Some Tibeto-Burman Sound Changes
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On Some Tibeto-Burman Sound Changes[1]

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0. In this paper a number of sound changes involving the influence of final consonants on vowel quality are examined. In general, it is found that final consonants in the denti-alveolar region have caused all but high front vowels to be either fronted (a, o, u > ε, ø, y) or to acquire an -i glide (a, o, u > ai, oi, ui.) First I will present the data, from Tibetan and some Tibeto-Burman languages of Nepal, and then I will discuss the acoustic and articulatory aspects of the problem. The discussion will focus on the direction, rather than the fact, of sound change.

1.0 In considering the data to be presented below, it is useful to bear in mind the systems of final consonants and of vowels of Written Tibetan (WT), whose orthography was established in about the eighth century. The consonant finals are spelled -b, -d, -g, -m, -n, -ŋ, -r, -l, -s. Conservative dialects of all the languages discussed here have similar systems, although some or all of the non-nasal continuants may be missing. The WT vowels are i, e, a, o, u. Conservative dialects discussed below generally have five or six vowel qualities. The influence of neighboring consonants and vowel harmony have led to a proliferation of vowel qualities in other dialects.

1.1 Tibetan.[2] Comparison between WT and the modern dialect of Lhasa described by Chang and Shefts (1964) reveals the following regular changes:

$$\text{WT} \begin{Bmatrix} a \\ o \\ u \end{Bmatrix} > \text{LT} \begin{Bmatrix} \varepsilon \\ \text{ø} \\ y \end{Bmatrix} \quad /\_\_d,\ n,\ l,\ s\ \text{(WT syllable final)}.$$

WT -d, -n, -s have no consonantal reflexes in Lhasa. In general, where stops or -s have been lost at the end of a word, the "falling tone" is produced (v̀), which B. Chang (1968abd) describes as a "glottal incident" followed by lowered pitch. Where nasal word-finals (-n always and -ŋ sometimes) have dropped, a long nasal vowel results. The changes in vowel quality are illustrated on the left side of Table 1.[3]

Olson (1974) has noted that an eastern (Kham) dialect shows the same changes as Lhasa, except that the fronted WT a merges fully with reflexes of WT e, and -l tends to be lost without trace.

Data on a few other Tibetan dialects has been included on the right side of Table 1. Balti and Lahul are western dialects; Balti provides modern evidence for the presumed WT system. Lahul shows few vowel

Table 1: Tibetan Vowels and Finals

Gloss	WT	Lhasa	Balti	Lahul	Amdo
sleep	gñid	ñīì	ngid	ñī	ñïl'
is	red	reè			rel'
eight	brgyad	kɛɛ̀	bgyad	giad	giel'
language	skad	qɛ̄ɛ̀	skat	kad	skel'
Tibet	bod	phöö̀	bodh-		wȯl'
demon	bdud	tüǜ			wdïl'
price	rin	rĩĩ	rin		
otherwise	gsen	sẽẽ			
medicine	sman	mɛ̃ɛ̃	sman	män~men	xmen
autumn	ston	tṏ-	ston	ton-	x̂ton
seven	bdun	tũ̈ũ̈	bdun	dun~dün	d̂ïn
mule	drel	thee		ṭri	ṭrī
wool	bal	phɛɛ	bal	bal'	wa~wal'
extra	thol	thöö			
country	yul	yüü	yul	jul'	jū-jïl
two	gñis	ñīī	ngis	ñī	ɣñī~ñī
know	śes	šẽ	shes-		šē-
cloth	ras	rɛɛ̀	ras	rai~rē	re
religion	chos	chöö̀	chhos	č'oi	č'ō
incense	spos	pöö̀		poi	xpē
body	lus	lüǜ		lui	l̂ī
Elsewhere, vowel quality is largely preserved:					
west	nub	nuù	nubkha		nïb
needle	khab	qhə̄p	kaḅ	khab	k'ap-k'ab
six	drug	ṭhuù	truk	ḍrug	ḍrïk~ḍrïg
roof	thog	thɔ̄ɔ̀	thoqsa	thog	t'og
yak	gyag	yāà	hyaq	ja	ɣăjaɣ
three	gsum	sūm	khsum	sum	gsïm~sïm
bear	dom	thom		dom	tom
sky	gnam	nām	khnam	nam	ɣnam~xnam
wind	rluŋ	lūŋ	hlung	luŋ-po	xluŋ
price	goŋ	qhṏò		goŋ	ɣoŋ
beer	chaŋ	chãā	chhang	č'aŋ	č'aŋ

LT: Goldstein 1968; Balti: Read 1935; Lahul, Amdo: Roerich 1933, 1958. Only LT may be regarded as phonemicized ⟨Chang + Shefts 1964⟩.

changes, mainly those induced by WT -s. It is interesting that the change is usually a diphthongization rather than simple fronting as in Lhasa. Amdo, an eastern dialect, shows still another effect of *-s: fronting with unrounding. ⟨Note that *u unrounds to i̲ anyway in Amdo.⟩ In Amdo, only *a is fronted by *-d, *-n.

1.2 Newari[4] In the Newari of Kathmandu, all consonant finals have been lost, with compensatory vowel length ⟨and nasality in the case of nasal finals⟩. The dialect of Dolakha conserves the finals of Classical Newari ⟨to 18C.⟩. Vowel quality is generally preserved, except before -*s in Kathmandu.

Classical	Dolakha	Kathmandu	gloss
hnas	nas	nhæ:	nose
hnəs	nəs	nhɛ:	seven
gvay⟨?*gos⟩	gõs	gwɛ̃:	moustache
kwos	kõsə	kwɛ̃:	bone

1.3 Bantawa The Bantawa dialects of Dilpa and Khawa are located on opposite sides of a small stream. They are virtually identical. But Dilpa's final -t has the reflex -i? ⟨except after i⟩ in Khawa. Similarly, Dilpa -n corresponds to Khawa ĩ. Final stops in both dialects ⟨and in Bahing, below⟩ are unreleased and accompanied by a simultaneous glottal stop. ⟨Michailovsky 1972b⟩.

Dilpa	Khawa	gloss
tit	ti?	clothing
set	sei?	he kills
sat	sai?	he spins thread
dot	doi?	he begs
tshut	tshui?	he sends
pɯt	pɯi?	he bathes
bin	bĩĩ	he flies
phen	pheĩ	he undoes
nan	naĩ	he rests a load
ton	toĩ	he pushes
rɯn	rɯĩ	he scours

1.4 Sunwar and Bahing:[5] Sunwar and Bahing are neighboring, mutually unintelligible languages of east Nepal. Dental finals of Bahing have diphthongization of non-front vowels as a reflex in Sunwar. The correspondence is quite parallel to that of the Bantawa dialects above, except that e is not diphthongized.

1.5 Tamang-Thakali: Tamang-Thakali ⟨and Gurung⟩ are not to be regarded as Tibetan dialects but as related to Tibetan as a whole ⟨Shafer 1966⟩. The examples below are monosyllabic nouns, illustrating correspondences in word-final position; verb-syllables behave a bit differently due to the influence of suffixes. Except where modified by finals, vowel qualities are largely preserved across Tamang and Thakali. Tamang has a 5-vowel system with distinctive length; in Thakali, long and short vowels have merged generally, but a new vowel quality, ʌ, appears as the reflex of Tamang short a, distinguishing it from the reflex of Tamang long a. The Eastern Tamang dialect of Risiangku ⟨Mazaudon 1973b⟩ may tentatively be regarded as close to Common Tamang-Thakali ⟨CTT⟩.

CTT *-t causes a shift a > e in Sahu ⟨W. Tamang: Taylor and Everitt 1972⟩ and also o > e in Thakali ⟨Hari 1971⟩. *-n has had an effect only in Sahu. Note that in Sahu the final consonant is preserved.[6]

Tamang		Thakali			
Risiangku	Sahu	Tukche	Marpha	Gloss	⟨WT⟩
2thet-mai	2thet	2the	2the	siblings, etc.	
2kat	2ket	2kʌi	2kʌi	voice	⟨skad⟩
4prat	4pret	4pre	4pre	eight	⟨brgyad⟩
4tot	4tot	4te	4te	load	
1man	1men	?mʌn	?1mʌn	medicine	⟨sman⟩
1kan	1ken	?kʌn	?1kʌn	cooked grain	

Tamang has few final -s; cognates of WT words in -s and often -l show fronted vowels in all dialects.

4ni:	4nji:	4ŋi	4ni	two	⟨gñis⟩
2ne: 'altar'					⟨gnas 'abode'⟩
2poiraŋ		?poi	2poi	incense	⟨spos⟩
3lɥi/lwi		3li	3lɥi	body	⟨lus⟩
3pai'Newar'	1phai	?pʌi	2pʌi	wool	⟨bal⟩
4kle				king	⟨rgyal-po⟩
4mwi	2mui		4mwi	silver	⟨dŋul⟩

Finally, Marpha in particular shows a change *ap > o; Tukche seems to be in an intermediate stage.

4tap	4tap	4tʌw	4to	needle	⟨khab⟩
3kap	3kap	3kʌp	3ko	cover	
3ko	3ko	3ko	3ko	back	

2. Acoustic Discussion: It is well known that the influence of consonants on neighboring vowels takes the form of transitions, or rapid changes in vowel quality, measurable as movement in the formant frequencies during the part of the vowel immediately adjacent to the consonant. Perceptual experiments have shown that the transitions of neighboring vowels contribute significantly to the recognition of stops ⟨Cooper et al. 1952; Schatz 1955⟩, although the stop bursts or explosions also have an important role. In languages with unexploded final stops, we would expect the transitions to play a critical role. In fact, it is found experimentally that transitions accompanying all final consonants are more pronounced ⟨Lehiste + Peterson 1960⟩ or

more uniformly realized ⟨Halle et al. 1957⟩ than those accompanying initials. This may be related to the general tendency of assimilative processes to be anticipatory in nature. In the present study, we will investigate whether the observed changes in vowel quality could have their origin in characteristics of the transitions induced by finals in the denti-alveolar region and not shared by finals at other points of articulation.

In the original version of their well known paper, "Transitions, Glides, and Diphthongs", Lehiste and Peterson give the F1, F2, and F3 frequencies of transitions in CVC utterances by English speakers ⟨L+P 1960 Tables V-X⟩. Some of these values have been used to construct Table 2 below. What the data shows, for our present purpose, is, first of all, that -t, -n, and -s do indeed form a natural group with respect to their F2 transitions ⟨perceptually the most important⟩ with values in the 1400-1600 Hz. range. In addition, we

Table 2: F2 transitions before finals in English CVC utterances.

Numbers represent the difference (F2t-F2v) in Hz., where F2t is the F2 frequency of the vowel at the end of the transition immediately before the final, and F2v is the F2 "target value" of the same vowel, averaged over all C_C environments studied. (The target value is measured during the steady-state portion of the vowel.) Data from Lehiste and Peterson 1960, Table IX, and 1961 Table 2.

Final:	Vowel: i	eI	ɛ	ə	ɑ	ɔ	oU	u	F2t Avg:
-p	-240	-160	-370	-10	-90		-240	-175	1225
-t	-95	+90	-210	+230	+200	+360	+400	+170	1485
-d	-240	-225	-240	+215	+265	+510	+310	+370	1465
-k	+45	+150	+195	/ +65	+85	+140	-280	-70	1059/2034
-m	-445	-310	-560	-210	-110		-225	-125	1160
-n	-300	-250	-285	+155	+225	+415	+220	+385	1430
-ŋ				/ -55		+70			1040/2093
-s	-200	-215	-195	+250		+545		+420	1560
-l	-535	-380	-530	-275	-160	-40	-145	-105	
F2v:	2200	2015	1610	1185	1110	880	960	865	

F2t averages based on all 15 vowels studied by L&P. Following L&P, separate averages are calculated for velar and palatal articulations of k, ŋ. Values after i, I, eI, ɛ, æ, aI, ɔI are considered palatal, others velar.

find a negative F2 transition after i, eI, and ε (eIt is an exception) and a positive one after all other vowels, suggesting a basis for the split found generally in the Tibeto-Burman data: fronting of a, o, u; no effect on i, e.

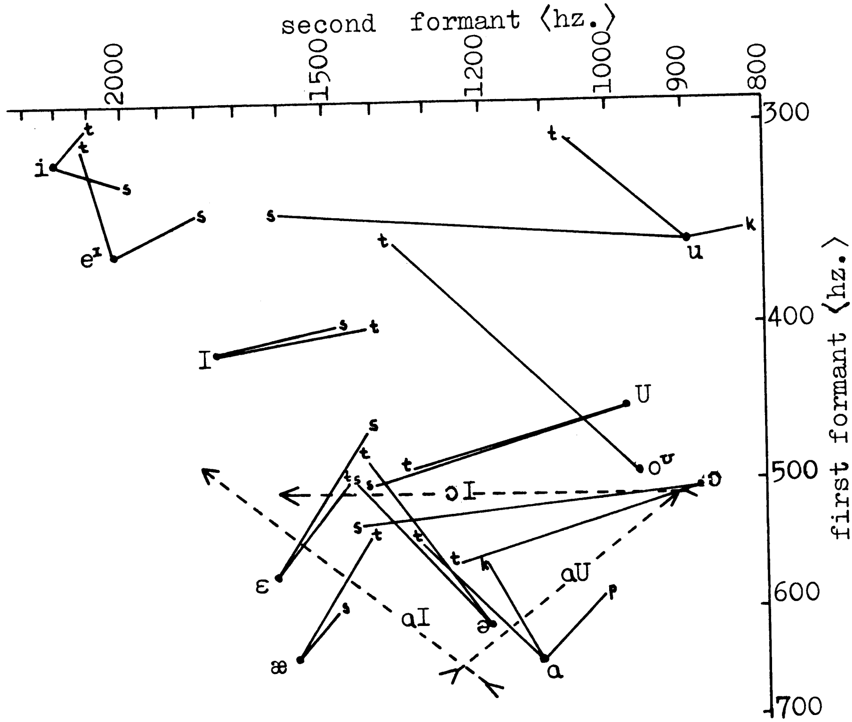
Similar data for Swedish, from Öhman 1966, is given in Table 3. The Swedish -d is dental, like the -t of western Tibetan, Tamang, Bantawa, and Bahing.

Table 3: Sequences Vba, Vda, Vga by speakers of Swedish. Transitions before the consonant for V=y, ø, ɑ, o, u. The target F2 frequencies of the vowels V have been measured separately for each sequence. From Öhman 1966 Tables II and IV.

V	Vba		Vda		Vga	
	F2v	F2t	F2v	F2t	F2v	F2t
y	2000	-500	1990	-260	2010	-185
ø	1650	-355	1620	-210	1650	-130
ɑ	990	-170	970	+125	990	+225
o	670	-25	690	+330	780	+110
u	670	-135	660	+345	770	-60

It is clear that non-front vowels before -t, -d, -n, and -s have rising F2 transitions. A rise in F2 corresponds to movement forward in the vowel space. This is precisely the direction of the vocalic quality changes observed in the Tibeto-Burman data: u > u, y, i; o > wε, oi, ø, e; a > ai, æ, ε, e. The one diachronic change involving movement toward the back of the vowel space, CTT *ap > Thakali ʌw, o, is associated with a negative F2 transition. To illustrate the relation between the transitions and the vowels, Figure 1 gives some of the Lehiste and Peterson data for English transitions plotted on the acoustic vowel space, with the English diphthongs ɑI, ɔI, ɑU included for comparison.

The formant movements of the transitions shown in Figure 1 are clearly smaller than those of diphthongs with similar starting points and directions. But the differences in magnitude in the cases of -ɔs or -ɔt vs. ɔI, or -ɑt vs. ɑI hardly seem sufficient to account for the difference in auditory quality between the vowels of, e.g., sauce and tot on the one hand and the diphthongs of soy and tight on the other. What Figure 1 does not show is the difference in timing between the transitions and the diphthongs. According to Lehiste and Peterson's measurements, the offglide (including the transition) after the steady-state portion



<u>Figure 1</u>: English transitions and diphthongs. Vowels are placed at target positions. Solid lines indicate transitions to final consonants. Broken lines show diphthong glides. ⟨Data: L+P 1961⟩

of the vowels <u>i</u>, <u>ɑ</u>, <u>ɔ</u>, and <u>u</u> only occupies about 25 per cent of the total duration of the vowel. But they find that the glide, second target, and offglide of the diphthongs make up over 60 per cent of their total duration ⟨L+P 1961 Table IV⟩. A schematic representation of this difference is given in Figure 2. The data on the diphthong <u>ɔI</u> is taken from Holbrook and Fairbanks ⟨1962 Table 2⟩. They did not find the "second steady-state target" portion described by Lehiste and Peterson.[7]

It may be noted that English final -l is always preceded by a negative F2 transition ⟨Table 2⟩, whereas in Tibetan and Tamang-Thakali, -l has had a fronting effect on preceding vowels. It is reasonable to suspect that the vowel changes observed were produced by an -l with acoustic properties quite unlike those of English "dark" -l. In fact, where Tamang -l is preserved, in some verb syllables, it is found to be a

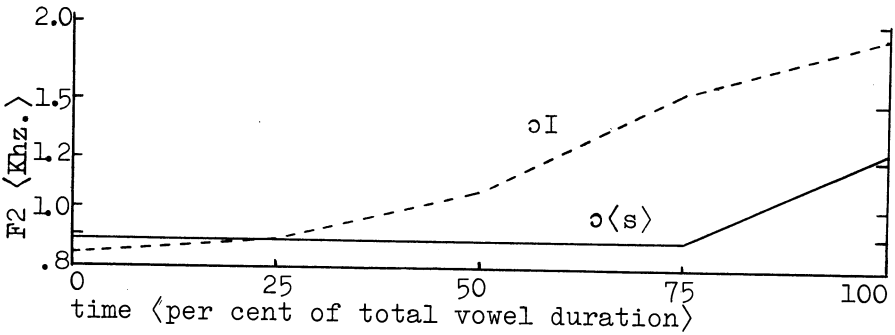


Figure 2: F2 change over time for the English vowel ɔ with transition to -s (solid line) and for the English diphthong ɔI (dotted line).

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dental -l. An acoustic discussion of the diachronic effects of various types of -l is Essen, "An acoustic explanation of the sound shift [ɫ] > [u] and [l] > [i]" (in Abercrombie et al. 1964).

3. Articulatory and Acoustic Models: It may be asked why the sound changes discussed here could not be described simply as anticipatory articulatory assimilations. Such a description would have speakers beginning to assume the articulatory position for the final consonants progressively earlier, thus altering preceding vowels. There are some difficulties in accepting such a model, however. It should be noted that a [t] requires articulatory movements quite different from those of an [-i] diphthongization or front vowel. The transition to -t should involve movement mainly of the tip of the tongue, whereas the diphthongization involves movement of the body, not the tip, of the tongue. In the case of the transition of -ap leading to a back vowel, Thurgood and Javkin have pointed out that the transition to -p should not involve any tongue movement, whereas the back vowel requires movement of the back of the tongue toward the velum. Thus both sound changes would involve some movements that are not assimilatory from an articulatory point of view.

The acoustic approach helps in several ways. The transition has been described acoustically, and experiment has proved that it is heard and used perceptually. This gives a sound phonetic basis for the process of phonologization that may then take place. The hearer, or learner, reinterprets the perceived formant shifts from being a feature of the following consonants to being a feature of the vowel. In his own pronounciation, he performs the articulatory movements necessary to produce the altered formant values earlier, starting either at the middle of the preceding vowel, producing a diphthong, or at the beginning of it, producing a new vowel. The actual articulatory movements used may differ from those involved in the earlier transition, as long as they produce the desired auditory effect. The result is a typical case of phonologization. ⟨Note that loss of the final consonant, which does not occur in all cases, is a separate phenomenon.⟩ The acoustic approach by no means minimizes the importance of articulatory factors, but it provides the link between speaker and hearer, or more importantly, learner, that is essential for sound change.

Notes

1. Some of the data quoted in this paper was collected while I was a Research Associate of the Institute for Nepal and Asian Studies, Tribhuvan University, Kirtipur, Nepal. I am grateful to that Institute and to its Dean, Dr. P.R. Sharma. Earlier drafts of this paper benefitted from suggestions by John Ohala.
2. The aspects of Tibetan dialectology touched on here are by no means original; they were commented upon by Jäschke ⟨1867, 1881⟩.
3. B. Chang ⟨1968e⟩ has published formant frequency data based on spectrograms of Lhasa Tibetan vowels:

i:	F1: 300 Hz.	F2: 2300;	o:	F1: 500 Hz.	F2: 900-1000
e:	400	22-2300;	u:	300	700-900
a:	7-800	13-1500;	ɔ:	?5-600	900-1000

   Also ⟨1968c⟩: ɛ: F1: ?600 Hz; F2: 19-2100 Hz. And finally, approximating from table 5C ⟨1968f⟩: F2 of ö: ~1500 Hz.
4. Newari sources: Classical, Jørgensen ⟨1936⟩; Kathmandu, Hale ⟨1971⟩ ⟨I have used my own transcription.⟩; Dolakha, Michailovsky ⟨1972a⟩.
5. On Sunwar, see Bieri and Schultze ⟨1971⟩. On Bahing see Hodgson ⟨1857-8⟩ and Michailovsky ⟨1973⟩.
6. The transcription of Sahu and Tukche has been modified by Mazaudon to accord with Risiangku ⟨Mazaudon 1973b⟩ and Marpha ⟨Mazaudon 1972⟩. Some of the sets given here ⟨and many others⟩ may be found in Mazaudon ⟨1973a⟩.
7. Gay ⟨1968⟩ shows that the second steady-state target for <u>ɑI</u>, <u>ɑU</u>, <u>ɔI</u> tends to disappear in rapid speech, and argues that neither it nor the precise offglide frequency is essential to the recognition of these diphthongs. The first target value and the speed and direction of formant movement are the important parameters.

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