ICSLP 2002 Proceedings, Denver (September 2002), vol. 2, pp. 1081-1084.

LARYNGOSCOPIC ANALYSIS OF TIBETAN CHANTING MODES AND THEIR RELATIONSHIP TO REGISTER IN SINO-TIBETAN

John H. Esling

Department of Linguistics, University of Victoria,
P.O. Box 3045, Victoria, B.C. V8W 3P4 Canada
esling@uvic.ca

ABSTRACT

To investigate how the articulatory structures of the larynx and pharynx behave in Tibetan chanting, we obtained laryngoscopic video sequences of several phonemic contrasts in Tibetan and of two principal chant modes: a "high" chant which adopts raised-larynx posture with the tongue and epiglottis retracted, and a "deep" chant which adopts lowered-larynx posture with an open pharyngeal area but constricted ventricular ring immediately above the glottis and ventricular/mucosal channeling of airflow. The two chants reflect different modes of the laryngeal sphincter mechanism: one with aryepiglottic approximation but without trilling; the other with only the ventricular component. Aspects of phonemic patterns found in the three Sino-Tibetan languages we have observed laryngoscopically (Yi, Bai, and Tibetan) can be seen in the way the two chant modes are produced in Tibetan. The high chant resembles "tense" register in Yi, while the deep chant resembles "tense/harsh/low-tone" register in Bai.

1. TIBETAN CHANTING

Tibetan chanting has long been of interest as a vocal technique. To investigate how the articulatory structures of the larynx and pharynx behave during chant modes, we invited Tibetan chant master, Gedun Jungney, to visit our facilities in Victoria to participate in video recording using fibreoptic laryngoscopy. We have used this technique to study other Sino-Tibetan languages and found a highly developed use of the lower pharynx to produce distinctive sound quality. Without wishing to imply any causal relationship, the sophisticated use of the aryepiglottic and ventricular sphincter mechanisms in the Yi and Bai languages warrants a phonetic comparison with Tibetan chant forms.

2. PROCEDURE

Gedun Jungney, whose family originates in western Sichuan (Dege) and extreme northwest Yunnan, China, is the 33-year-old chant master of the Ganden Jangtse Norling Monastery in Madras, India. At the time of filming in 1999, he had been learning and perfecting chanting techniques for over 15 years.

Laryngoscopic video images of the pharyngeal/laryngeal area were obtained by means of a Kay 9100 RLS light source and Olympus ENF-P3 fibreoptic nasendoscope fitted with a 28mm lens. An analog S-VHS videotape master was produced at 30 frames/sec, and video images were exported to a PC PIII-450 for processing using MediaStudio Pro 6.0 and synchronous waveform and spectrographic analysis using MultiSpeech and WaveSurfer. The video images show the behaviour of the lower pharynx including vocal folds, ventricular folds, aryepiglottic folds (laryngeal sphincter), epiglottis and tongue root.

Two principal forms of chanting were elicited in repetitive sequences. A third type of chant was produced in an attempt to emulate a form used in a different monastery but which appears not to differ substantially from the deep chant mode familiar to the chant master. Video sequences were also obtained of several phonemic contrasts in Tibetan, focusing on the high/low tonal register distinction in twelve minimal pairs. Vowels /i,œ,ɑ,ɔ,u/ were sampled, but were not the main focus of study. [i,u] environments produce the clearest view of the larynx, while [ɑ] often obscures the view of the larynx in an essentially pharyngeal manoeuvre. [i,u] examples are illustrated here. All examples are available in audio format only in the *UVPD* [1].

First, laryngoscopic videos of the two chanting modes are reviewed to assess lower pharynx posture. Then laryngoscopic images of minimal pairs in Tibetan and in other Sino-Tibetan languages are reviewed to evaluate the similarity of chanting postures to the postures found in contrasting phonemic forms.

3. OBSERVATIONS

The two chanting modes observed include a "high" chant and a "deep" chant, differing substantially in articulatory production. Figure 1 illustrates four pharyngeal/laryngeal postures during the high chant, and Figure 2 illustrates four postures at different points during the deep chant.

The views are taken with the tip of the nasally inserted laryngoscope positioned in the velo-pharynx just behind and at about the height of the uvula, looking down directly onto the epiglottis (attached to the back of the tongue). Figures 3-5 show more clearly the cartilaginous valvular mechanisms of the glottis and pyriform recesses beneath. The glottis is central, between the arytenoid cartilages, and the opening to the oesophagus would be exactly behind (above) the arytenoids at the base of the posterior pharyngeal wall.

The high chant adopts a raised-larynx posture with the tongue and epiglottis retracted, while the deep chant adopts a lowered-larynx posture with an open pharyngeal area but constricted ventricular ring immediately above the glottis. The ventricular folds form a tube that channels airflow through a circular mucosal wall, but apparently without aryepiglottic trilling. The two chants can be regarded as different modes of the laryngeal sphincter mechanism. Judged auditorily, the high chant is not as constricted at the level of the vocal/ventricular folds, but is achieved by what could be called superior constriction of the laryngeal sphincter. The deep chant could be called an inferior constriction of the laryngeal sphincter.

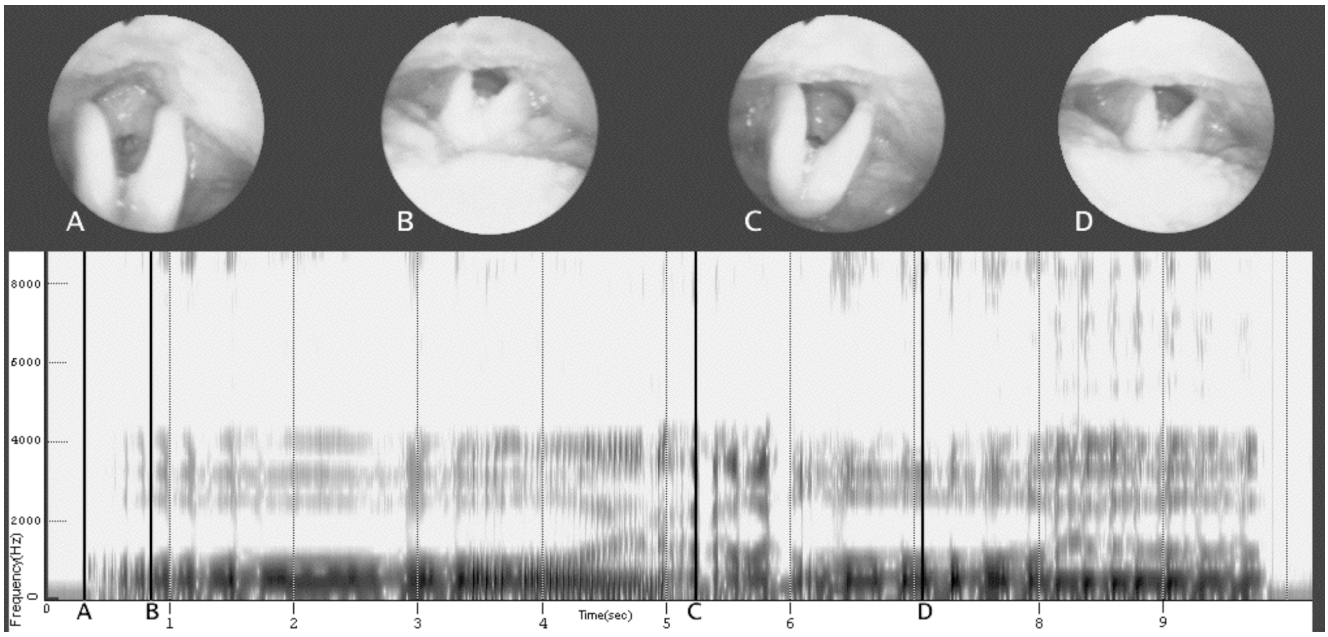

Figure 1: Laryngoscopic view of pharynx for the high chant (རངས་སྐོར་). U-shaped epiglottis and tongue retract as the larynx rises. The effect on spectral quality of reduced pharyngeal volume resulting from this adjustment has been called "muted", "covered" or "raised larynx".

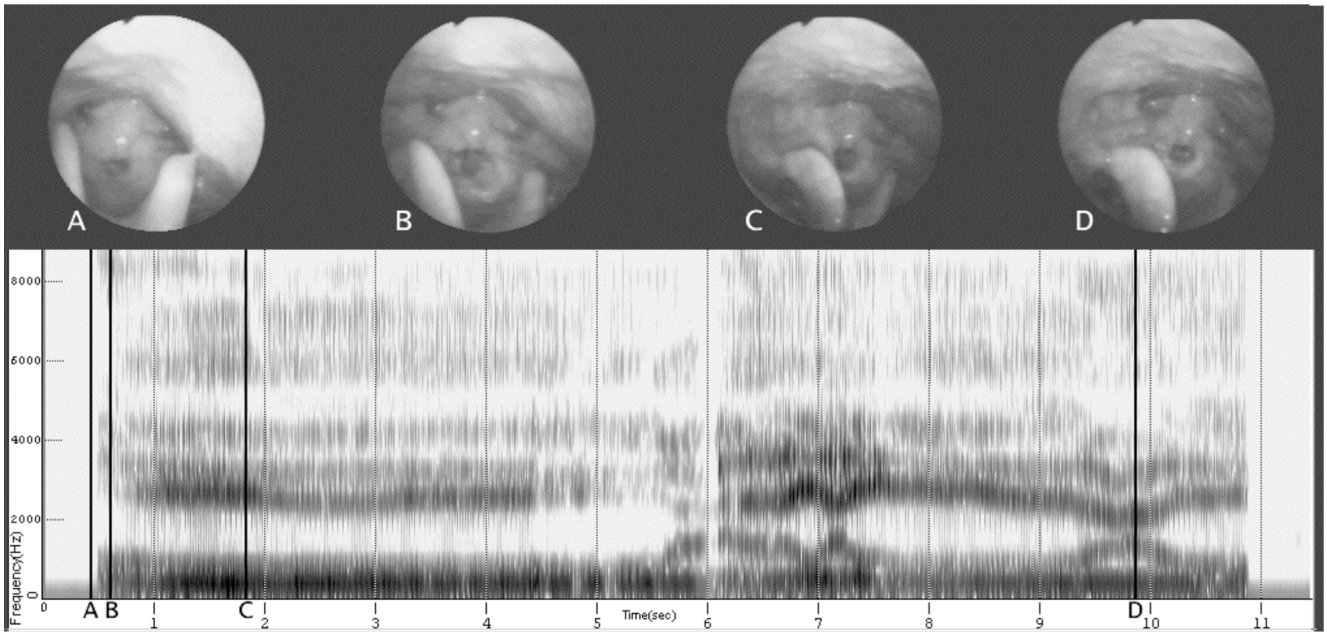

Figure 2: Laryngoscopic view of the pharynx shows the open lower pharyngeal space (with advanced tongue root and lowered larynx) during the production of the deep chant (རྡོག་སྐོར་). Arytenoids, vocal folds, ventricular folds and lower muscular components of the laryngeal sphincter mechanism are tightly adducted to form a channel of substantial height with a distinct ring of mucus at its upper border.

The musculature we hypothesize to be responsible for the high chant setting are the external (lateral) fibres of the thyroaytenoid muscles and, for the deep ventricular sphincteric manoeuvre, the more medial internal fibres of the thyroaytenoids.

The auditory difference in the minimal pairs 'die/four', 'ten/grasp', 'water/coral' (Figures 3-5) is one of pitch and of phonation type. This study does not exhaust the combinatory tone-class paradigm of Dege Tibetan but only touches on one broad distinction. The first item in each pair is high in pitch and modal in phonation type, and the second is lower pitched and breathier, but lower pharynx shape is substantially similar. We are unable to determine if the apparent larynx height difference (descending for low tone) is due to laryngeal tilt (cricothyroid adjustment) or to the vertical raising and lowering of the larynx

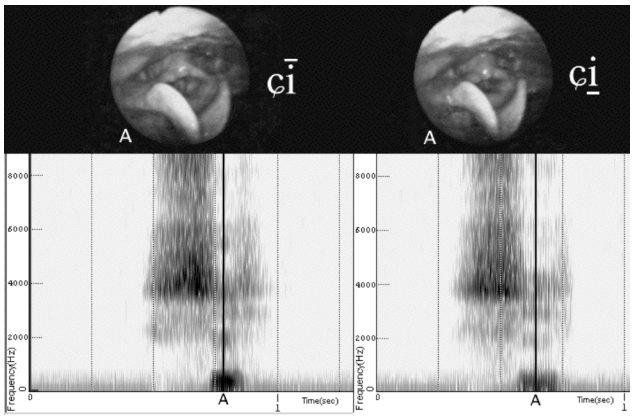

Figure 3: Spectrograms and laryngoscopic images (at point A in each vowel) of the Tibetan contrast between the "high" and "low" syllables /ɕi̱/ 'to die' vs. /ɕi̲/ 'four'.

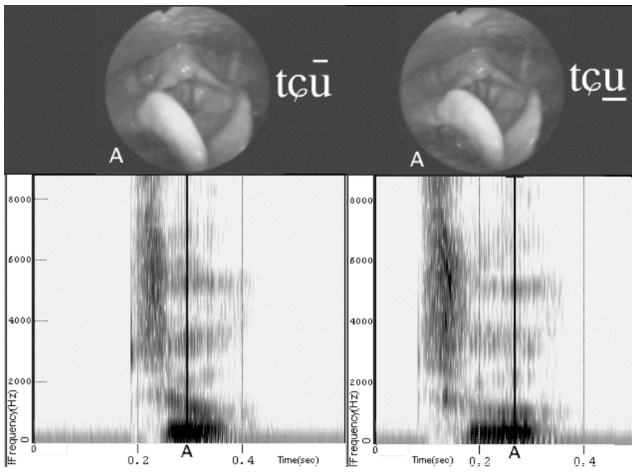

Figure 4: Tibetan contrast between /tɕū/ 'ten' vs. /tɕu̲/ 'to grasp'. The "low" series is breathier, lower in pitch, longer in duration; but not different in lower pharynx shape. The glottal opening itself becomes wider for /tɕu̲/.

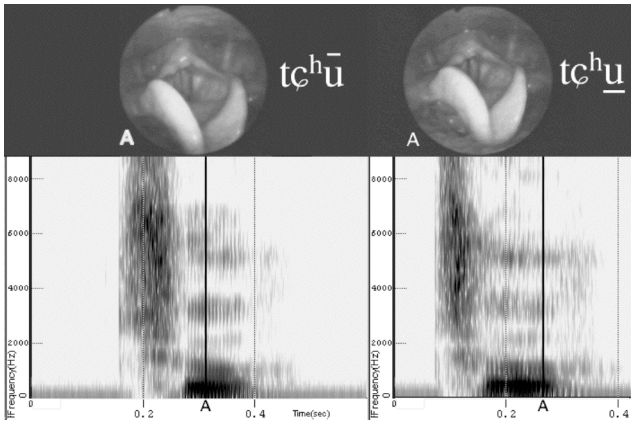

Figure 5: Tibetan /tɕʰū/ 'water' vs. /tɕʰu̲/ 'coral'. Breathiness in the "low" series is reflected in the opening at the glottis and the noisy spectrum throughout.

(adjustment of the hyoid musculature to facilitate modal voice in the higher position and breathier airflow in the lower position). This phonemic contrast is not very large phonetically and could be adequately achieved either through pitch or phonation alone. The contrast nevertheless contains two distinct auditory qualities which can be supposed to have two different physiological origins. The sphincter raised-larynx setting of the high chant resembles the retracted posture of an [ɑ] vowel, but is even more larynx raised and tongue retracted than an open back vowel and could be called a cardinal example of a raised-larynx voice quality setting [2]. It also resembles the singing styles that have been found to use a raised-larynx (sphincter) setting [3].

The lowered laryngeal posture for low tone words is not the same setting as for the deep chant. Low tone has open, breathy phonation, while the deep chant has extreme ventricular constriction and lowered larynx and open pharynx apparently to enhance the extremely low pitch. Physiologically, a sphincter setting such as this might be expected to cause the larynx to rise [4, 2]. Here, however, the larynx is pulled lower, perhaps to increase the size of the entire pharyngeal cavity for enhanced low-pitch resonance in synchrony with the source characteristics generated by the reinforced inferior channel.

Because pharyngeal postures do not differ greatly between phonemic contrasts in this dialect of Tibetan, it will be useful to compare Tibetan chanting postures with configurations of the lower pharynx found in other Sino-Tibetan languages.

4. LAX/TENSE AND PHONATORY REGISTER IN SINO-TIBETAN

The three Sino-Tibetan languages which we have observed laryngoscopically (Yi, Bai, and Tibetan) use the phonetics of the larynx and pharynx in different ways. Yi (Tibeto-Burman) has a phonological contrast between "lax" and "tense" syllables which is realized articulatorily as a neutral mode of voicing with neutral positioning of the epilaryngeal structures in the case of lax vowels and as a raised-larynx, retracted-tongue, laryngeally sphincter posture of the epilaryngeal structures in the case of tense vowels [5, 6]. Both postures occur commonly at mid tone (see Figure 6), but tense syllables are phonetically predisposed at high tone, and lax syllables at low tone; a result of the compatibility of raised-larynx quality (tense mode) with high pitch and of modal quality (lax mode) with low pitch. As in Tibetan, Yi low tone has an opener quality, but this may be typical of a two-way contrast. Distinctions of further complexity (as in Bai, below) may group low pitch (and creaky and harsh modes of phonation) together with the ventricular type of constriction as opposed to the raised-larynx type.

Bai (variably categorized as Sinitic, para-Sinitic or Tibeto-Burman) does not use the lower pharynx as in Yi. In Bai, modal syllables at 55 and 33 tone have an open epilarynx in lax mode but ventricular stricture in tense mode [7, 8, 6]. The tongue does not retract for tense mode as in Yi, and the epiglottis does not approximate the back wall of the pharynx, except of course when the vowel is open and back. Only ventricular and inferior aryepiglottic structures appear to be involved. At 31 tone in Bai, this type of ventricular sphincter becomes even more pronounced for the tense series, inciting aryepiglottic trilling at the lowest 21 tone. These articulatory relationships have been outlined in cardinal terms [9], and correspond to the behaviour of pharyngeals in many languages [9, 10, 11] and tonal and register features of phonation in others [12, 13, 14, 15].

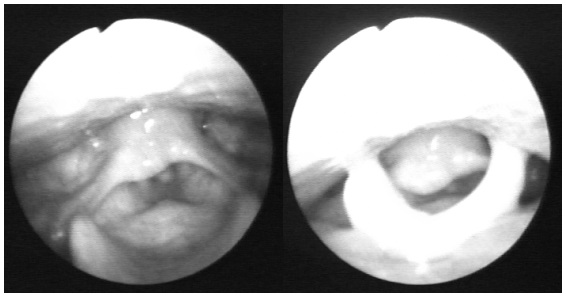

Figure 6: The lax /i̱/ vowel of Yi (as in /pi̱ ^{33}/ 'to exclaim') with open lower pharynx, and tense /a̱/ (as in /pa̱ ^{33}/ 'to exchange') with sphincterered lower pharynx.

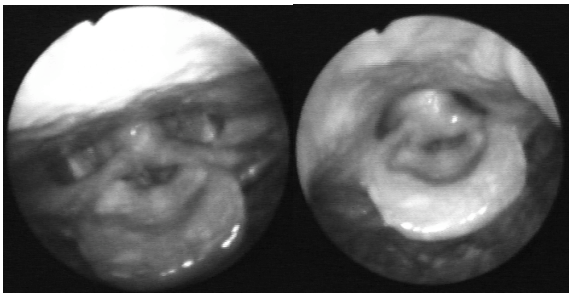

Figure 7: At 31 tone, the lax /i/ vowel of Bai (/tɕi/ 'field, soil') with open lower pharynx, and its tense counterpart (/tɕi̱/ 'to chase') with ventricular sphincterering.

5. IMPLICATIONS

The three Sino-Tibetan languages which we have observed laryngoscopically (Yi, Bai, and Tibetan) use the phonetics of the larynx and pharynx in different ways. Aspects of the phonemic patterns found in each language can be seen in the way the two chant modes are produced in Tibetan. The high chant resembles "tense" register in Yi, while the deep chant resembles "tense/harsh/low-tone" register in Bai.

The contrasts that commonly occur in Sino-Tibetan languages maximally exploit the fine articulatory adjustments available in the lower pharynx, epilarynx and glottis. Elements of these configurations account for laxness/tenseness, register, and tone in the phonology. Similarly, these same elements, to a more refined and professionally nurtured degree, account for the exceptional sound quality of formal styles such as Tibetan chanting. It remains to research the musculature responsible for the two main postures of the laryngeal sphincter identified here, and to explain the aerodynamic relationship between the channeled/mucosal source of the deep chant and the chamber resonance of the pharynx.

6. ACKNOWLEDGEMENTS

This research was carried out with the support of grants from the Social Sciences and Humanities Research Council of Canada (#410-93-0539 and #410-2000-0901). We would like to thank Jerold A. Edmondson, Lama Ziwo, Li Shaoni, and Jimmy G. Harris for their collaboration in the filming and analysis of Yi and Bai; Bill Lewis and Allison Benner for the filming and analysis of Tibetan; Greg Newton for technical and software support; Craig Dickson and STR Ltd. for accommodating research procedures, and Gedun Jungney and the monks of the Ganden Jangtse Norling Monastery for their willingness to participate in research in the interest of phonetic theory.

7. WEB-SITE VIEWING

The laryngoscopic video images illustrated in this paper can be viewed in full-motion video/audio format at the University of Victoria Phonetics Laboratory web site:

http://web.uvic.ca/ling/research/

8. REFERENCES

[1] Esling, J.H. University of Victoria phonetic database (version 4.0), Speech Technology Research, Victoria, BC, and Kay Elemetrics, Lincoln Park, NJ, 1999.

[2] Esling, J.H. "The IPA categories 'pharyngeal' and 'epiglottal': Laryngoscopic observations of pharyngeal articulations and larynx height", *Language and Speech*, 42: 349-372, 1999.

[3] Honda, K., Hirai, H., Estill, J. and Tohkura, Y. "Contributions of vocal tract shape to voice quality: MRI data and articulatory modeling". In O. Fujimura and M. Hirano (eds.) Vocal fold physiology: Voice quality control (pp. 23-38), Singular Publishing, San Diego, 1995.

[4] Esling, J.H., Heap, L.M., Snell, R.C. and Dickson, B.C. "Analysis of pitch dependence of pharyngeal, faucal, and larynx-height voice quality settings", *ICSLP 94* (pp. 1475-1478), Acoustical Society of Japan, Yokohama, 1994.

[5] Lama Ziwo (Qiu Fuyuan), A phonetic and phonological overview of the Yi (Lolo) language. M.A. thesis, University of Texas at Arlington, 1998.

[6] Edmondson, J.A., Esling, J.H., Li Shaoni, Harris, J.G. and Lama Ziwo,. "The aryepiglottic folds and voice quality in Yi and Bai languages: Laryngoscopic case studies" (in Chinese), *Minzu Yuwen*, 2000(6): 47-53, 2000.

[7] Li Shaoni, "On the combination of glottal squeezing and friction in the Bai language" (in Chinese), *Minzu Yuwen*, 1992(4): 68-72, 1992.

[8] Edmondson, J.A. and Li Shaoni, "Voice quality and voice quality change in the Bai language of Yunnan Province", *Linguistics of the Tibeto-Burman Area*, 17(2): 49-68, 1994.

[9] Esling, J.H. "Pharyngeal consonants and the aryepiglottic sphincter", *Journal of the International Phonetic Association*, 26: 65-88, 1996.

[10] Catford, J.C. "The articulatory possibilities of man". In B. Malmberg (ed.) Manual of phonetics (pp. 309-333). North-Holland Publishing, Amsterdam, 1968.

[11] Catford, J.C. Fundamental problems in phonetics, Edinburgh University Press, Edinburgh, 1977.

[12] Traill, A. "The laryngeal sphincter as a phonatory mechanism in !Xóõ Bushman". In R. Singer and J.K. Lundy (eds.) Variation, culture and evolution in African populations: Papers in honour of Dr. Hertha de Villiers (pp. 123-131), Witwatersrand Univ. Press, Johannesburg, 1986.

[13] Rose, P.J. "Phonetics and phonology of the yang tone phonation types in Zhenhai", *Cahiers de Linguistique Asie Orientale*, 18: 229-245, 1989.

[14] Rose, P.J. "Independent depressor and register effects in Wu dialect tonology: Evidence from Wenzhou tone sandhi", *Journal of Chinese Linguistics*, 30: 39-81, 2002.

[15] Kjellin, O. "Observations on consonant types and 'tone' in Tibetan", *Journal of Phonetics*, 5: 317-338, 1976.