

# Correlates of Breathy Voice in Plang Vowels

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Breathy vowel phonation is a phonemic event common to Mon-Khmer languages of Southeast Asia. The exact acoustic correlates of breathy voice have been debated. Phonetic realization of a specific language breathy vowel cross-linguistically may not be the same acoustically. Impressionist articulatory observations of breathy voice have been classified into a binary feature bundle called 'register' (Henderson 1952, Gregerson 1976). The phonological nature of breathy register in Southeast Asia may include features of pitch, vowel quality and duration, voice phonation, nasalization, or initial / final consonant types. Thus, at an abstract phonological level, breathy register may be regarded as a syllable level complex, from which a specific language will select one or more phonetic features to realize the classificatory set labeled 'breathy register'.

The goal of this current study is to contribute to the discussion of the acoustic properties of register in Southeast Asian languages by providing further evidence from a language in which both tone (high and low) and register (breathy and clear) are distinctive. Very few acoustic studies of register in the Palaungic branch of Mon-Khmer have previously been done.

## 2.0 Research

This study investigates the acoustic correlates of breathy vowel in Plang by examination of the wave form alone for clear and breathy vowel [a]. The Kontoi dialect of Plang has seven vowels in the clear register [i, e, a, u, o, ɔ] and five in the breathy register [i, e, a, u, o]. Six data sets of [a] and [a̤] were measured for vowel and initial consonant duration, pitch, vowel quality (the relation of F1 to F2), and the relation of F0 to the second harmonic (H2) (Ladefoged 1982; Huffman 1985). The data are from one 48 year old female speaker, recorded isolated words using a Sony TCM 500 recorder, digitized and analyzed using the Acoustic Speech Analysis Program for the IBM PC. Values for each of the above variables were analyzed using paired t-test for each pair of coupled values.

The data sets of this study are:

### Modal Voice

1. kah (high tone) 'give'
2. ka? (high) 'fish'
3. ?ata? (high) 'grandfather'
4. tah (high) 'open'
5. ?ai (high) 'friend'
6. pha? (high) 'to split'

### Breathy Voice

1. kah (high tone) 'take off'
8. setah (high) 'winnow basket'
3. ta? (high) 'vegetable'
4. tah (high) 'mushroom'
5. ?ai (high) 'to rear'
6. ba? (low) 'breast'

## 3.4 Voice Phonation in relation to Vowel Quality

The Breathy and Modal vowel in relation to their average F1 and F2 values have been charted and demonstrate the following patterns.

Figure 4.

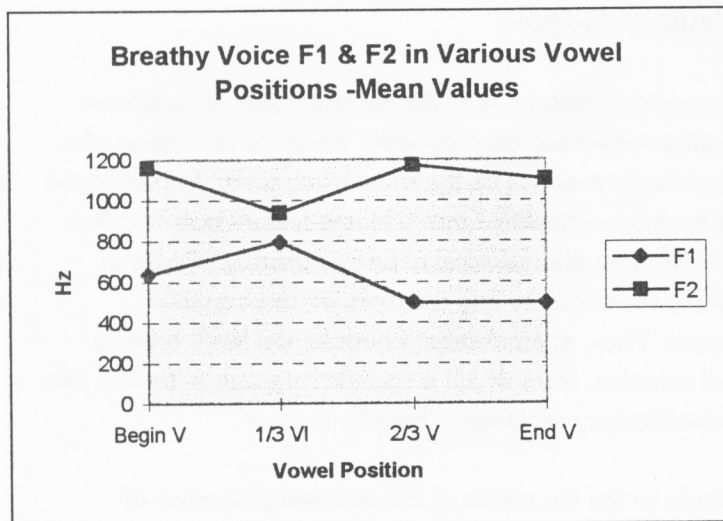
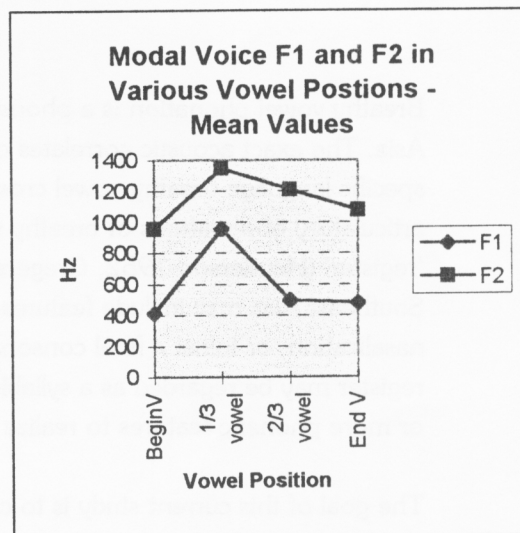


Figure 5.



While the patterns appear distinctive, the mean values for all positions were averaged together and the means compared using a paired t-test.

Table 4. Vowel Phonation Type and Vowel Quality:

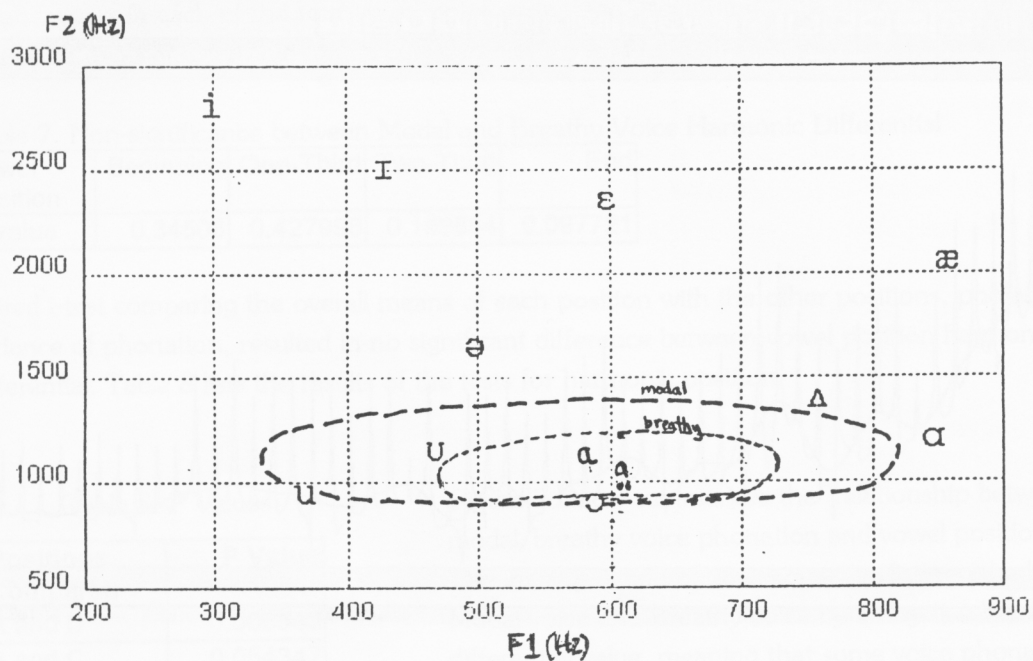
Breathy Vowel /a/						
	Begin V	1/3 V	2/3 V	End V	Mean	St Dev.
F1	635	795	498	493	605	142.568
F2	1159	936	1172	1102	1092	108.491
Modal Vowels /a/						
	Begin V	1/3 vowel	2/3 vowel	End V	Mean	St Dev.
F1	412	957	493	478	585	250.642
F2	957	1346	1210	1078	1148	167.764

According to a paired t-Test the difference between vowel quality for breathy /a/ and modal voice /a/ is not significant.  $P=0.362959$ . Therefore we can assume that some other difference signals the difference between breathy and modal voice in Plang.

Table 5. Mean Values of Breathy and Modal Vowels, Pooled Variance for all Positions

	Breathy	Modal	
	Mean	Mean	St Dev.
F1	605	585	142.568
F2	1092	1148	108.4907
P=	0.362959		

### 3.4.2. Mapping of /a/ onto F1-F2 Vowel Space.



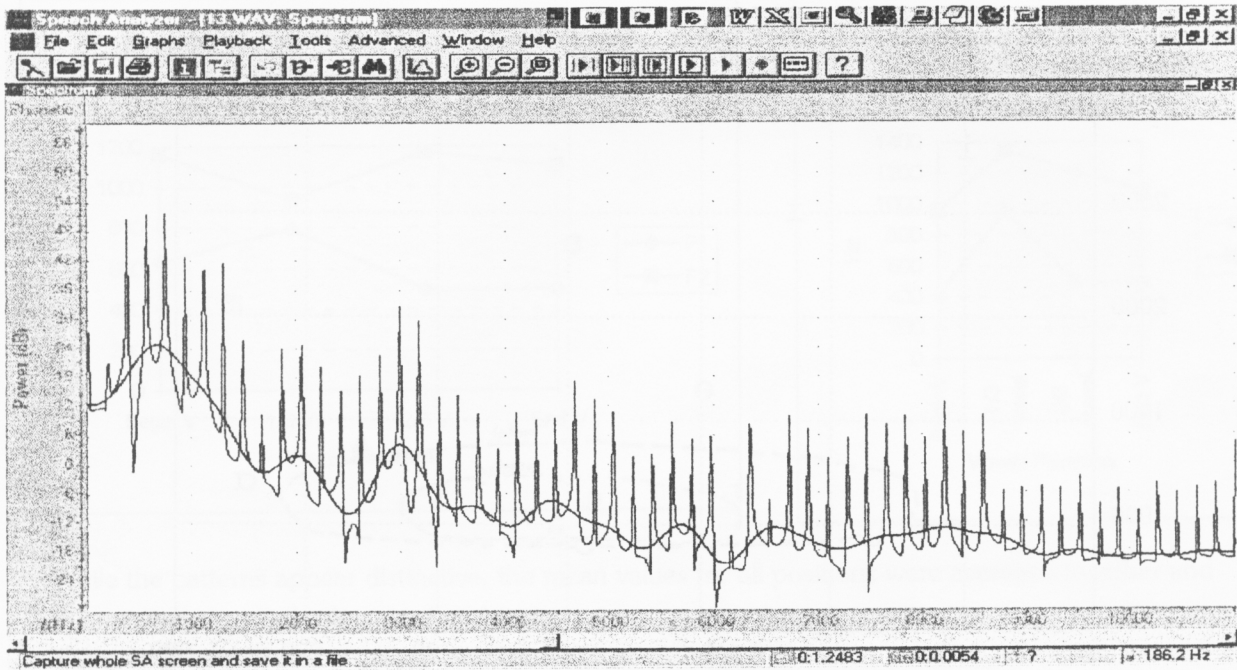
### 3.5 Voice Phonation in Relation to Harmonic Differential.

The harmonic differential (difference between H1 and H2) was examined at four different points in the vowel (beginning, one-third of the duration, two-thirds duration, and the end). In modal voice, the relation of H1 to H2 is positive, with H1 higher in amplitude than H2. In breathy and/or creaky voice H2 is typically higher than H1 (Maddison and Ladefoged 1985, Kirk et al 1984).

The Plang waveform, glottal pulse was viewed by using the cepstral spectrum and zooming in on the harmonic waves for measurement of amplitude. See Figure 5. and Figure 6 examples of the two types of harmonic relationships.

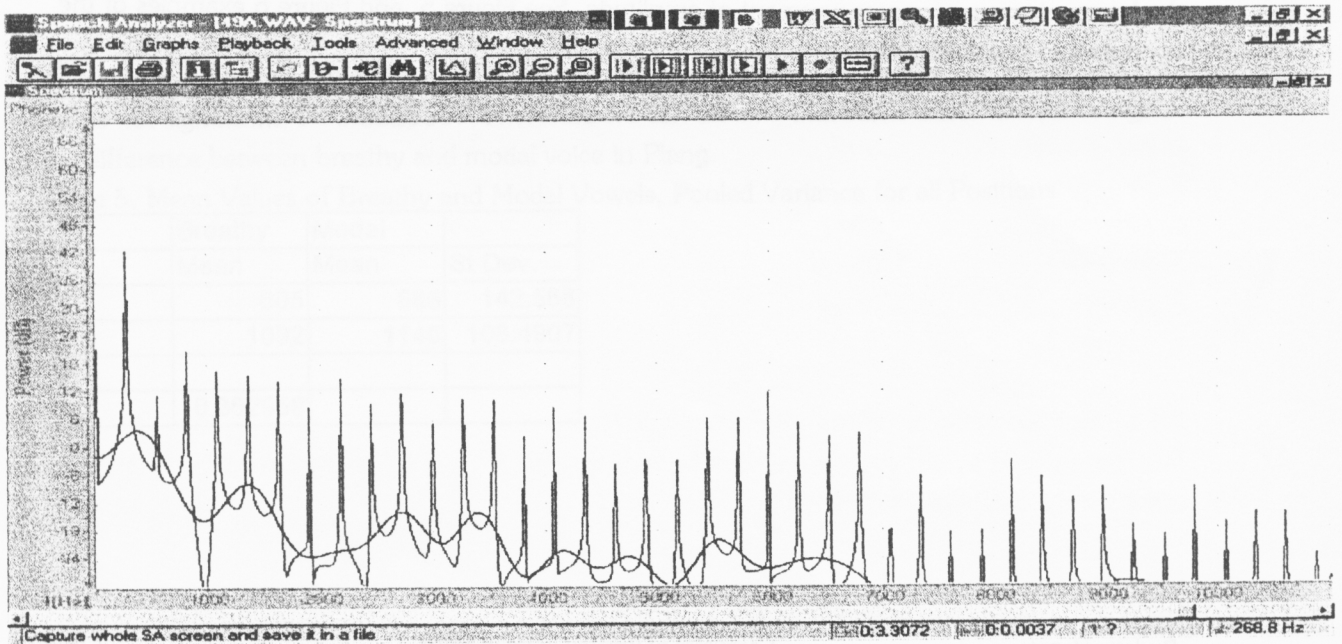


Figure 5. Spectral Tilt typical of Breathy Voice (H1 is lower than H2) ba? ʌ 'breast'



*Not sure where H1 + H2 are located*

Figure 6. Spectral Tilt typical of Modal Voice (H1 is higher than H2) ? a i 1 'friend'





The means of the harmonic differential for modal and breathy vowel phonation were compared using a paired t-test with the result that no significant difference was found between modal and breathy voice in each of the four vowel points examined, Beginning, one-third, two-thirds, and end point. No significant difference between breathy and modal voice, position by position.

Table 7. Non-significance between Modal and Breathless Voice Harmonic Differential

Vowel Position	Beginning	One-Third	Two-Third	End
P-value	0.34508	0.427998	0.199854	0.097721

Paired t-test comparing the overall means of each position with the other positions, pooled variance of phonation, resulted in no significant difference between vowel position harmonic differential. Table 8 lists the results of the tests for harmonic position.

Table 8. P Values

Positions Compared	P Value
A and D	0.068943
A and C	0.054347
A and B	0.030114
B and D	0.119962
B and C	0.085094
C and D	0.232114

Figure 7 below summarizes the relationship between modal/breathy voice phonation and vowel position. The initial position of vowel onset is distinguished in both Modal voice and Breathless voice by a negative harmonic differential value, meaning that some voice phonation phenomena, either breathy or creaky voice occurs immediately after consonantal release but is not sustained. Modal and Breathless voice demonstrate a very similar phonation at one-third of vowel duration.

Contrary to expectation, Breathless phonation has a higher harmonic differential than Modal voice during the second-third of vowel duration. At vowel end, Modal voice differential rises increases but is not statistically significant (see Table 7.)

FIGURE 7. Harmonic Differential Tracking of Modal and Breathless Voice

