

## A FUZZY BOUNDARY BETWEEN TONE LANGUAGES AND VOICE-REGISTER LANGUAGES

*Arthur S. ABRAMSON, Theraphan LUANGTHONGKUM*

### ABSTRACT

A pure case in which tone uses only pitch for phonological distinctions, while voice register uses only phonation type for the same purpose, is fairly rare. More often than not we see pitch combined with phonation types and other properties in phonemic tones and phonation types combined with pitch and other properties in registers. Many a language traditionally classified as one or the other seems to be more of a hybrid of the two. Furthermore, phonation type is probably a stage in tonogenesis. The worth of a sharp typological distinction is surely in doubt.

**Keywords:** register, tone,  $F_0$ , phonation, typology

### 1. INTRODUCTION

Now that some decades of instrumental and experimental work on tone languages and voice-register languages have passed, the conventional boundary between the two types turns out to be not very sharp. Tones and voice registers are phonologically relevant prosodic units typically taken to have the syllable as their domain. The frequent considerable overlap of their phonetic properties gives rise to the blurring of the boundary between the two linguistic categories.

The imprecision surely arises from the classical view of tones as expressed by Kenneth Pike [19, p. 3]: "A tone language may be defined as a language having lexically significant, contrastive, but relative pitch on each syllable." This, it would seem, continues to be the normative expectation of linguists, although such an outlook obscures e.g. the important role of creakiness and breathiness in Vietnamese, which is always taken to be a tone language [18]. It was the work of experimental phoneticians in making measurements of the major acoustic correlate of pitch, the fundamental frequency ( $F_0$ ) of the voice that led to the discovery of the importance of other phonetic properties. Ilse Lehiste [14, p. 79] comments, "It is not impossible that in two words presumably differing in tone, the fundamental frequency differences may happen to be minimal, while concomitant features of intensity, quantity, or segmental quality may carry the chief distinctive burden." This concession on her part certainly speaks to the question addressed herein.

In some languages, syllables are phonemically distinguished by complexes of phonetic properties called voice registers [11]. The term was introduced by Eugénie Henderson [13] as a construct to cover such features as phonation type, pitch, vowel quality, and length, with one of them, commonly phonation type (heard as voice quality), found to be dominant. In some instances, however, in languages conventionally described as having voice registers the dominant property now appears to be pitch [1][25][2] with fundamental frequency ( $F_0$ ) serving as a powerful and sufficient acoustic cue in perception. The question arises then as to whether we must treat such a language as having voice registers or as having changed to a tone language. Given the existence of phonetic properties concomitant with pitch even in languages generally accepted as tonal, it may be hard to say just when such a change has occurred.

Some of the thinking presented here has been expressed in the past but seems to have been limited mainly to circles of Sino-Tibetan and Mon-Khmer scholarship. It may be helpful to disseminate it further afield.

## 2. TONE LANGUAGES

Pitch-accent languages, such as Japanese and Swedish, are not considered here. Even if some scholars might argue that they fit into the category of tone languages, the distributional limiting of the accents to certain kinds of syllables renders them quite different from our frame of reference.

There are indeed languages in which  $F_0$  heights and contours [10] underlie pitch percepts that alone are essential to the distinction of phonemic tones. For example, Mandarin Chinese and Standard Thai are generally taken to be such "pure" tone languages. That is not to say that in certain contexts there are no concomitant properties unique to one tone or another, nor that in those contexts these properties are inaudible. Rather, we mean that in such a language the dominant and pervasive carrier of tone is pitch. Such languages do present challenging problems, including rate of pitch change [30] and the constraints of coarticulation and perception [31].

There are also "phonation-prominent" tone systems [15] or "mixed pitch/phonation-type tones" [5][8], yet in an important edited book on tone [9] only one paper [4] out of nine mentions them. The category covers tonal systems in which both pitch and other properties, mainly phonation types, share in phonologically distinguishing the tones. Burmese [16][29], Vietnamese [18], and Green Mong [4][5] are examples of such languages.

Let us look briefly at Green Mong of the Hmong-Mien family. The study by Jean E. Andruski and Martha Ratliffe [5] is concerned with seven tones, focusing on the two with phonation types, which also have pitch contours. (There is an eighth "minor" tone of limited distribution.) Five of the tones on modal (clear) voice can be described as having high, high falling, mid, rising, and low falling pitch contours, as suggested by their  $F_0$  contours. The two tones characterized by phonation type are breathy and creaky respectively. As for pitch, the low falling creaky tone and the mid falling breathy tone are rather similar to the low falling modal tone. Discriminant analysis of the authors' extensive acoustic measurements of the three tones with similar  $F_0$  contours but differing in phonation type, showed that of all the potential acoustic cues the best discriminator for the modal, creaky, and breathy tones of Green Mong is the relative amplitudes of the first and second harmonics, a good reflex of the changes in duty cycle of the larynx. Perceptual validation of the results, presumably with synthetic speech, remains to be done. A step in that direction has been taken [6] with listening tests using tokens of natural speech to assess the relative intelligibility of the three tones.

A study has just been completed [17] of a somewhat similar situation in Tamang, a Bodic language of the Sino-Tibetan family spoken in Nepal. An elaborate and meticulous examination of the four tones of the language, combining acoustic analysis with electroglottography of the larynx, reveals here too a phonologically complex set of "tonal" contrasts. Apparently both phonation type (modal vs. breathy voice) and  $F_0$  have the same level of importance in differentiating the four tones. That is, according to the investigators, there is no hierarchical ordering of distinctive features. With no distinctive voicing of consonants in the language, at least a minor role in differentiating tones is the occasional voicing of initial obstruents in syllables with breathy voice.

## 3. VOICE-REGISTER LANGUAGES

Upon first encountering languages that later became known for their voice registers, linguists, who were mostly trained in the West, must have been struck by seemingly unusual properties of voice quality in elicited lexical items. Only later after much experience, perhaps, did they also become aware of concomitant differences of pitch and other features. Even so, in such cases the empirical

question remains as to whether, in the presence of an apparently salient difference in phonation type, other properties that are linked to it are themselves sufficiently salient to play a role in perception. Thus, breathy voice as a phonation type is likely to occur with a lower  $F_0$  contour than modal voice; nevertheless, only an experimental approach can determine the relative power of these two potential cues in the perception of the register distinction. Our extensive fieldwork with Mon, for example, leads us to believe that pitch plays at most a rather minor role in differentiating its modal and breathy registers; this observation has yet to be validated experimentally. Be that as it may, we are confronted today with many languages of this type. In the Mon-Khmer family, for example, three types are commonly recognized: languages with neither registers nor tones, languages with voice registers, and languages with tones. As for the group with registers, present-day observation finds among them a state of transition toward tonal systems; for some of them it is likely that the tonal stage has been reached. A brief account of our recent studies of two Mon-Khmer languages may be illustrative here.

### 3.1 Suai

In a fairly recent study [1] we have been innovative in that we examined the acoustics of both production and perception of voice registers in the Kuai dialect of Suai, a Mon-Khmer language. The language is said to have two registers, modal (clear) and breathy.

The work was done with a sampling of speakers in a Suai village of northeastern Thailand. A control test with natural-speech utterances of good exemplars of the registers revealed mixed levels of perceptual acuity, ranging from mere chance to rather good identification. This left eight out of 16 listeners whose data in the later synthesis experiments could be evaluated.

The utterances of six speakers were analyzed for ratios of harmonic intensities (spectral slope),  $F_0$  and overall amplitude contours, vowel duration, and formant frequencies. The significant factors were a greater spectral slope and a lower  $F_0$  contour for the breathy register.

For the perception tests, five parameters of the speech synthesis program SynthWorks® were used to make combinations of variants in contours of overall amplitude and  $F_0$ , level of turbulence, duration of the open quotient of the simulated voice source, and spectral tilt. The responses showed  $F_0$  to be the primary factor. The open quotient, physiologically relevant to spectral tilt, was also significant.

The language, at least in this village, appears to be in a state of flux. We wonder whether the register distinction is on the brink of extinction or is on its way toward a stable tonal system.

### 3.2 Khmu'

In a more recent paper [2], we have studied the Mon-Khmer language Khmu' in its Rawk dialect spoken in a village of Nan, a province of northern Thailand. It is also described as a language with a modal register (R1) and a breathy one (R2). We did an acoustical analysis of all the seemingly relevant properties in the recorded utterances of 25 speakers (9 men and 16 women). For the possible relevance of phonation type we measured the ratio of the relative intensities of the second harmonic ( $H_2$ ), the principal harmonic of the first formant ( $H_{F1}$ ), and the principal harmonic of the second formant ( $H_{F2}$ ) to that of the first harmonic ( $H_1$ ). These ratios are taken to be an acoustic reflex of the open quotient of the vocal folds during phonation. The essence of the results of an ANOVA of the data broken down by sex is given in Table 1.

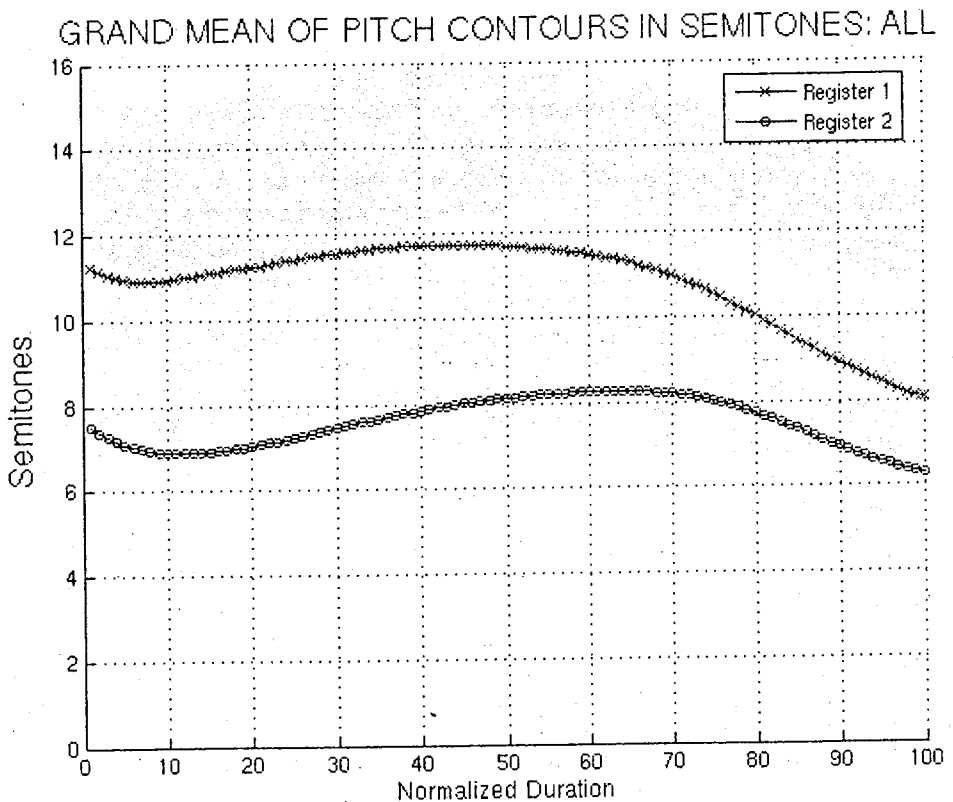
As can be seen in the first row of the table, the men show no significant difference between the registers. That is, the acoustic evidence for a distinction between modal (clear) and breathy voice is not statistically significant. For the women, however, there is a significant difference but only for the first ratio. This is a sign that the language is undergoing change. The women, who spend most of their time in the village, are linguistically somewhat more conservative. The men, who generally work outside the village in contact with Thai and Lao speakers, no longer systematically produce two

phonation types, although they may well respond to them auditorily when used by their womenfolk. It would be interesting to study the speech of young children.

**Table 1:** The probability  $p$  that ratios.  $H_2/H_1$ ,  $H_{F1}/H_1$ ,  $H_{F2}/H_1$  are independent of voice register abridged from Table 6 of [9].

Ratio:	$H_2/H_1$	$H_{F1}/H_1$	$H_{F2}/H_1$
Male $p$	0.4566	0.0645	0.4002
df	(1,7)	(1,7)	(1,7)
F	0.621	4.806	0.802
Fem. $p$	0.0005	0.0106	0.4232
df	(1,15)	(1,15)	(1,15)
F	19.442	8.508	0.678

The measurements of  $F_0$  yielded significantly different contours for all the speakers. The results, converted into pitch in semitones, are shown in the graph of Figure 1. The difference is mainly one of height.

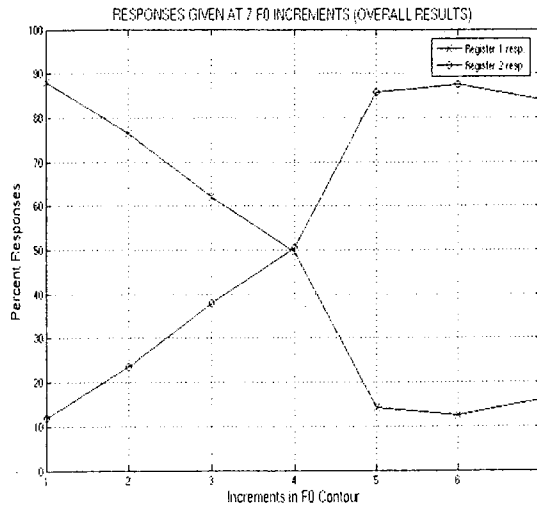


**Figure 1:** Normalized pitch contours averaged over the Register 1 and Register 2 utterances of 25 Khmu' speakers. The dark and lighter shaded regions indicate the standard deviations of the Register 1 and Register 2 contours respectively. (Adapted from [2])

Because of the exigencies of scheduling the running of perceptual experiments in Thailand, it was necessary to prepare the listening tests and run them before we had fully analyzed the acoustic data. Having no knowledge at that time of the significance of the harmonic ratios, at least for the

women, we limited our speech synthesis to seven  $F_0$  variants from low to high that we imposed upon a syllable that might be heard, as determined by voice register, as one member or the other of the minimal pair meaning “tooth” (R1) or “flower” (R2).

The mean responses of 29 listeners are shown in Figure 2. The stimuli rise in pitch incrementally from left to right. The categories are quite good even though neither register exceeds 90 percent identification. Perhaps the stimuli could be made a bit more natural.



**Figure 2:** The percentages of Register 1 vs. Register 2 responses of 29 listeners to incremental changes in the  $F_0$  contours of synthesized versions of the Khmu’ syllable [ra’N]. (Adapted from [2])

The contrast between the two voice registers of Khmu’ Rawk is stable, although this stability floats on the surface of an underlying instability in the properties that differentiate the registers in speech production. We predict the disappearance of phonation type and the consequent dominance of pitch in both production and perception of speech. If this happens, the only reason for not calling this variety of Khmu’ a tone language might be out of sentiment. Indeed, we are convinced that even among scholars there is a reluctance to depart, for a given language of interest, from a traditional classificatory nomenclature. This is perhaps illustrated by the conventional treatments of the Chong and Burmese languages. Both of them have four-way phonologically relevant prosodic distinctions. Concomitant phonetic properties make it hard to conclude whether they are tonal or register languages. Since Chong [26] is a Mon-Khmer language, the bias is to decide that it has four registers. Burmese [29], on the other hand, is a member of the Tibeto-Burmese branch of the Sino-Tibetan family, so it must be tonal.

#### 4. DIACHRONIC OUTLOOK

Putting aside the possibility of the emergence in a language of new phonological units solely through intensive contact with another language, we see from the reconstructions of historical linguists that both tones and voice registers were apparently born in similar environments. That is, to make a long story short, the changing nature of final consonants and the loss of some, together with the loss of the consonantal voicing contrast in initial position gave rise to tones [12][15][27][28] and registers [7][8]. Other treatments with a focus on Mon-Khmer languages are to be found e.g. [20][21][22][23][24]. A critical review of the phonetic data and arguments [3] furnishes many additional references.

The classical explanation of the origin of tones was formulated by André-G. Haudricourt [12] and helpfully clarified by James Matisoff [15], who also gave us the term *tonogenesis*. Credit goes to Graham Thurgood [27][28] for revising the model and building a bridge between tone and voice register. That is, he argues convincingly that the appearance of phonation types is a stage of tonogenesis.

## 5. CONCLUSION

Confusion can arise in setting a conceptual boundary between tone languages, especially phonation-prominent tone languages, and voice-register languages. The confusion is heightened when phonation type has a communicative function, along with pitch, in a tone language and pitch has a communicative role in a voice-register language along with phonation type. To this must be added the at least minor role that other properties, such as vowel length and quality, may play in differentiating both tones and registers. In addition, the circumstances in which both prosodic types apparently arose would argue for an intimate link between them. A good bridge, in Thurgood's sense, may well be provided by Khmu' (Mon-Khmer) and Cham (Austronesian), which are typologically alike as languages that comprise dialects with tones, with registers, and with neither. Perhaps broadening the meaning of *tone* would be helpful.

Not to be neglected is the possible problem in abstract phonology of how to handle such complex distinctions between members of a putative single class of phonemes. That is, can we still speak of a single class of either tones or voice registers, or must we somehow divide the units in such a language between two categories, tone and register?

## 6. ACKNOWLEDGEMENTS

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