OPEN QUOTIENT AND SKEWNESS OF THE LARYNGOGRAPH WAVEFORM AS MEASURES OF PHONATION TYPES AND LARYNGEAL ARTICULATIONS IN WA[1]

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1 Introduction and objectives

This paper is a road-test of two methods, one established and one new, of assessing the relationship between the laryngograph (electroglottograph, EGG) waveform and phonation types and glottal consonants in the Wa language. The work is a pilot study carried out in the preliminary stages of a larger-scale research project into the pronunciation of Wa.

The new method of measuring the laryngograph waveform proposed here provides a means of quantifying phonation type for descriptive purposes, allowing vowels and laryngeal consonants to be treated identically. This study is a sneak preview of work in progress examining the phonetics of phonologically contrastive phonation types in Wa. Relatively few studies have been undertaken which make use of the laryngograph for linguistic phonetic purposes (e.g. Lindsey et al. 1992). It is hoped that this work may add to the growing repertoire of descriptive techniques available to the phonetician, given the current broad interest in the phonology, history and nature of tones and phonation types in Asian languages. For example, this work could serve as an alternative or complement to inverse filtering techniques or acoustic methods of investigating the linguistic use of phonation types.

2 The Wa languages

Wa belongs to the Palaungic branch of Northern Mon-Khmer (Diffloth 1980). Wa speakers number roughly one million, and are located in an area which Gérard Diffloth has described as the Waic corridor (Diffloth 1980:5), between the Salween and Mekong rivers in the Shan States of Burma and China's Yunnan province.

3 Register in Mon-Khmer

Mon-Khmer register is a binary phonological contrast which is associated with a variety of phonetic phenomena, among them pitch-based tone, as in Kammu (Svantesson 1983) and Blang (Zhou and Yan 1983); phonation type, as in Wa (Zhou and Yan 1984, Maddieson and Ladefoged 1985, Theraphan 1988, Svantesson 1993) and Mon (Theraphan 1987:161; 1990:12), or some combination of these features. Eugénie Henderson (1952:151), who was first to use the term register to refer to Mon-Khmer languages, describes the registers of Cambodian in terms of voice quality, pitch and larynx height.

A connection between Mon-Khmer register and tongue-root position was asserted by Kenneth Gregerson (1973). Register is described in terms of two contrasting 'laryngeal attitudes' by Jim Matisoff (1973:76), which he calls 'tense-larynx syndrome' and 'lax-larynx syndrome', which involve the tongue root and supra-glottal cavity as well as the larynx. But the articulatory domain of the Mon-Khmer register contrast is primarily, if not exclusively, the larynx.

4 Phonation types and laryngeal articulations in Wa

The phonological inventory of Wa speech sounds includes the following laryngeally articulated possibilities:

1) a four-way contrast in initial stop consonants
   i) unvoiced unaspirated /p/
   ii) prenasalised voiced unaspirated /ᵐb/
   iii) unvoiced aspirated /pʰ/
   iv) prenasalised voiced aspirated /ᵐbʰ/

2) the binary registral phonation type contrast
   i) 'creaky' phonation /a̰/
   ii) breathy phonation /a̤/

3) syllable final consonants
   i) none (open syllable) / /
   ii) glottal stop /ʔ/ /ʔ/
   iii) glottal fricative /h/ /h/

The term 'creaky' is applied to Wa with some hesitation, since for many speakers, including the one used in this study, the phonation type of this register may be more accurately labelled as tense, pressed or even modal. The term 'creaky' is used throughout the paper nonetheless.

The following set of syllables illustrates the size of the phonological burden borne by the larynx in Wa. Keeping constant the supralaryngeal articulatory sequence of bilabial plosive initial consonant plus open unrounded /a/ vowel, and changing only laryngeal activity though each syllable, the matrix of eighteen syllables shown Table 1 is generated. The registral contrast is not found in syllables beginning with aspirated consonants, after which vowel phonation is creaky.

p̰a	p̤a	ᵐb̰a	ᵐb̤a	pʰ̰a	ᵐbʰ̰a
p̰ah	p̤ah	ᵐb̰ah	ᵐb̤ah	pʰ̰ah	ᵐbʰ̰ah
p̰a?	p̤a?	ᵐb̰a?	ᵐb̤a?	pʰ̰a?	ᵐbʰ̰a?

Table 1: Eighteen possible Wa syllables, the phonological heterogeneity of which is preserved by laryngeal articulations alone.

For reasons of project size management, the effect on phonation type of initial consonant voicing contrasts is left outside the scope of this paper, which concentrates instead on the phonation type characteristics of the Wa vowel registers and laryngeal consonants.

5 A phonation type continuum

Despite some involved descriptive systems which have been developed to account for the complex agility of the vibrating larynx (see, for example, Catford 1964; Laver 1980:93-140), for descriptive purposes in a South East Asian linguistic context it is generally only necessary to define a three-way classification of phonation: creaky, modal and breathy (Theraphan 1988:321). In such an analysis, only two of these three categories are required to describe Wa vowels: creaky and breathy. Ladefoged points out that in Wa the difference between the phonation types is not as extreme as in other languages whose contrastive use of phonation type has been investigated experimentally, such as Jalapa Mazatec and !Xóõ (Ladefoged et al. 1988:314).

The Wa consonant inventory makes use of phonological oppositions which are laryngeally articulated: initial stop consonant voicing contrasts and final glottal consonants. In Wa, the glottal stop, which term properly describes the cessation of vocal fold vibration, is in fact realised as a short period (typically about 50ms) of true, aperiodic creaky phonation. In utterance-final position, vocal fold vibration may slow to an indistinct stop. The Wa glottal fricative is realised as a period of breathy phonation of similar length.

Breathy phonation in Wa is associated with breathy vowel register and with glottal fricative consonants, while relatively creakier phonation is associated with the creaky vowel register and glottal stops. The acoustic similarity in Wa of breathy phonation to glottal fricatives and of creaky phonation to glottal stops becomes apparent if spectral profiles are compared. The relative amplitudes of the first and second harmonics (H1, H2) have been shown to be an index of phonation type in Wa (Svantesson 1993:103) and in other languages which make phonologically contrastive use of phonation types (Ladefoged et al. 1988). The following illustrations derived from syllables in the corpus of recordings used for this study make this point clear:

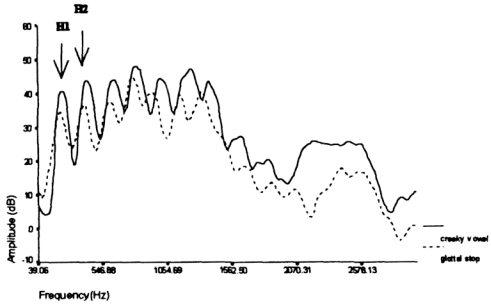

Figure 1 Overlaid spectral profiles (40 Hz b/w, 256-point, 20KHz sample rate, up to 3KHz shown) of Wa syllable-final creaky /a̰/ and of syllable final /ʔ/, realised phonetically as [a̰].

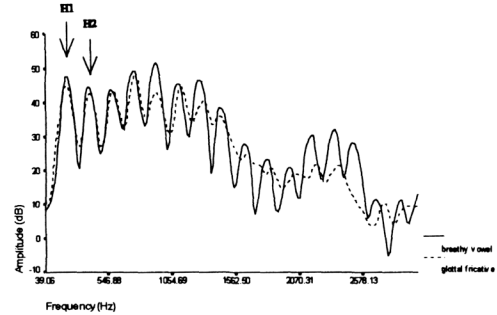

Figure 2 Overlaid spectral profiles (40 Hz b/w, 256-point, 20KHz sample rate, up to 3KHz shown) of Wa syllable-final breathy /a̤/ and of syllable final /h/, realised phonetically as [a̤].

Notice in the spectra of a Wa vowel with modal phonation and of a Wa glottal stop shown in Figure 1 that the amplitude of the first peak representing the first harmonic (H1) is higher than the second peak, indicating that the amplitude of H1 is greater than the second harmonic (H2). The reverse is true in Figure 2, which depicts the spectral profiles of a vowel with breathy phonation and of a glottal fricative. The overall formant structure of all four spectra in these illustrations is similar because they are all associated with an **/a/** vowel produced by the same speaker.[2]

Potentially conflicting phonation types may be found within a single syllable, and it is with the aim of describing this that this paper explores a hypothetical phonation type 'continuum' which may be invoked to describe the range of phonation types found in Wa, be they associated with vowels or consonants. For instance, breathy vowel **/a̤/** and creaky consonant **/ʔ/** adjoin one another in the syllable **/pa̤ʔ/**, while in the syllable **/pa̰h/**, creaky vowel /a̰/ is followed by breathy consonant **/h/**.

Creaky and breathy phonation types are placed at opposite ends of the continuum, the extremes of which are not absolutes, since no absolute measure of