faithfully reflected in the loanwords, at least when the syllable shape permits. However, our data indicate that Mandarin tones are entirely ignored in the adaptation process. Loans are assigned to the Tibetan H vs. L classes on the basis of the onset of the initial syllable.[2] These generalizations are illustrated in (3). We see that the noninitial syllables are always H while the initial syllables are H when the onset is an obstruent and L when the onset is a sonorant. It is evident that the tones of the Mandarin source word play no role in the adaptation. Only a handful of exceptions appear in our corpus.

[2] The entire corpus is provided as an appendix to Hsieh & Kenstowicz (2006). The Mandarin loanwords are drawn primarily from the fields of modern material and political culture and date from c.1950 when the PRC annexed Tibet. We have excluded loanwords from Old Chinese and from Mandarin dialects (in particular, Sichuan Chinese). A reviewer asks whether the absence of reflexes of Mandarin tones in our corpus indicates transmission via a nontonal Tibetan dialect such as Amdo. This is implausible because Lhasa has been the sociopolitical capital of modern Tibet and hence the most likely point of contact between the two languages.

(3) a. Obstruent-initial

Standard Chinese		Lhasa Tibetan		
ʂuʨi	HF [14]	hru'uci	HH	‘secretary (of a CCP committee)’
ʂənwej	RL [23]	hreng-u	HH	‘provincial CCP committe
taŋɥan	LR [32]	tang-yon	HH	‘CCP member’
faʨisɻ	LHH [311]	hpashisi	HHH	‘Fascism’
tʲentsɻ	FL [43]	tentsi	HH	‘electron’

b. Sonorant-initial

jatsɻ	HL [13]	yatse	LH	‘duck’
litsɻ	RL [23]	litsi	LH	‘ion’
ɥanzɻitan	RLF [234]	yontsitan	LHH	‘atomic bomb’
wasɻ	LH [31]	wasi	LH	‘gas’
zəxətsɻ	FRL [423]	rehotsi'i	LHH	‘thermonuclear’

c. exceptions

kʷuotʃi	RF [24]	goci	LH	'Communist International'
putʂaŋ	FL [43]	pu'ukrang	LH	'minister'
loŋtsɻ	RL [23]	rlungtsi	HH	'cage'

The tonal correspondences we have found for the words in our corpus are tabulated and summarized in (4) below.

(4)

Mandarin input	LT output	
Obstruent-initial	H-H	L-H
H-T	64	0
R-T	37	6
L-T	31	1
F-T	42	4
total	174	11
Sonorant-initial	H-H	L-H
H-T	0	2
R-T	1	26
L-T	0	3
F-T	0	10
total	1	41

While the assignment of H-register tone to the noninitial syllables in the loans can be attributed to a constraint of the native Tibetan grammar, the treatment of the initial syllables is not so easily explained since H and L tones freely combine with both obstruent-(aspirated and unaspirated) and sonorant-initial onsets in the Lhasa dialect. This is shown by the following minimal pairs. (The Written Tibetan (WT) forms are based on Wylie's (1949) transcription system.)

(5)

High-register			Low-register		
LT	WT	Gloss	LT	WT	Gloss
ka	bka’	‘decree’	ka	sga	‘saddle’
k^ha	kha	‘mouth’	k^ha	go	‘hear’
ma	rma	‘hurt’	ma	ma	‘mother’

The independence of the [±sonorant] and [±H-register] contrasts is further confirmed by a hand count of the distributions of word-initial High- and Low-register tones in *Yu et al.* (1980) (see section 4 below for more fine-grained tallies of each consonant).

(6)

	Word-initial H-register	Word-initial L-register
Obstruent-initial words	12,136 (60%)	8,023 (40%)
Sonorant-initial words	3,236 (44%)	4,081(66%)

4. Discussion

The tones assigned to the LT loans are problematic for two of the principal models of loanword adaptation that have been proposed in the recent generative literature. According to the Phonological model (LaCharité and Paradis 2005), bilingual adapters draw on their competence in both the donor and the recipient languages to abstract away from details of phonetic realization and assign the closest phonological category. Since LT has just H and L tones, we might expect Mandarin tones 1 (high level) and 2 (mid rise) to be adapted as Tibetan H and LH respectively since they match best for tone level and shape.

While this correspondence holds in some cases, we fail to explain why Mandarin words with tone 1 are systematically adapted with LT L when the onset is a sonorant as well as why Mandarin words with tone 2 are adapted with LT H when the onset is an obstruent. This change is not a rule of Tibetan grammar since the High and Low tones contrast after sonorants, as seen in (6).

On the other hand, the model of loanword adaptation that proposes an extra-grammatical module of speech perception (Peperkamp & Dupoux 2003) is equally challenged by the data. On this view adapters should match the Mandarin tones with the closest surface F0 contours in Tibetan--at least for the initial syllable. We therefore might expect Mandarin tones 1, 2, and 4 to be adapted as LT H since they occupy the upper pitch space for the majority of their trajectories. But as we have seen, the Mandarin tones are systematically ignored.

It thus appears that neither of these models of loanword adaptation makes the correct prediction, since each is committed to selecting the closest match (phonological or phonetic) for the feature or phonetic dimension that is at play. Under a third alternative proposed by Kenstowicz (2005) and Yip (2006), among others, adapters are not passive recipients of data from the donor language but can exercise active control over their grammars to achieve the best match. This approach permits greater flexibility in adaptation. Our suggestion is that the F0 contours in the two languages (LT and Mandarin) are judged to be too dissimilar to count as equivalent. This hypothesis is based in part on the F0 tracings in Hsieh (2007) (cf. Hu (1980) and Hu et al. (1982)). As shown in the normalized contours below (10~20 tokens for each combination), the Tibetan tones

are quite flat, with minimal F0 fluctuation (within 10 Hz). (The blank area between the two syllables indicates a hypothetical transition between two tones.)

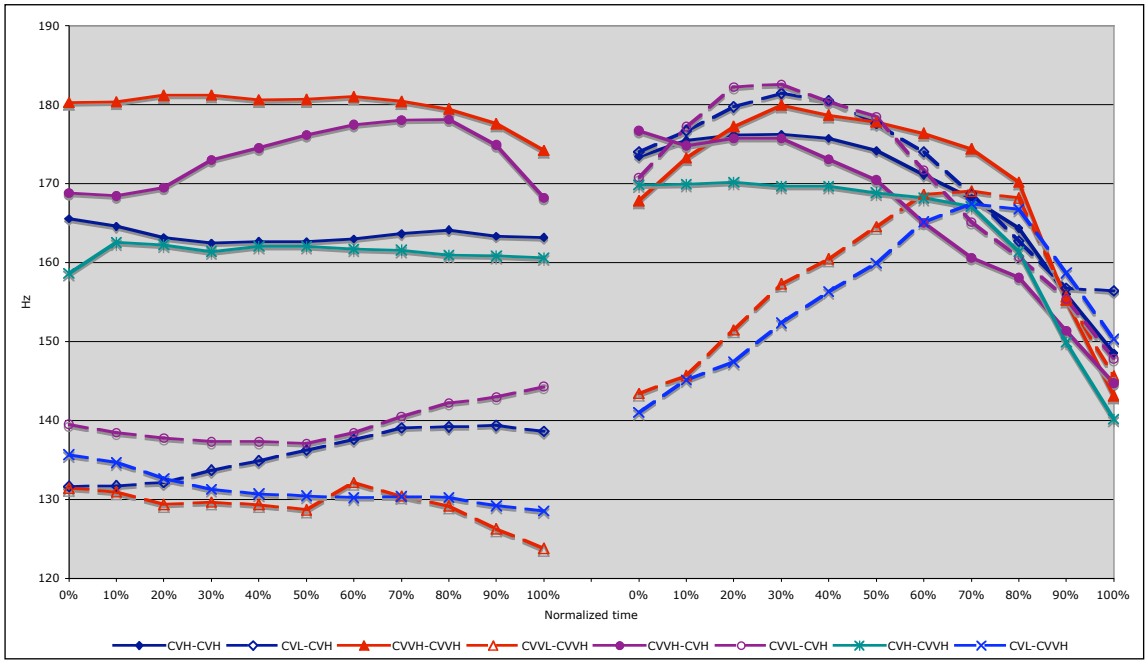


Fig 2 Pitch tracings of disyllabic tone sandhi in Lhasa Tibetan

By contrast, Mandarin tones are typically quite dynamic and show considerable coarticulation when concatenated (Xu 1997 et seq.). This is evident from the normalized pitch contours in Fig. 3 below that track F0 across disyllabic sequences of [ma] syllables for all possible tone combinations.

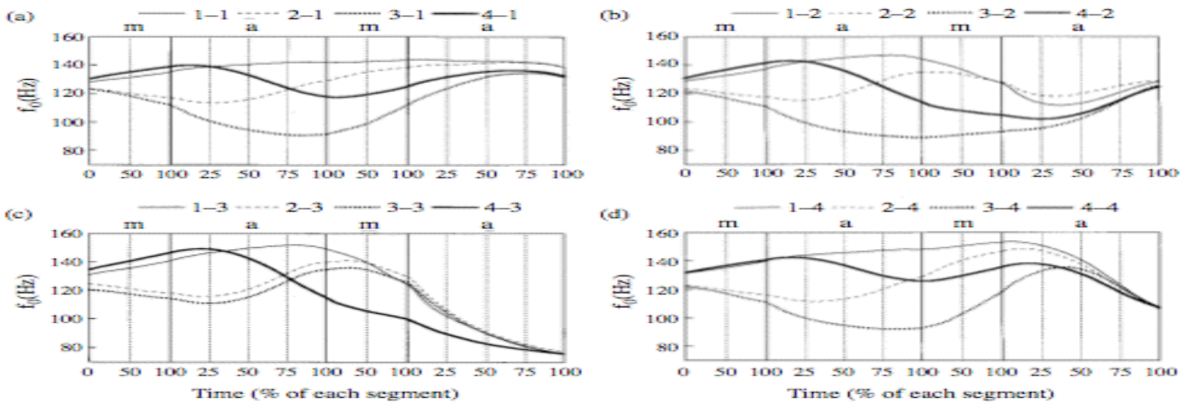


Fig. 3 Xu's (1997) pitch tracings of disyllabic tone patterns in Mandarin

Other researchers have commented on the disparity between the LT and Mandarin tones. For example, Kjellin (1977) points to a smaller pitch range occupied by the LT contrast (c. 20 Hz for isolation words and 40 Hz. for phrasal contexts for his subject) in comparison to a c. 100 Hz. drop between the peak in Mandarin tone 4 [51] and the valley of tone 3 [21(4)] in a study by Chuang (1972). The latter values are about twice the magnitude of those seen in Xu's (1998) recent study, however. In order to more accurately gauge the magnitude of the disparity between the Mandarin and LT tones, a carefully controlled experiment in which the tones of the two languages are systematically compared is required. This is a task for future research.

The phonological systems underlying the LT and Mandarin tones differ radically as well. Under one phonological interpretation of the LT system (Kenstowicz 1994:378-9 based on Meredith 1990), the tones are assigned to an upper and lower register as well as receiving a contour specification for rise, fall, or level in the notation devised by Bao (1990, 1999). The tone sandhi involves preserving the register specification of the initial syllable while eliminating its contour node; the noninitial syllable is shifted to the upper register while retaining its contour specification in the final (stressed) position. When this system is compared with Mandarin, it is far from obvious how the four Mandarin tones and their allophonic variants should be assigned to a particular register let alone whether a register distinction would be useful for characterizing any Mandarin tonal sandhi processes. We conclude that the decision of the LT adapters to ignore the tones of Mandarin makes sense on both phonetic and phonological grounds.

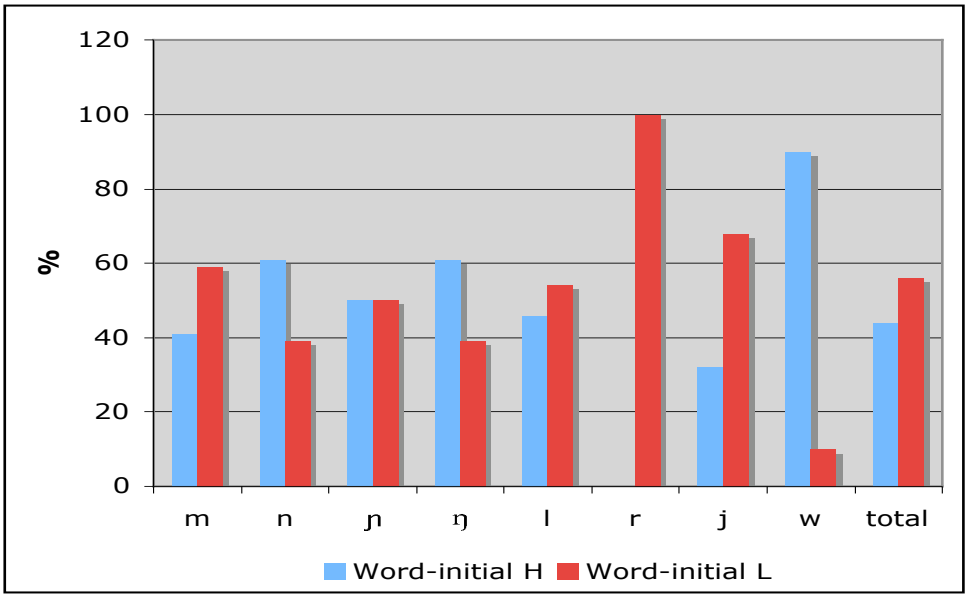
How then can we understand the mechanism that comes into play in the Mandarin loanword adaptations--basing the choice of the tonal register on the voicing of the initial onset consonant and otherwise assigning default H? Let us symbolize this process as $P^{(h)}a^{H}$-σ^{T} and Ma^{L}-σ^{T}, where [a] indicates any vowel and P and M abbreviates obstruent and sonorant, respectively.

Recent research has shown that native speakers are sensitive to the statistical distribution of phonological categories in the lexicon (Ernestus & Bayn 2003, Pierrehumbert 2003). Therefore, we might wonder whether Ma^{H}-σ^{T} and $P^{(h)}a^{L}$-σ^{T} forms are significantly outnumbered by Ma^{L}-σ^{T} and $P^{(h)}a^{H}$-σ^{T} forms so that Tibetan speakers assign the tonal contour in the loanwords on the basis of the most frequent structure in the native lexicon, where it might function as a default.

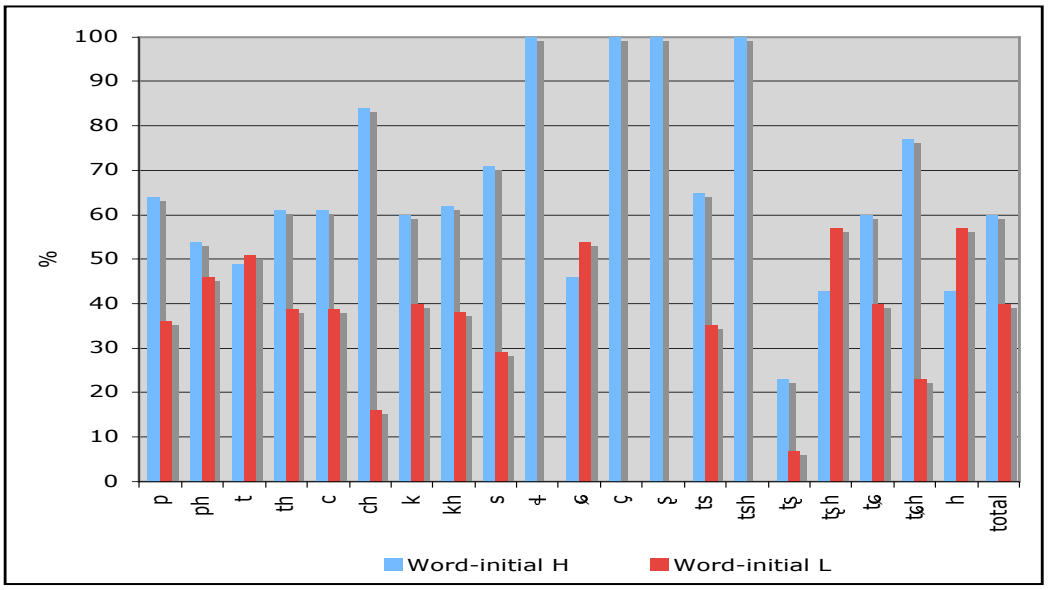
To see if this interpretation is viable, we conducted a hand count of the distributions of word-initial High- and Low-register tones in Yu *et al*. (1980). Functional words were excluded because most of them are underlying toneless. The results are shown below.

(7) Tonal distributions in initial position

a. Sonorant-initial words



b. Obstruent-initial words



As illustrated in the graphs, it is not uncommon to see a High-register tone appearing on a sonorant-initial syllable. In particular, there are more High-register tones on initial syllables starting with [n] and [ŋ]. On the other hand, although it is evident that Low-

register tones appear less frequently on initial syllables starting with an obstruent, there are still a large number of words of this type. As we can see, the High vs. Low-register ratio across the entire lexicon is approximately 60%-40% for obstruents and 40%-60% for sonorants. If adapters are approximating the distribution in the native lexicon, then we should expect more variability than the nearly exceptionless rule based on the initial consonant.[3]

Alternatively one might argue that speakers consult their lexicon to determine the default rule on a confidence basis (Albright in press). The idea would be that given that F0 of the Mandarin (or English) source word is not reflected in the loanword, some decision must be made as to whether to assign H or L. The native grammar instructs the adapter what to do for nonitinitial syllables (the default H). But it offers no guidance for initial syllables since this is a site of phonemic contrast. In such cases of grammatical uncertainty, Albright (in press) finds that learners follow the statistically most reliable outcome, since on average this results in a larger number of correct responses.

While we believe there is merit to this approach, it cannot be the entire story for the Tibetan loans since it's viability depends on choosing the frequencies based on the [±sonorant] or [±voice] distinction of the onset consonant. But why not assign the tone on the basis of the particular onset consonant (leading to a correct choice of L after [m] but incorrectly predicting H after [n])? Another a priori reasonable default strategy would be to simply assign the tone that is most frequent for initial syllables across the entire lexicon, incorrectly predicting a consistent H for the first syllable.

[3] See Walter (2006) for an example of Spanish adaptation of loans from Arabic that mimics the frequencies of the Spanish lexicon.

We conclude that the tonal assignments found in the Tibetan loanwords cannot be projected from the statistical distribution of H and L in the native lexicon.

5. Adaptation by Enhancement

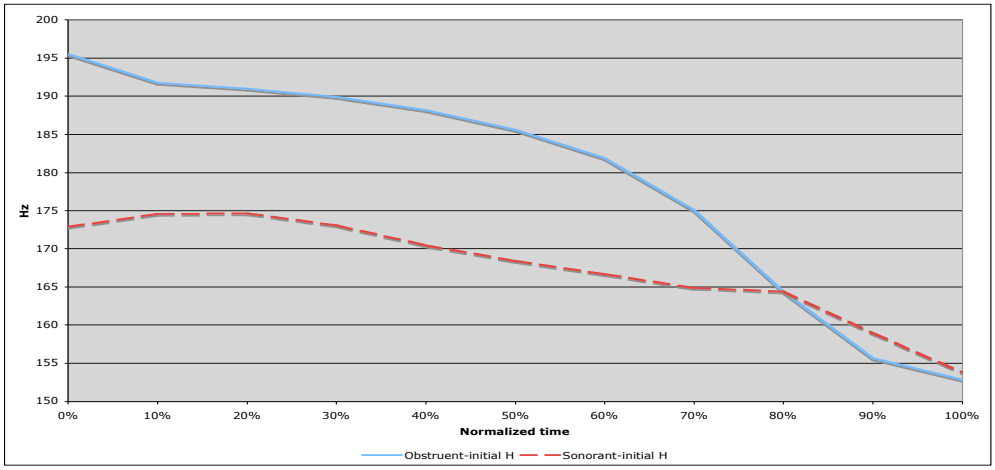
Our suggestion is that native speakers have access to a repertoire of enhancement processes (Keyser and Stevens 2006) that state how a contrast in a given position can be reinforced by another feature or articulatory maneuver. Given that the H vs. L register categorization is not being used for lexical contrasts in the LT loanword vocabulary, it remains available to reinforce other feature oppositions that are in contrast. For the case at hand, we have two options. High vs. Low tone may be enhancing either the [±voice] or the [±sonorant] contrast that underlies the opposition between /p/ and /p^h/ vs. /m/ in LT. The tonogenesis phenomenon strongly points to the first option. As Kingston and Solnit (1988) and others have observed, in the East Asian languages at least, when the phonological inventory supplements /p/ and /m/ with voiced /b/ and or voiceless /^{h}m/, it is the [+voice] /b/ and /m/ that pair together in tonogenesis--typically inducing low tone--not the [-sonorant] /b/ and /p/. Similarly, voiceless /^{h}m/ patterns with /p/ and not with /m/, as in Burmese (Maddieson 1984). Furthermore, Kingston and Diehl (1994) and more recently Kingston (2004) point out that speakers can actively control this consonantal voicing -> F0 relation as part of linguistic competence (Phonetic Knowledge) rather than it being an automatic, articulatorily determined consequence or byproduct. Our suggestion is that the Tibetan adapters call on this knowledge (either innately present or arising in first language acquisition) to assign the Mandarin loans to the H vs. L register

classes that characterize LT words.[4] This particular enhancement relation is expressed as the phonotactic constraint in (8).

(8) VOICE ENHANCEMENT: [+voice] ≈ L-register, [-voice] ≈ H-register

A syllable is assigned to the lower pitch register when its onset consonant is [+voice] and to the upper register when its onset consonant is [-voice].

When a syllable lacks a tonal specification, as in the adaptations of the Mandarin loanwords, then Voice-Enhancement is the sole determinant of tone. But we find that Voice Enhancement also plays a role in syllables that have a lexical tone. Based on an analysis of data extracted from Zhou's (1983) recordings, both H and L register tones are lowered after the voiced nasals in comparison to voiceless unaspirated stops. For this measurement we used {p, t, k}+{a, i, u} for obstruent-initial words (three tokens for each combination) and {m, n, ŋ}+{a, i, u} for sonorant-initial words (three tokens for each combination). The results are shown in Figure 4.



[4] The situation here is analogous to what Uffmann (2006) reports for English loans in Shona. Due to its CV syllable structure, consonant clusters are broken by epenthesis in loanword adaptation. The epenthetic vowel (by definition) is not the site of lexical contrast. It is determined as [i], [u], or [a] as a function of the coronal vs. labial vs. dorsal character of the preceding consonant by enhancement relations linking vocalic tongue body configurations to oral cavity consonantal constrictions (labial ≈ [+back, +round], coronal ≈ [-back, -round], [dorsal ≈ [+back, +low].

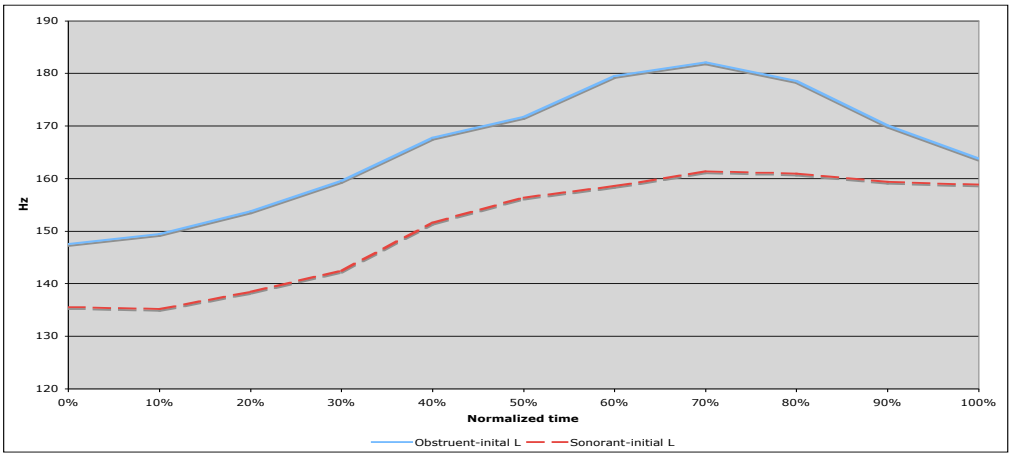


Fig 4. Voicing contrast and tonal realization

As we can see, the obstruent-initial H and sonorant-initial H are separated by around 20 Hz while the obstruent-initial L and sonorant-initial L are separated by around 10 Hz throughout. The 20 vs. 10 Hz difference between H and L is attributable to the positive skew of tonal distribution (Zhu 1999, Hsieh 2007), i.e. the well-attested cross-linguistic tendency for tonal spacing to be narrower in the lower part of the pitch range.

The role of (8) here can be usefully compared with the situation in contemporary Korean. As shown in Silva (2006), F0 is now the primary correlate of the tense-lax contrast of stops in phrase-initial position in the (standard) Seoul dialect. For the Kyungsang dialects that preserve lexical tonal contrasts, Kenstowicz and Park (2006) find that F0 is lowered after voiced nasals as well as breathy lax stops in both H and L tones. Thus, even a tonal dialect can utilize F0 to enhance a laryngeal contrast in onset consonants. For LT the Mandarin loanwords are comparable to Seoul Korean where F0 is determined solely by the consonantal onset contrast while LT lexical tones are comparable to Kyungsang Korean where the [±voice] contrast in the onset modulates the F0 of the underlying lexical tonal contrast.

Our formal analysis begins with the assumption that the enhancement constraint in (8) must itself be dominated by the LT phonotactic that bars L from noninitial syllables. Let us refer to the latter constraint as simply *σ-σ^{L}. The initial adaptation process can be modeled by treating the surface form of the donor language as the input to the *σ-σ^{L} >> VOICE-ENHANCEMENT ranking. We illustrate the analysis with two typical adaptations. In (9) we show the adaptation of Mandarin /lienin FR/ 'Lenin' as LT *lenyin* (*ringlugs*) LH (Lenin(ism)). The phonotactic constraint barring noninitial L tones eliminates the second and fourth candidates while VOICE-ENHANCEMENT excludes the adaptation with an initial H, leaving LH as the optimal tonal assignment. For the reasons given in the preceding section, we assume that the LT H and L register distinctions fail to match any Mandarin tones and hence all candidates violate Ident-Tone.

(9)

/lienin/	*σ-σ^{L}	IDENT-TONE	VOICE-ENHANCEMENT
a. H H		* *	*!*
b. H L	*!	* *	*
☞c. L H		* *	*
d. L L	*!	* *	

Next in (10) we see the adaptation of Mandarin /pejtɕiŋ/ LH 'Beijing' as LT *petɕin* HH. This time VOICE ENHANCEMENT penalizes the candidate with initial L since the onset consonant is voiceless.

(10)

/pejtɕiŋ/	*σ-σ^{L}	IDENT-TONE	VOICE-ENHANCEMENT
☞a. H H		**	
b. H L	*!	**	*
c. L H		**	*
d. L L	*!	**	**

To recapitulate our analysis, we have seen that Mandarin tones are ignored in loanword adaptation. Yet every word must carry a tone to be a valid LT lexical item. We argue that the enhancement constraint (8) is activated to assign a tone.

6. Covert Voice-Enhancement: English loanwords

In this section, we examine tonal adaptation of English loanwords into Tibetan. Our source (Yu et al. 1980) contains about forty loanwords from English. In contrast to tonal languages such as Cantonese (Silverman 1992), Yoruba (Kenstowicz 2005), and Thai (Kenstowicz & Suchato 2006), where the stressed syllable of English is consistently marked by a high tone in loans, we find that stress plays no role in the Tibetan adaptation process. The location of the stressed syllable (and the F0 change that is associated with it) is not reflected in the Tibetan loans. Instead, the same principles that hold for Mandarin loans apply--with one additional important point. If the onset of the initial syllable in the English source word contains a voiced obstruent, then the initial syllable in the loan is L even though the obstruent itself is adapted as voiceless (unaspirated) since Tibetan lacks voiced obstruents. The data in (11) illustrate.

(11)

	English	LT	Tone	WT
a.	police	pulisi	HH	pulisi

	ton	tsøn	H	kron
	cabbage	koopiʔ	HH	ko'opig
	cigarette	ɕikrɛ	HH	shigras
b.	bottle	potora	LHH	sbodora
	bag	pɛk	L	’beg
	double	təppar	LH	sdabspar
	dozen	tarts^{h}ɛn	LH	sdartshan
	motor	motʂa	LH	moda
	rail(way)	rili	LH	rili
	lighter	letʂa	LH	leda
c.	iodine	^{ʔ}ɛtʂin	HH	a'ikrin
	aspirin	^{ʔ}ɛsipilin	HHHH	assispilin

The English data also show that when there is no onset consonant (11c), then the initial syllable is assigned to the H tone category. This suggests that H is the default tone in LT--the same tone that shows up when contrasts in noninitial positions in the compounds are neutralized.

These data have a strong bearing on the analysis of the Mandarin loans discussed earlier. First, they support the contention that the contrast being enhanced by the choice of H vs. L register in the loans is [±voice] rather than [±sonorant]. Otherwise, we would expect English voiced obstruents to induce a high tone. Second and more importantly they raise the question as to the nature of the enhancement process itself. If it is merely a

standard OT structural (markedness) constraint stating the wellformedness of a feature specification in a particular output context, then it fails to do the work we want precisely because the obstruents are voiceless on the surface in LT. We could evade this problem by analyzing the voicing and F0 in terms of the same feature [±stiff] or [±slack] (following Halle and Stevens 1971). Then a high-ranked markedness constraint *[+slack, -sonorant] and feature faithfulness to [+slack] will allow the [+slack] specification to survive in the following vowel where it is phonetically interpreted as low F0.

(12)

/ba/ | [+slack]	*[-sonorant,+slack]	Max-[+slack]	Ident-[+slack]
[bá]	*!		
[pá]		*!	
☞ [pà]			*

But this would not be a general solution to the problem. The [±voice] contrast can be enhanced by a variety of maneuvers that promote vocal fold vibration but do not directly control the glottal articulators such as duration in the consonant itself or the neighboring vowels. Our suggestion is that the H vs. L register distinction is the surface reflex of a phonological contrast over the entire syllable that has a variety of possible phonetic manifestations that have been documented in the tonogenesis literature: modal vs. laryngealized voicing, breathy vs. creaky voice, upper vs. lower tonal register, etc. Choice among this menu of enhancements is under speaker/grammatical control. As Keyser and Stevens observe, the enhancements may end up bearing most of the burden of realizing the contrast, allowing the underlying phonological feature ([±voice] in our

case) to be neutralized. We suspect that phonological opacity that is tied to enhancement has a different grammatical status from opacity arising from other sources such as segmental deletion. Spelling this speculation out in greater detail is a task for future research.

An indication that something like this scenario is playing out in LT is Kjellin's (1977) finding that the onset stops have different closure durations in the two different tonal registers. They are c. 10 ms. shorter in the L- register syllables than in the H-register ones. Correlated with this is a compensatory difference in vowel duration--longer in the lower register. Kjellin did not find any difference in phonation (though he states others have reported breathy voice for the L-register and this is found in other Tibetan dialects). Citing Hyman and Schuh's (1984) dictum that "consonants influence tone but tone does not influence consonants," Kjellin postulates an underlying voicing contrast in the onset consonants that then determines the H vs. L register, concluding that LT is not a tonal language. A similar conclusion is drawn by Svantesson and House (2006) for the H vs. L tonal contrast in Northern and Western Kammu. Their proposal is strongly supported by phonotactic constraints between the onset consonants and the syllable's tone (e.g. onset [h] is not compatible with L-register) as well as morphophonemic alternations in the initial consonant that change the syllable's tonal specification. So far as we know, such evidence is lacking in LT and so we are not in the position to assert with any confidence that the correlation between tone and voicing that we have uncovered in loanword adaptation can be reduced to a synchronic rule of LT grammar such as is found in Kammu. Rather it would fall under the rubric of an Emergence of the Unmarked

phenomenon where the choice of L vs. H register for the loans is determined by the UG Voice-Enhancement process (8).

Finally, we briefly address the role of orthography in the adaptation process. The modern Tibetan spelling system is based on Old Tibetan dating back to the Seventh Century (Ma 1991/2003: 97). Due to diachronic processes such as cluster simplification, most of the digraphs (and trigraphs) nowadays correspond to a single phoneme. We might postulate that LT speakers are aware of the fact that there is, for example, only one 'm' in the English word "motor," so they transcribe the word as "moda" in written form. More precisely, the syllable "mo" carries a L-register tone while a H-register [mo] sound is written as "smo," "rmo," etc. However, the orthography in the source is not always respected. For instance, "bottle" is spelled as **sbo**dora [potora LHH]. It is clear that the English source does not contain a consonant cluster (in written form) here. We thus conclude that the loans are spelled in such a way that the initial consonant is compatible with its assignment to the H or L tonal categories. In other words, the tonal assignments as H or L determine the orthographic representation, not vice versa.

7. English loans in Mandarin

The effect of onset voicing on the choice of tone for the following vowel has been documented for at least one other case in loanword adaptation. Wu (2006) assembled a corpus of over 100 Western loans that survive into contemporary (Taiwanese) Mandarin from a dictionary of foreign words (Liu 1984). We briefly summarize her results here.

First, monosyllables are adapted with Tone 4 (falling) if the relevant combination of syllable and tone exists in the Mandarin lexicon--a faithfulness/structure preservation constraint imposed on all loanwords. This adaptation is comparable to that found for

Cantonese, Yoruba, and other languages and evidences an attempt to match the falling F0 contour associated with an English monosyllable in citation form. The absence of a comparable process in LT adaptations supports our contention that the phonetics and underlying phonology of the LT and Mandarin grammars differ. Examples appear in (13).

(13)

English	Mandarin
pound	pâng 4
bar	pâ 4
cool	k^{h}û 4

For the disyllabic loans that are SW trochees, approximately three out of four have Tone 1 or Tone 2 on the initial syllable. Thus, the stressed syllable of English is preferentially adapted with a tone from the upper pitch space (55 or 35).

(14)

Tone	1 H	2 LH	3 L	4 HL	total
examples	29	44	18	11	102
ratio	.28	.43	.17	.11	1.0

There is an interesting distribution among the first two tones, which we reproduce in (15). Sonorant onsets prefer Tone 2 while obstruent onsets prefer Tone 1.

(15)

onset	tone 1	tone 2
sonorant	4	32

obstruent	25	12

English	Mandarin	
modern	muódə̄ng	RH
rupee	lúpì	RL
laser	léiṣɤ̂	RF
salad	ṣālā	H H
peso	p^{h}ǐsuò	H L
quart	k^{h}wāthuō	H H

Wu finds that these data show a significant statistical bias (Fisher's Exact Test, 2-Tail : p-value = 8.263880135646174e-7): voiced sonorants prefer a lower-starting tone [35] on the following vowel compared to voiceless obstruents, which prefer high [55]. This finding is reminiscent of the Voice Enhancement relation we saw operating in Tibetan loanwords except that the numbers are smaller and the effect is less categorical. Wu (2006) also reports an on-line adaptation experiment in which Mandarin subjects showed a bias to adapt sonorant-initial nonsense words with Tone 2 vs. Tone 1 on a 63% vs. 37% ratio. These results suggest that her subjects may be drawing on the same Voice Enhancement constraint when faced with a psycholinguistic task that replicates loanword adaptation.

8. Summary and Conclusions

We have examined two examples of loanword adaptation concerning a tonal language. In the case of Tibetan, the F0 contours of the donor language (both Mandarin and English) are ignored and loans are assigned to native tonal categories (H and L) on the basis of an enhancement process that either reinforces (in the case of sonorants and voiceless obstruents) or replaces (in the case of voiced obstruents) a voicing contrast in the onset of the syllable. The statistical distribution of tones in the native lexicon plays no role in this process. On the other hand, for English loans into Mandarin we see that the F0 peak of English is adapted. But its realization as H (Tone 1) or Rising (Tone 2) tends to reflect the voicing state of the onset consonant.

While the phonetics of Mandarin tone have been well-studied in comparison to Lhasa Tibetan, experiments probing the crosslinguistic perception of F0 contours are sorely underrepresented when compared with the extensive literature on the crosslinguistic categorization of consonants and vowels, and more recently stress (Peperkamp and Dupoux (2002)). The generalizations emerging from loanword adaptation lead us to believe that interesting asymmetries should arise in the tonal domain as well. It is also a task for future research.

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