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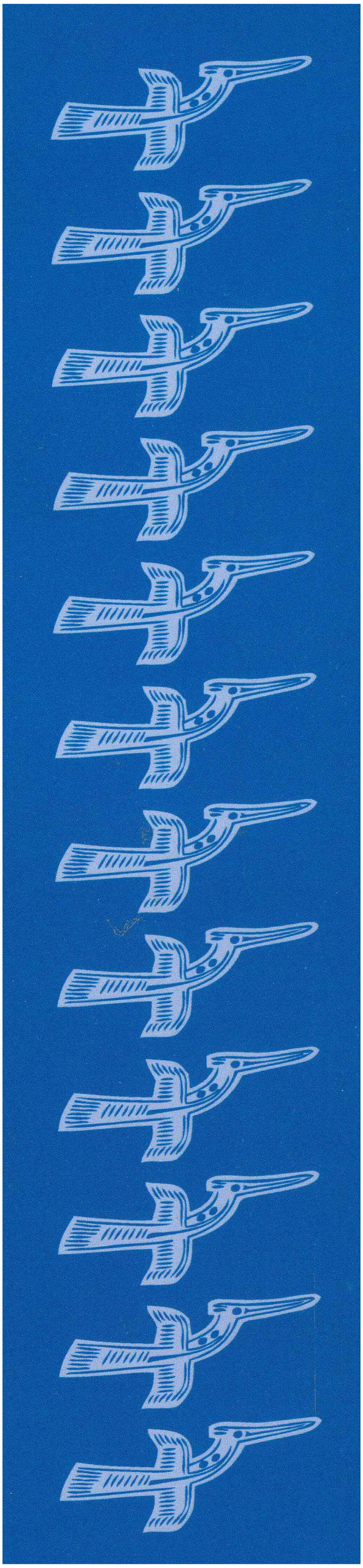

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A comparison between the vowel systems and the acoustic characteristics of vowels in Thai Mon and Burmese Mon: a tendency towards different language types[1]

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Abstract
Previous acoustic studies on a variety of Thai Mon (TM) (Luangthongkum, 1988a; 1990) have found salient pitch patterns, which would seem to indicate a tendency to evolve into a tonal language. However, no acoustic analyses have been undertaken in Burmese varieties of Mon (BM). This research is a synchronic study of vowel systems with an acoustic analysis of vowels in four TM and four BM varieties. A number of vowel phonemes and characteristics were found to be slightly different in TM and BM. H1-A1 and F0 values show a clear distinction between clear vowels and breathy vowels in TM and BM. Conversely, on-gliding and off-gliding vowels were mainly found in BM varieties. Overall, TM and BM are register languages with a pitch pattern. Nevertheless, in the future, TM may become a solely tonal language, while BM seems to tend towards becoming either a tonal language or a restructured one.
Keywords: phonetics, register, vowels
ISO 639-3 language codes: mnw

1. Introduction

The term "register" was first mentioned by Henderson (1952) to describe Cambodian phonology in association with complexes of laryngeal features. First register vowels with a clear voice are more open and have a higher pitch than those of the second register which have a breathy voice. Multidimensional laryngeal features or bundles of laryngeal parameters, resulting from complex laryngeal activity during the phonation process, might be best described as "register complexes". Register complexes comprise several phonetic characteristics, such as phonation type, pitch, loudness, vowel quality and vowel length. Theoretically, one of these parameters could dominate the others due to register distinction; however, more than one feature has been found to be salient due to a possible tendency towards language change. For example, in the case of Kui, a register language, phonation type and pitch play a central role in the language, according to the results of significant H1-H2 and F0 values (Luangthongkum, 1989). Later in 2004, a pitch pattern was found to occur in Kui (Abramson et al., 2004) as well as Khmu (Premsrirat, 2004; Abramson et al., 2007). Perception tests support the idea that Kui and Khmu speakers use pitch as a cue to differentiate word meaning (Abramson, et al., 2004; 2007). These languages, Kui and Khmu, may possibly become tonal languages. Nevertheless, due to the loss of register, complex vowel quality on the co-occurrence of different degrees in glide, height and length can compensate for previous clear vowels and breathy vowels. For example, clear vowels may occur with off-gliding and lower quality in which on-gliding and higher quality may appear with breathy vowels. The vowel system can become restructured with the vowels changing in position and diphthongisation. This can lead to a variety becoming a restructured language in the same way as Khmer (Huffman, 1985), Bru (Phillips, Phillips and Miller, 1976), and Haroi (Mundhenk and Goschnick, 1977).

The Thai Mon (TM) and Burmese Mon (BM) varieties are said to be the same language due to minor differences in their vowel systems (Huffman, 1987-1988). However, previous acoustic studies on Thai Mon (Luangthongkum, 1988a) have revealed significant F0 values which exhibit pitch patterns as a possible salient exponent. This variety is possibly evolving into a tonal language. Meanwhile, Shorto (1966) explains that vowels in the head register are characterised by a clear voice with peripheral quality whereas vowels in the chest register are in breathy voice more centralised. Vowel quality may eventually become dominant in some Mon varieties. Nevertheless,

1 This research is part of my Ph.D. Dissertation "A comparison between the change of vowel systems and the acoustic characteristics of vowels in Thai Mon and Burmese Mon: a tendency towards different language types" submitted to the Department of Linguistics, Faculty of Arts, Chulalongkorn University.

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no acoustic analyses have been performed on vowels in BM varieties. It is possible that TM varieties could be distinct from BM varieties, internal and external factors are taken into account.

2. Objective

This research investigated the vowel systems of four Thai Mon varieties in comparison with four Burmese Mon varieties. In addition, single vowels with register contrast in these varieties were acoustically analysed using four parameters: phonation type (the difference of relative amplitude), pitch (F0 values), vowel quality (F1 and F2 values) and vowel length (vowel duration) in order to display the prominent components that could demonstrate whether TM and BM exhibit a tendency to change towards different language types in the future.

3. Data Collection

3.1 Language consultants

The language consultants were male native speakers of Mon born and raised using four different Thai Mon varieties: Ban Kho (TM1), Ban Muang (TM2), Ban Bangkhanmak (TM3), Ban Nong Duu (TM4), and four different Burmese Mon varieties: Mokaneang (BM1), Tancanuʔ (BM2), Sapuʔ (BM3) and Kawbein (BM4). The data was collected in Thailand. Due to the small number of Thai Mon native speakers, the age range of TM speakers was between 50-70 years, while that of the BM speakers was between 30-40 years, due to the fact that they mainly migrated to Thailand looking for work.

3.2 Word lists

In order to analyse the vowel systems, three sets of word lists were used to interview the language consultants. The first one, with 500 vocabulary items, was adapted from the 436 SIL word list (SIL, 2006). The second one, of 300 items, consisted of items selected from Shorto (1962) and Diffloth (1984). The final list consisted of 112 words from Bauer's unpublished dialect word lists.

For acoustic analysis, citation forms consisted of single vowels with register contrast of each variety. The selected monosyllabic and sesquisyllablic words were words used in the speakers' daily life. Syllable structures included open syllables (CV), syllables with glottal finals (CVh), syllables with stop finals (CVT) and syllables with nasal finals (CVN) with mostly voiceless initials. The number of test words varied for each variety according to vowel phonemes: 109 words in TM1, 107 in TM2, 103 in TM3 and TM4, 106 in BM1, 104 in BM2, 103 in BM 3 and 100 in BM4, a total of 835 words.

3.3 Acoustic analysis

3.3.1 Recording

To record the citation form, three native speakers from each variety pronounced each word three times in randomised sequence through a ECM-719 SONY microphone connected to a laptop with 22500 sampling rates. The test tokens totaled 7,515 items.

3.3.2 Acoustic measurement

Vowels in stressed syllables were selected to be measured. To avoid any influence of consonant voicing on the vowels, initials and finals were omitted by visual identification. Each register contrast between clear vowels and breathy vowels were analysed and compared via their phonetic parameters: phonation type, pitch, vowel quality and vowel length, by using "Praat" version 5.2.27. The significant differences of each parameter were statistically analysed by t-test at $p < 0.05$. The four parameters were investigated as follows:

(1) *Relative amplitude of harmonic*: the difference in decibel (dB) between relative amplitude as H1-H2, H1-H3, H2-H4, H1-A1, H1-A2, H1-A3 were measured at five time points of vowel duration: 0% 25% 50% 75% and 100%.

(2) *Fundamental frequency (F0):* F0 values in Hertz (Hz) were measured at five time points of vowel duration as 0% 25% 50% 75% and 100%. Hertz was later converted to semitones using the formula $P_{semitones} = 3.32 \times 12 \times \log_{10} ((F0_{Hz})/base)$ in order to normalise the F0 range across the speakers.

(3) *Formant frequency (F1,F2):* F1 and F2 values were analysed in Hertz at 50% in steady state of vowel.

(4) *Duration:* The onset to offset of vowel was measured in milliseconds (ms).

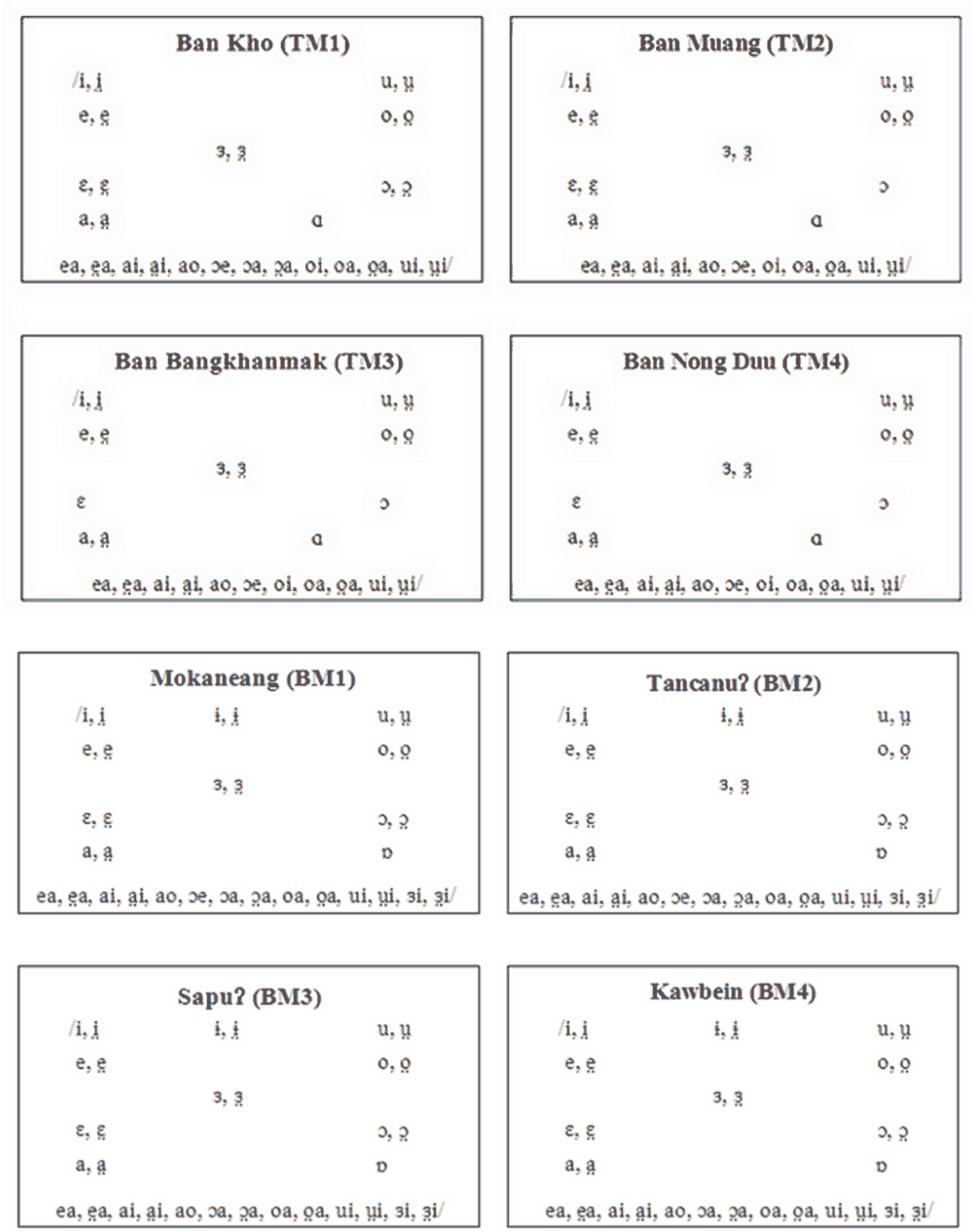

Figure 1: Vowel systems of four Thai Mon and four Burmese Mon varieties

4. Results

4.1 Vowel system

Most of vowel inventories in Thai Mon and Burmese Mon varieties occur with register contrast. Based on impressionistic data collection, the phoneme inventories of four Thai Mon and four Burmese Mon varities are illustrated in Figure 1.

From Figure 1, there are 17 monophthongs and 13 diphthongs in TM1 while there are 16 monophthongs and 11 diphthongs in TM2, and 15 monophthongs and 11 diphthongs in TM3 and TM4. Some examples of minimal register contrast are:

/ki/	'bark'	/həki̤/	'centipede'
/cut/	'put in/ put on'	/cṳt/	'bone'
/sai/	'bee'	/sa̤i/	'thin'

In addition, in Thai Mon varieties, /ɛ̤/ is found in TM1 and TM2 as an example of /həʔɛm/ 'to clear one's throat' vs. /tɛ̤k/ 'tie', and /ɔ̤/, /ɔa/ and /ɔ̤a/ appear in TM1 as examples of /sɔt/ 'fruit' vs. /tɔ̤p/ 'hatch' and /ʔədɔa/ 'inside' vs. /jɔ̤a/ 'sick' respectively but not in TM2, TM3 and TM4.

In BM varieties, there are 19 vowel phonemes in all four varieties for monophthong while 14 diphthongs are found in BM1 and BM2, and 13 diphthongs in BM3 and BM4. The vowel phoneme which occurs only in BM1 and BM2 is /ɔe/ such as/ hətɔe/ 'sand'. Some examples of minimal and analogical register contrast are:

/həmot/	'ant'	/mo̤t/	'eye'
/kɨt/	'bite'	/həkɨ̤t/	'bedbug'
/ʔədɔa/	'inside'	/jɔ̤a/	'sick'
/tɜiʔ/ 'over there'		/sɜ̤ih/	'deep'

In all varieties, monophthongs appear in open and closed syllables. While most diphthongs occur only in open syllables, /ea-e̤a/ in TM and BM varieties, /ɜi-ɜ̤i/, and /ao/ in BM varieties also appear in closed syllables.

Overall, the number of vowel phonemes and phonetic realisation are slightly different between Thai Mon and Burmese Mon varieties. Nevertheless, some vowel phonemes might indicate whether a variety belongs to TM or BM varieties as /ɑ/ and /oi/ which occur only in TM varieties whereas /ɒ/, /ɨ/, /ɨ̤/, /ɜi/ and /ɜ̤i/ appear in BM varieties.

4.2 Acoustic analysis

4.2.1 Relative amplitude

To produce phonation contrast, glottal stricture can vary along the glottal continuum, i.e. breathy voice with more open glottal constriction, creaky voice with tight constriction and modal voice with moderate one (Ladeforged, 1971). Thus, air passing through the glottis is modified differently. The energy difference demonstrates phonation contrast. This can be measured by examining the differences in relative amplitude of a harmonic to that which precedes it, in other words H1 (first harmonic or F0) - H2 (second harmonic), H1-H3 (third harmonic), H2-H4 (fourth harmonic) and the relative amplitude of the first harmonic to that of the strongest peak of formant as H1-A1 (amplitude of F1), H1-A2 (amplitude of F2) and H1-A3 (amplitude of F3). Some of these measurements can successfully distinguish phonation contrast in certain languages. Keating et al. (2010) reveal that H1-H2 distinguishes phonation contrast in Gujarati, White Hmong and Southern Yi, and Esposito (2006) mentions eight other languages. While H1-A1 and H1-A3 differentiate phonation contrast in Gujarati, Jalapa Mazatec and Southern Yi, H1-A3 indicates significant differences in voice quality in Chong (DiCanio, 2009). To distinguish between clear (modal) phonation and breathy phonation, Esposito (2006) shows H1-A2 and H1-A3 to be a successful measurement. In some languages, both H1-H2 and H1-An (H1-A1, H1-A2 and H1-A3) differentiate phonation contrast; for example, H1-H2 and H1-A2 clearly distinguish contrast in

Mazatec (Blankenship, 2002), and H1-H2 and H1-A1 characterize clear (modal) vowels and breathy vowels in Chanthaburi Khmer (Wayland and Jongman, 2003).

The relative amplitude difference of each phonation should differ due to the presence of distinct glottal stricture. In this study, the greater difference occurs in breathy vowels. Figures 2 and Figure 3 show the relative amplitude of H1-H2, H1-H3, H2-H4, H1-A1, H1-A2 and H1-A3 at 0%, 25%, of vowel duration and those of 50%, 75% and 100% are shown in Appendix 1. The results of H1-An (H1-A1, H1-A2 and H1-A3), notably H1-A1, show a significant distinction between clear vowels and breathy vowels ($p < 0.05$) at every time point in most varieties; meanwhile, H1-H2 and H1-H3 show significant differences at 0% and 25% and H2-H4 shows a few significant differences after 50% of vowel duration.

4.2.2 Fundamental frequency

F0 values of clear vowels are higher than those of breathy vowels as seen in Table 1. The results show that F0 values at every time point are significantly different ($p < 0.05$) in TM2, TM3, TM4 and all BM varieties. Meanwhile, the F0 values of TM1 can be distinguished at 0% - 75%, as also seen in Table 1.

The time-normalized average F0 contours of clear vowels and breathy vowels are plotted on a semitone scale in Figure 4. There are similar contours between clear vowels and breathy vowels. The vowel onset rises slightly and then gradually falls to the offset. The slope of clear vowels is higher than that of breathy vowels. However, the slope of breathy vowels in TM1 falls abruptly at the end. A large difference of semitones between clear vowels and breathy vowels occurs in BM and TM1 with a scale range of 3.7-6.1 semitones, while the difference in other TM varieties is 1.4-2.9 semitones. Pitch differences is apparently greater in BM and TM1.

4.2.3 Formant Frequency

F1 and F2 values of some clear vowels and breathy vowels are significantly different at $p < 0.05$ as shown in Tables 2-3. From Table 2, it can be seen that F1 values in Thai Mon exhibit significant differences for /ɛ-ɛ̤/ in TM1, /o-o̤/ and /u-ṳ/ in TM3, and /a-a̤/ in TM4; meanwhile, a significant difference occurs in the F2 values of /i-i̤/ and /ɜ-ɜ̤/ in TM1, /e-e̤/, /o-o̤/ and /u-ṳ/ in TM2, /i-i̤/ and /ɜ-ɜ̤/ in TM3, /i-i̤/, /o-o̤/ and /u-ṳ/ in TM4. Both the F1 and F2 values in some pairs of vowels exhibit significant differences as /u-ṳ/ in TM1, /i-i̤/ in TM2 and /e-e̤/ in TM3. In BM varieties, F1 values are significantly different for /i-i̤/, /a-a̤/ and /o-o̤/ in BM1, /i-i̤/, /e-e̤/ and /a-a̤/ in BM2, /i-i̤/ and /ɨ-ɨ̤/ in BM3 and /a-a̤/ in BM4. The difference of F2 values is found significantly in /ɜ-ɜ̤/ of BM1, /o-o̤/ and /u-ṳ/ of BM3, /ɛ-ɛ̤/, /ɜ-ɜ̤/ and /ɨ-ɨ̤/ of BM4 as shown in Table 3. In addition, F1 and F2 values of /ɔ-ɔ̤/ in BM1, BM2, BM4 and /o-o̤/ in BM2 are significantly different.

Notwithstanding these values, the difference of F1 and F2 values between clear vowels and breathy vowels are not systematic. No obvious patterns indicate vowel quality difference in vowel space. Neither clear vowels nor breathy vowels are more open or more close, or more front or more back as can be seen in Appendix 2.

4.2.4 Duration

Most breathy vowels are longer than clear vowels, but the duration of breathy vowels in TM2 and TM4 is shorter than that of clear vowels in CVN, as shown in Appendix 3. Overall, the longest duration of breathy vowels in CV is 32-42 ms. and that of clear vowels is 27-38 ms. In other syllable types such as CVh, CVT and CVN, the duration range between clear vowels and breathy vowels is 14-19 ms. and 18-24 ms., 12-19 ms. and 14-23 ms., 17-24 ms. and 15-27 ms. respectively.

This study reveals that a small number of clear vowels and breathy vowels can be significantly distinguished at $p < 0.05$. The significant difference between clear and breathy vowels occurs in CV of TM2, TM3, TM4 and BM3, CVh of BM1 and BM4, and CVN of TM1, TM3 TM4 and BM1. No significant difference is found for CVN syllables except in TM4, whose clear vowels are longer than breathy ones.

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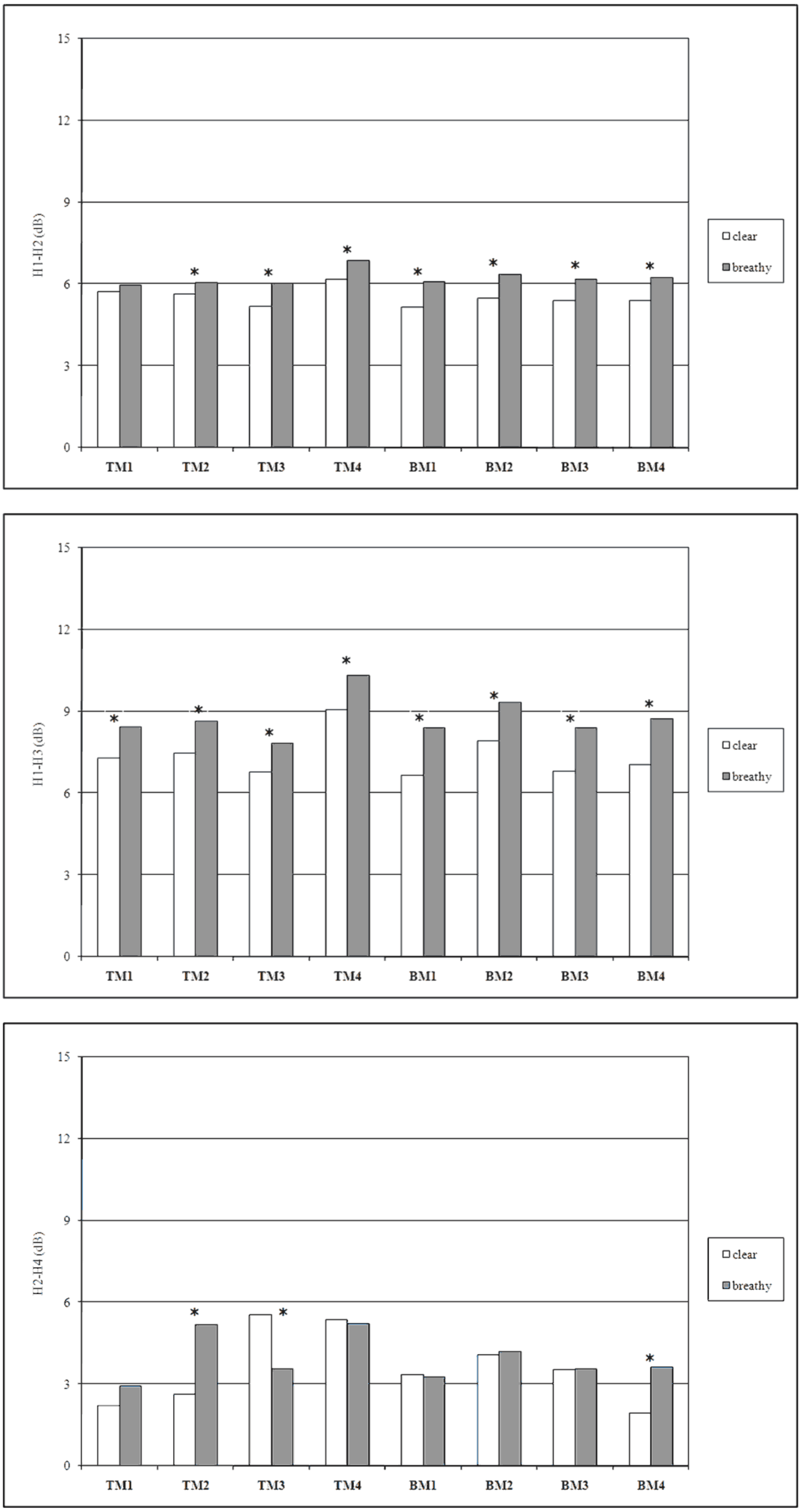

Figure 2.1: Mean values of H1-H2, H1-H3 and H2-H4 (in dB) at 0% from four Thai Mon and four Burmese Mon varieties with clear vs. breathy vowels (An asterisk indicates the values that are significantly different.)

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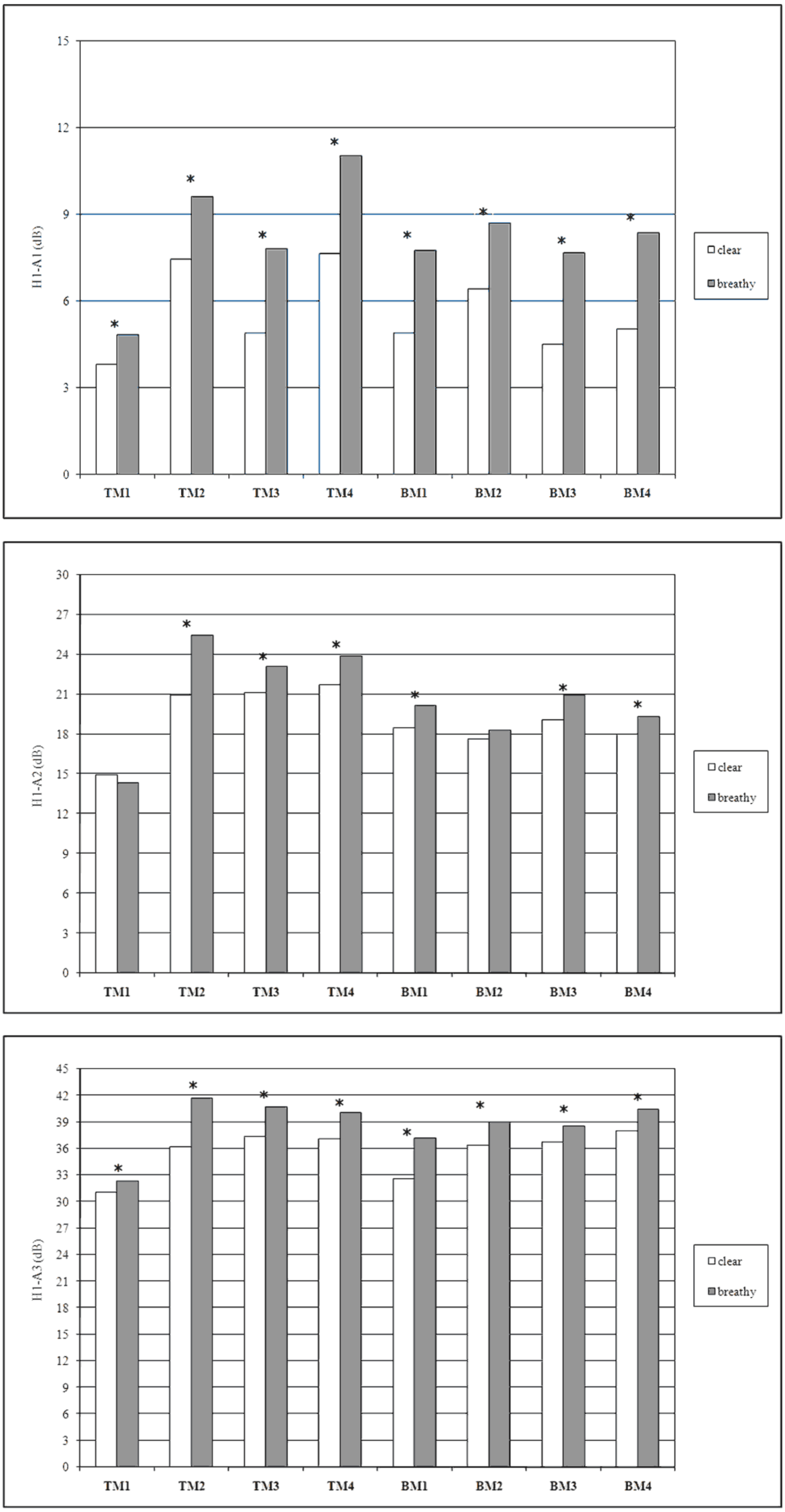

Figure 2.2: Mean values of H1-A1, H1-A2 and H1-A3 (in dB) at 0% from four Thai Mon and four Burmese Mon varieties with clear vs. breathy vowels (An asterisk indicates the values that are significantly different.)

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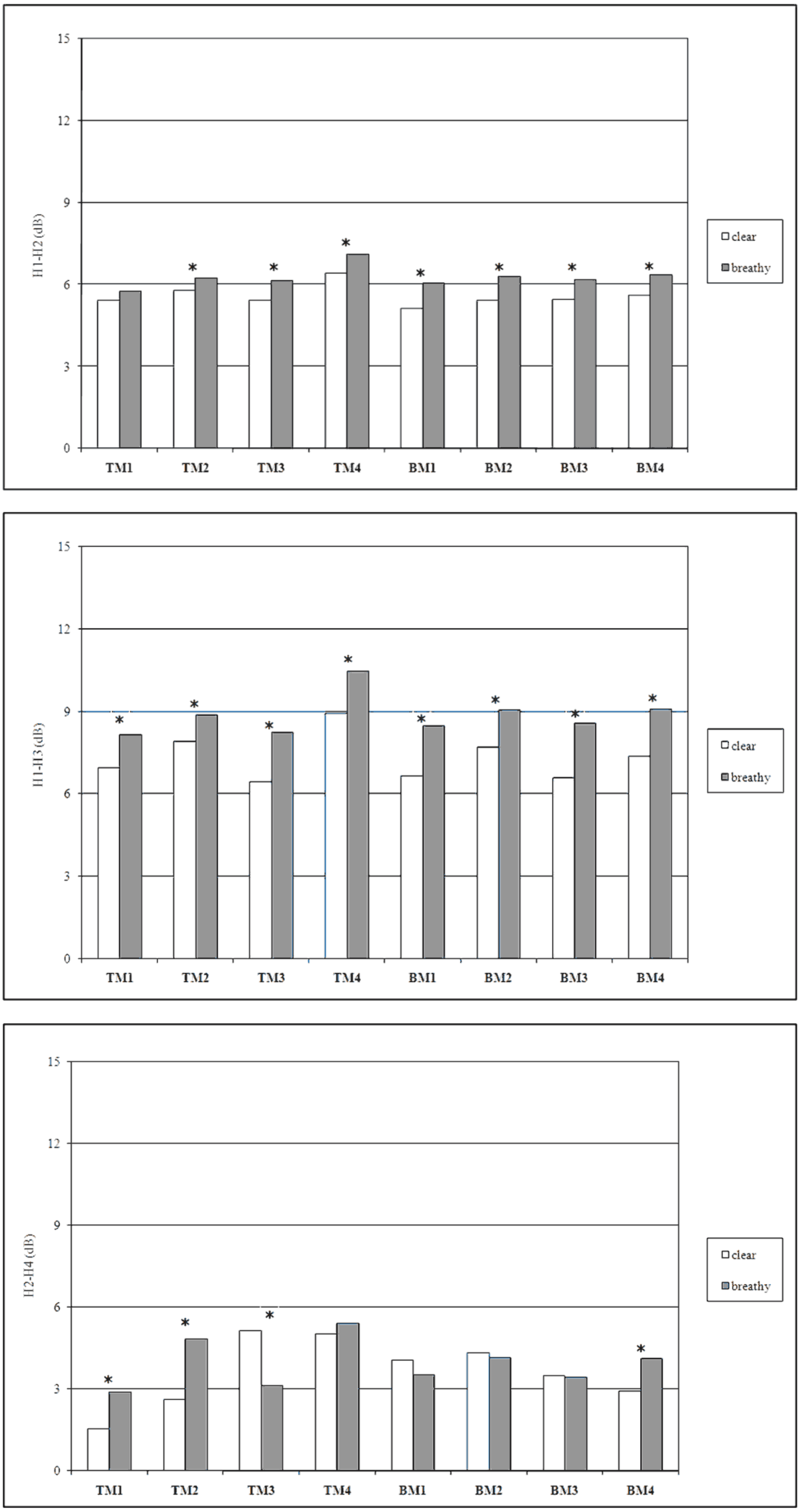

Figure 3.1: Mean values of H1-H2, H1-H3 and H2-H4 (in dB) at 25% from four Thai Mon and four Burmese Mon varieties with clear vs. breathy vowels (An asterisk indicates the values that are significantly different.)

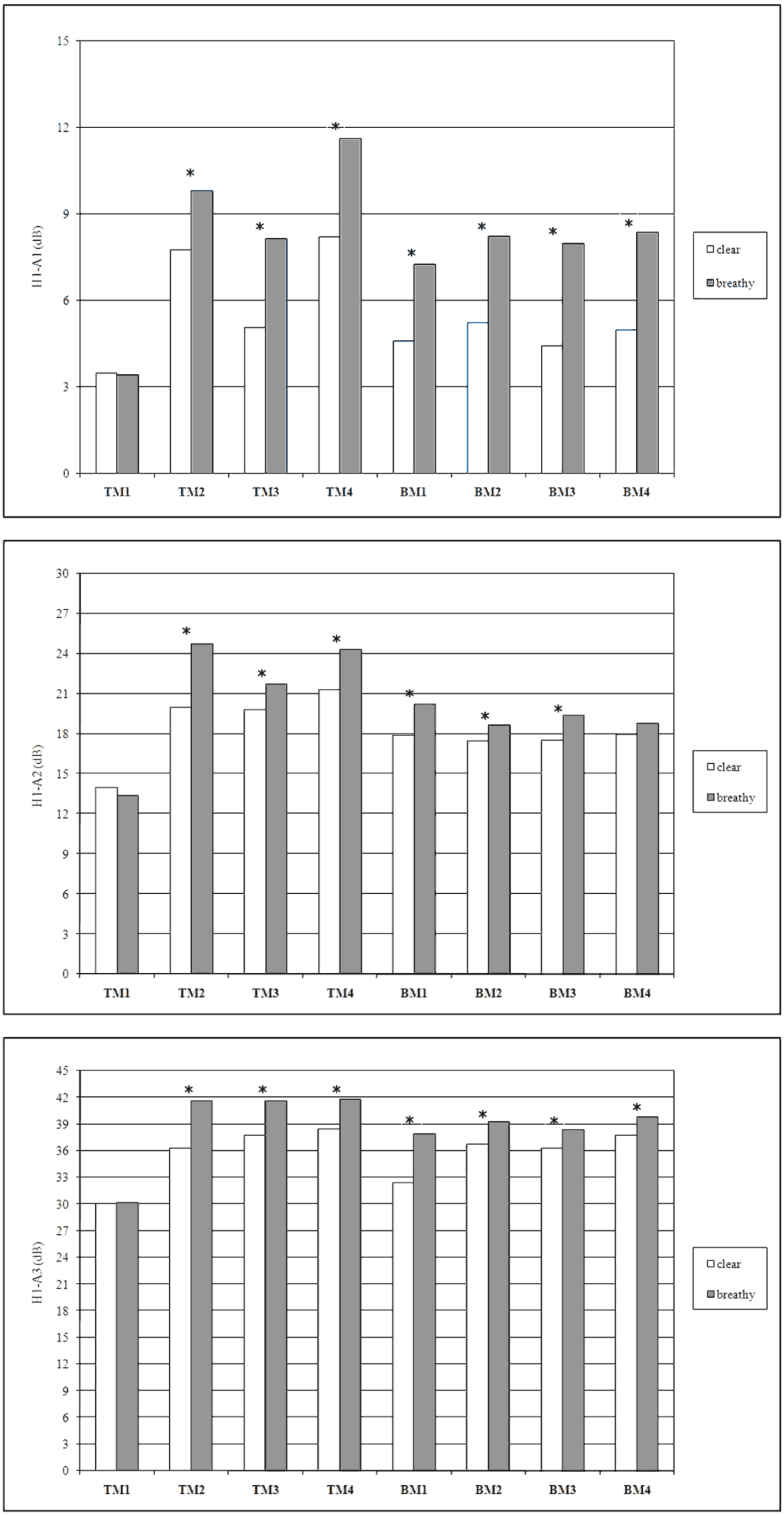

Figure 3.2: Mean values of H1-A1, H1-A2 and H1-A3 (in dB) at 25% from four Thai Mon and four Burmese Mon varieties with clear vs. breathy vowels (An asterisk indicates the values that are significantly different.)

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Table 1: Mean of F0 values (in Hz) at 5 time points (0%-100%) (An asterisk indicates the values that are significantly different.)

Variety	Time / Vowel	0%	25%	50%	75%	100%
TM1	v	166.31*	178.63*	183.96*	168.71*	146.87
	v̤	122.04*	137.06*	162.82*	167.09*	140.43
TM2	v	167.38*	167.31*	162.99*	151.56*	141.33*
	v̤	153.57*	156.31*	156.21*	146.8*	137.03*
TM3	v	165.35*	170.42*	166.55*	150.53*	135.73*
	v̤	141.33*	148.14*	149.18*	139.16*	128.92*
TM4	v	163.37*	163.42*	156.04*	142.30*	130.30*
	v̤	137.59*	139.48*	135.73*	128.95*	124.50*
BM1	v	184.12*	189.65*	183.70*	162.68*	143.05*
	v̤	144.96*	153.96*	157.96*	151.20*	136.83*
BM2	v	183.55*	185.54*	178.35*	157.54*	141.16*
	v̤	147.42*	151.88*	151.93*	141.49*	128.53*
BM3	v	195.01*	199.79*	194.43*	169.25*	145.94*
	v̤	136.66*	143.72*	153.93*	151.54*	136.42*
BM4	v	178.52*	178.72*	168.41*	148.40*	134.82*
	v̤	144.68*	144.62*	142.98*	136.41*	128.76*

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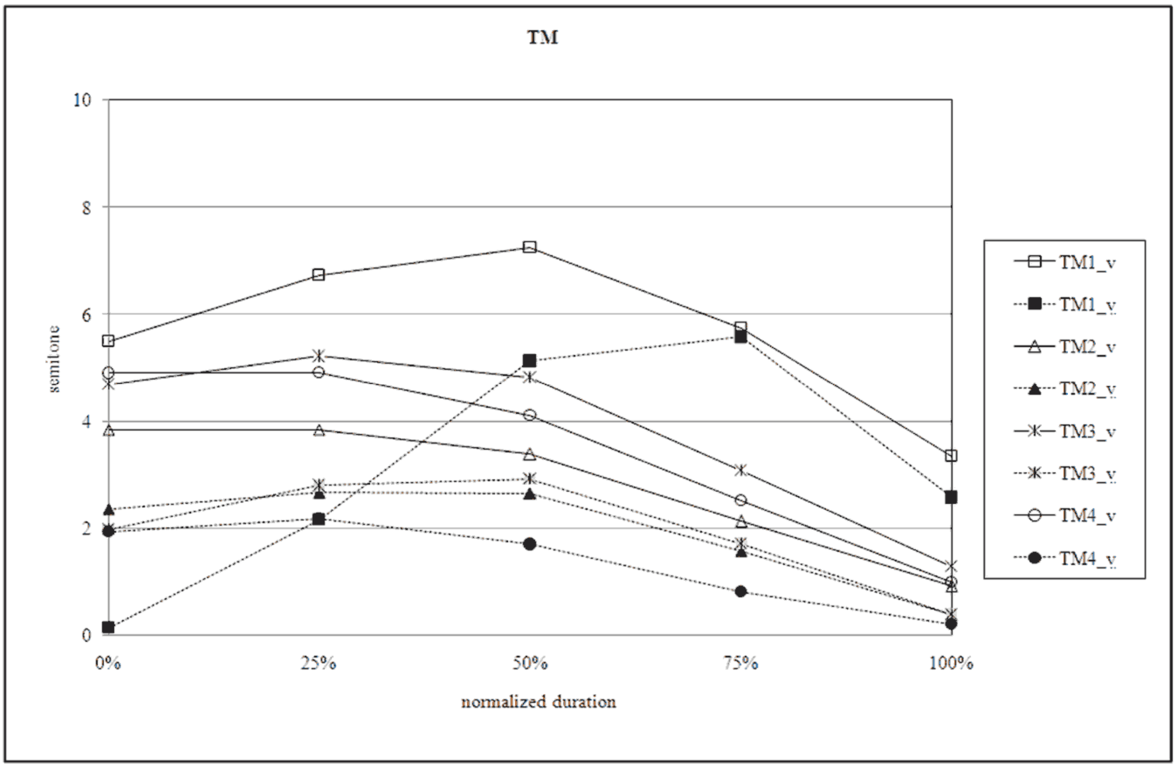

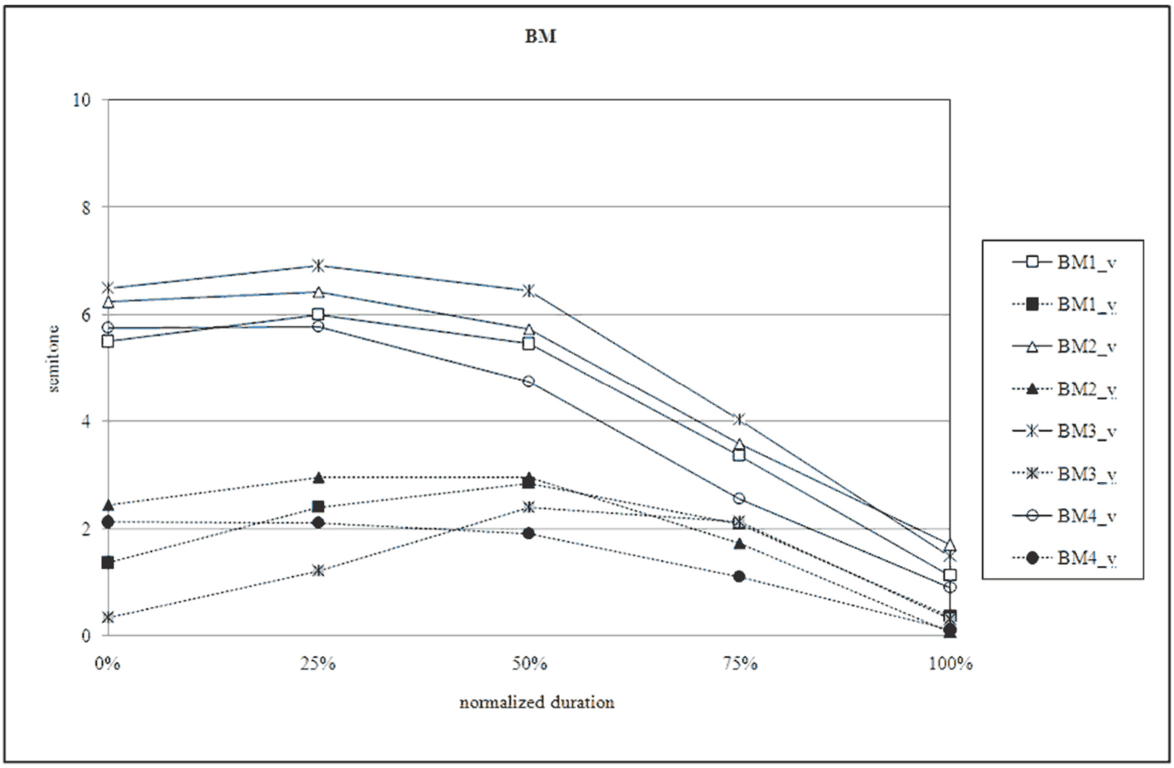

Figure 4: Semitone values at 5 time points of normalized duration from Thai Mon varieties (top) and Burmese Mon varieties (bottom).

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Table 2: Mean of F1 and F2 values (in Hz) at 50% in steady state of vowel in TM varieties (An asterisk indicates the values that are significantly different.)

Variety	Vowel		i	e	ɛ	a	ɑ	ɔ	o	u	ɜ
TM1	F1	v	477.48	618.07	864*	1008	959.26	845.50	666	567.50*	567.50
		v̤	471.27	624.04	787*	979	-	852	726	726*	741
	F2	v	2112.68*	1977.50	1958	1558	1260.15	1116	945	964*	1252.50*
		v̤	2055.00*	1928.43	1865	1340	-	1148	974	850*	1244*
TM2	F1	v	478.90*	570.27	844.65	897.69	895.54	827.51	650.38	538.19	676.66
		v̤	453.90*	538.63	756.77	841.21	-	-	550.30	466.73	566.14
	F2	v	1972.47*	1854.48*	1726.11	1532.29	1383.59	1162.82	979.33*	985.78*	1335.15
		v̤	1918.63*	1802.86*	1771.13	1307.52	-	-	919.99*	902.21*	1259.34
TM3	F1	v	448.28	565.03*	872.55	979.89	868.07	761.16	603.12*	485.32*	664.45
		v̤	444.53	532.20*	-	899.00	-	-	580.66*	516.89*	600.82
	F2	v	2048.52*	1949.18*	1875.29	1512.47	1180.12	1051.15	910.36	949.52	1222.90*
		v̤	1979.85*	1827.95*	-	1372.45	-	-	906.78	893.21	1178.97*
TM4	F1	v	391.78	562.84	761.19	966.28*	814.32	726.20	583.43	489.12	600.47
		v̤	400.20	554.08	-	925.58*	-	-	567.16	470.03	593.13
	F2	v	2233.22*	2064.49	1863.34	1530.42	1174.64	1032.25	837.06*	959.66*	1429.59
		v̤	2194.72*	2036.71	-	1432.82	-	-	880.89*	868.13*	1357.41

Table 3: Mean of F1 and F2 values (in Hz) at 50% in steady state of vowel in BM varieties (An asterisk indicates the values that are significantly different.)

Variety	Vowel		i	e	ɛ	a	ɑ	ɔ	o	u	ɜ	ɨ
BM1	F1	v	465.79*	558.14	743.24	879.40*	810.77	736.14*	579.74*	442.14	492.18	643.62
		v̤	411.33*	552.99	748.80	854.46*	-	756.41*	613.29*	437.38	499.84	643.81
	F2	v	2056.71	1956.83	1796.81	1544.97	1160	1108.35*	946	985.39	1545.91*	1321.16
		v̤	1860.88	1935.15	1745.202	1389.76	-	1103.96*	930.21	956.28	1449.40*	1266.64
BM2	F1	v	439.82*	548.51*	756.91	905.13*	820.29	706.83*	581.35*	434.90	453.09	622.18
		v̤	400.70*	556*	762.54	871.01*	-	715.25*	596.87*	444.81	519.28	655.16
	F2	v	1975.74	1958.97	1800.29	1510.72	1171.80	1030.94*	868.58*	1056.11	1427.81	1379.56
		v̤	1989.51	1977.52	1736.63	1361.11	-	1059.01*	962.90*	1035.96	1470.31	1319.46
BM3	F1	v	454.17*	574.99	827.69	990.26	869.28	783.30	608.38	473.11	490.63	678.93*
		v̤	431.57*	570.68	840.38	988.49	-	805.12	625.22	459.69	541.53	665.35*
	F2	v	2189.97	2086.64	1861.49	1670.95	1167.24	1126.55	973.95*	1031.33*	1313.97	1272.63
		v̤	1968.39	2062.28	1871.64	1540.62	-	1118.27	911.32*	1085.55*	1327.21	1277.43
BM4	F1	v	444.70	591.13	706.97	855.53*	796.42	722.72*	598.82	458.16	457.08	638.55
		v̤	441.31	519.06	714.09	899.20*	-	756.35*	589.99	445.64	492.75	632.17
	F2	v	2148.38	1944.10	1725.24*	1518.98	1122.68	1072.13*	940.05	911.25	1361.99*	1258.39*
		v̤	1967.12	1881.31	1798.99*	1453.31	-	1107.02*	944.11	918.89	1481.86*	1310.62*

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5. Discussion

5.1 Vowel system

This study found minor differences between the TM and BM vowel systems, in line with Huffman (1987-1988). The number of monophthongs in TM and BM is similar to those of TM discussed in Bauer (1982) and those of BM in Jenny (2005) respectively. In addition, more diphthongs were found in BM varieties. However, this study cannot conclude whether this is an innovation or retention of vowels from old Mon. A fuller explanation would require a diachronic study. Nevertheless, it can be concluded that TM and BM varieties do belong to the same language.

5.2 Acoustic analysis

5.2.1 Relative amplitude

To produce phonation contrast, it is possible that vocal-fold velocity, a posterior glottal opening and ligament closure which depend on a degree of vocal-fold abduction and vocal-fold adduction and volume of air passing through are different in the particular contrast. This is related to the strength of higher frequencies in the spectrum. Even though, it is not absolute that one of which is greater than the others, the values of amplitude differences can distinguish the phonation contrast (Ladefoged, Maddieson and Jackson, 1988). In this study, the larger difference of relative amplitude mostly occurs in breathy vowels than that of clear vowels. Thus, it shows that distinct glottal stricture apparently exists among TM and BM varieties. Phonation type plays an important role in these varieties as well as Nakhon Chum Mon (Luangthongkum, 1988a). In addition, H1-An (H1-A1, H1-A2 and H1-A3), notably H1-A1, seems to indicate phonation contrast in the Mon varieties studied.

5.2.2 Fundamental frequency

The findings show that phonation type interacts with pitch in TM and BM varieties: clear vowels with higher pitch and breathy vowels with lower pitch. According to statistical analysis, F0 values of clear vowels and breathy vowels are significantly different at every time point in most varieties. Pitch is apparently a salient exponent, as found in Lee (1983) and Luangthongkum (1988a); however, it occurs with phonation type, for example in Nakhon Chum Mon (Luangthongkum, 1988a). This may lead both TM and BM varieties to become tonal languages. Moreover, the difference of pitch contours in BM and TM1 is larger than that of TM2, TM3 and TM4 as shown in Figure 4. Pitch may be more important than other cues in BM and TM1 perception. To give a definite answer, a perception study is needed.

5.2.3 Formant frequency

F1 and F2 values between clear vowels and breathy vowels do not show any systematic differences. The vowel quality of most clear vowels is similar to that of breathy vowels. Vowel quality cannot indicate whether breathy vowels are more close or more open, more front or more back or more centralised (Shorto, 1966) than clear vowels. Neither raising the larynx versus lowering the larynx (Thurgood, 2000) nor tongue-root retraction versus tongue-root advancement (Gregerson, 1976) has been found to be a primary exponent of register contrast in TM and BM.

Nonetheless, the limitations of acoustic measurement at 50% in steady state of vowels may not appropriately demonstrate the real characteristics of vowels in BM. Many on-gliding and off-gliding vowels are found in BM, while the vowel characteristics are mostly pure in TM, as shown in Figure 5.

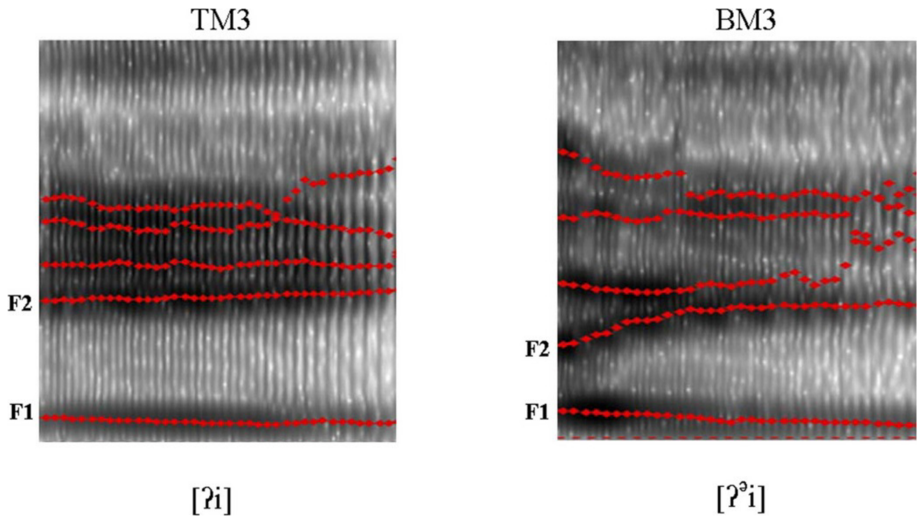

Figure 5: Examples of wide band spectrogram showing F1 and F2 movements in a Thai Mon variety (left) and a Burmese Mon variety (right)

Figure 5 shows F1 and F2 values at the beginning of the vowel for the word /həʔi/ ‘cucumber’ – for TM they are static, while those of BM are dynamic, especially F2 values. This reflects tongue movement from the centre of vowel area towards the front, for example [əi] occurring in BM varieties.

On-gliding and off-gliding appear with both clear vowels and breathy vowels. This finding differs to the viewpoint of Thurgood (2000) which speculates that clear vowels occur with off-gliding and breathy vowels with on-gliding. This findings discussed in this paper suggest that voice quality and vowel quality correlation do occur in BM, affecting vowel characteristics and possibly increasing the number of vowel phonemes. In this way, BM varieties could become restructured.

5.2.4 Duration

Breathy vowels can be perceived as longer than clear ones although Mon has no vowel length distinction. However, duration of most clear vowels and breathy vowels in this study are not significantly different which differs from the finding of Lee (1983). In these varieties, vowel length may not be an important exponent in register complexes but it may in other varieties contribute to indicate the distinction of clear vowels and breathy vowels.

6. Conclusion

Even though it can be said that Mon is a register language which phonation type combines with pitch patterns, vowel quality may also become a prominent component. Obvious pitch patterns in TM and BM varieties could result from internal and external factors. To illustrate pitch per se is one parameter of register complexes. In addition, language contact with Thai and Burmese, a tonal language, could help enhance salience of pitch. However, vowel quality as another parameter of register complexs could also develop and might be a salient parameter like those found in BM varieties. Consequently, TM varieties alone could become tonal while BM varieties may evolve to either a tonal or restructured language. Nevertheless, the perception test might help exhibit an important cue for native speakers in order to determine the tendency of language change in the future.

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BEHR, Narinthorn Sombatnan. 2013. A comparison between the vowel systems and the acoustic characteristics of vowels in Thai Mon and Burmese Mon: a tendency towards different language types. *Mon-Khmer Studies* 42:54-80

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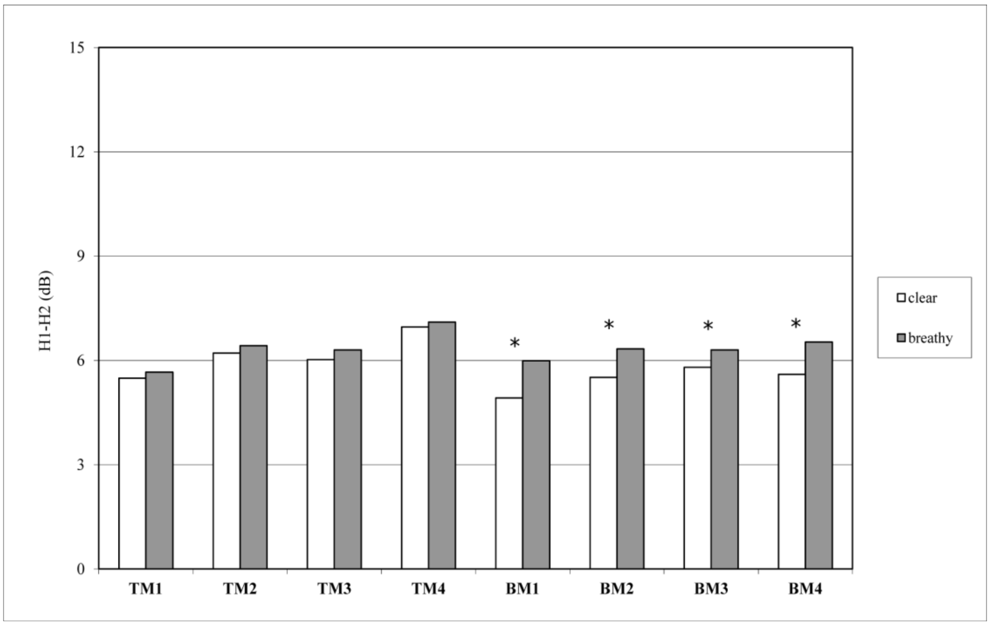
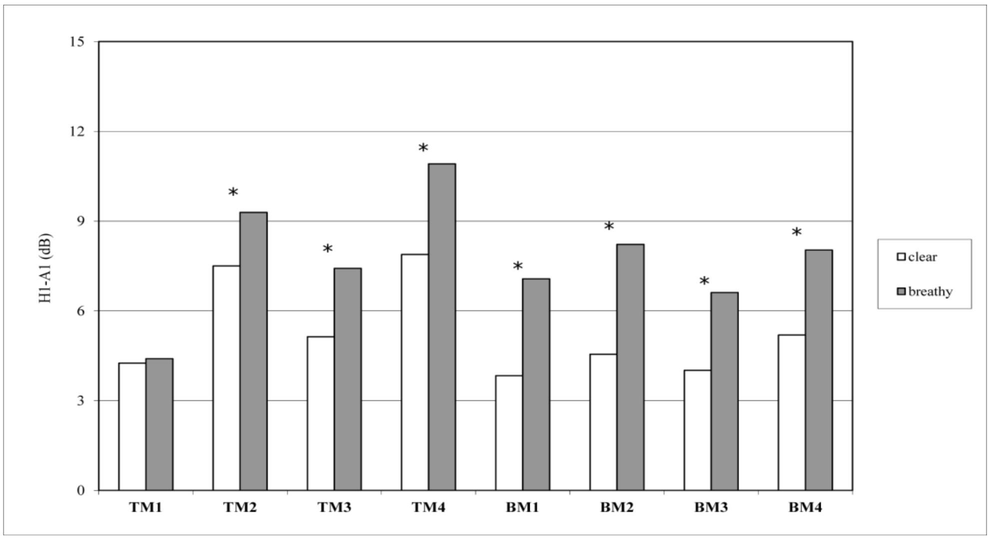
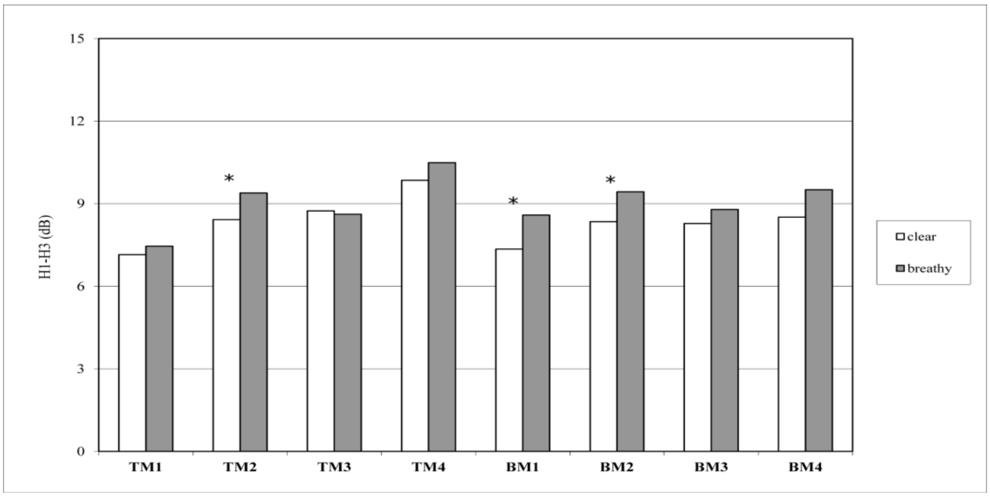
Appendix 1

Mean values of H1-H2, H1-H and, H2-H4 (in dB) at 50% from four Thai Mon and four Burmese Mon varieties with clear vs. breathy vowels. (An asterisk indicates the values that are significantly different.)







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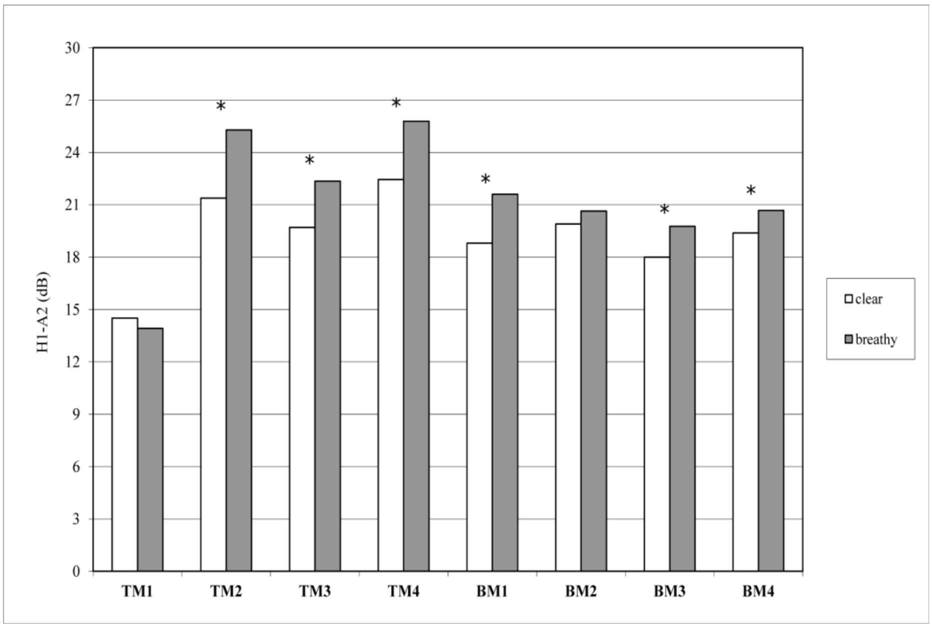
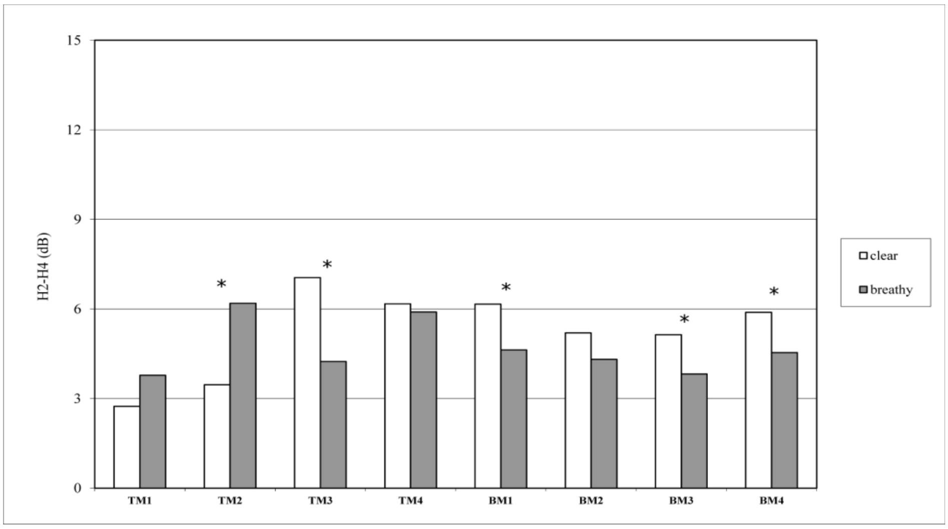
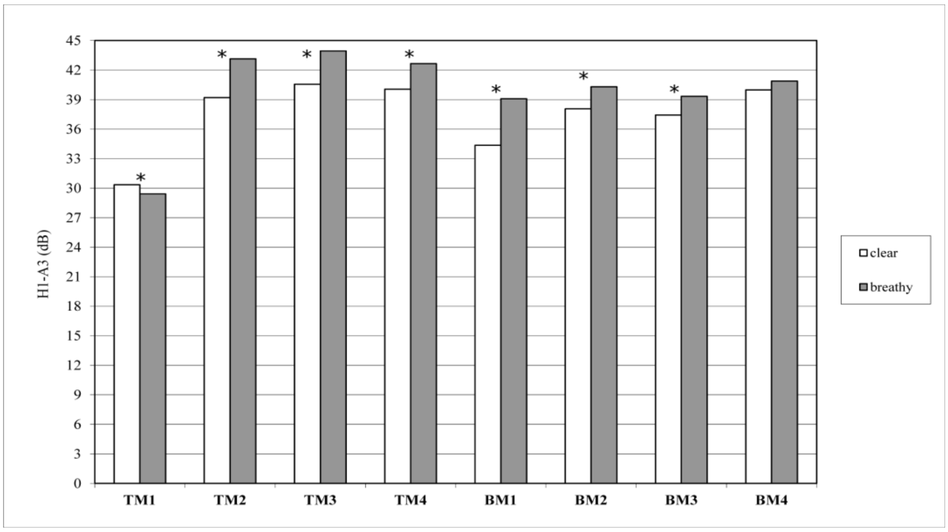
Mean values of H1-A1, H1-A2 and H1-A3 (in dB) at 50% from four Thai Mon and four Burmese Mon varieties with clear vs. breathy vowels. (An asterisk indicates the values that are significantly different.)







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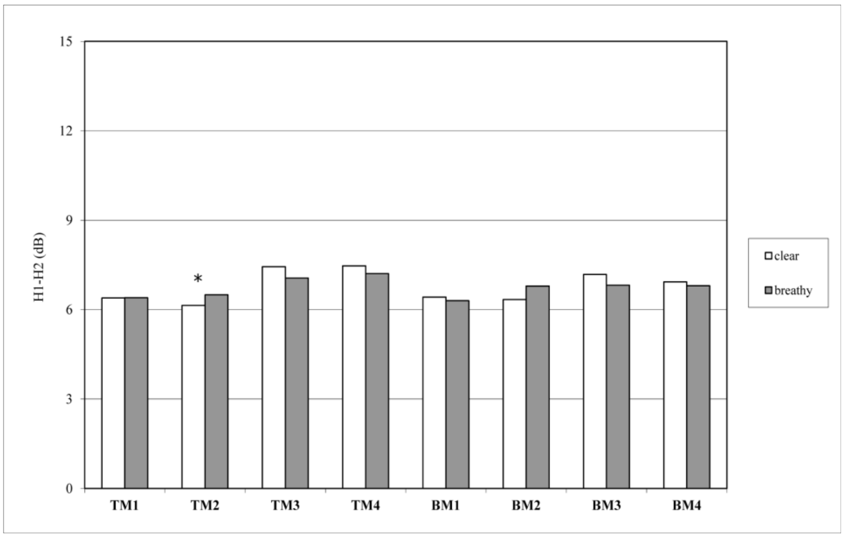
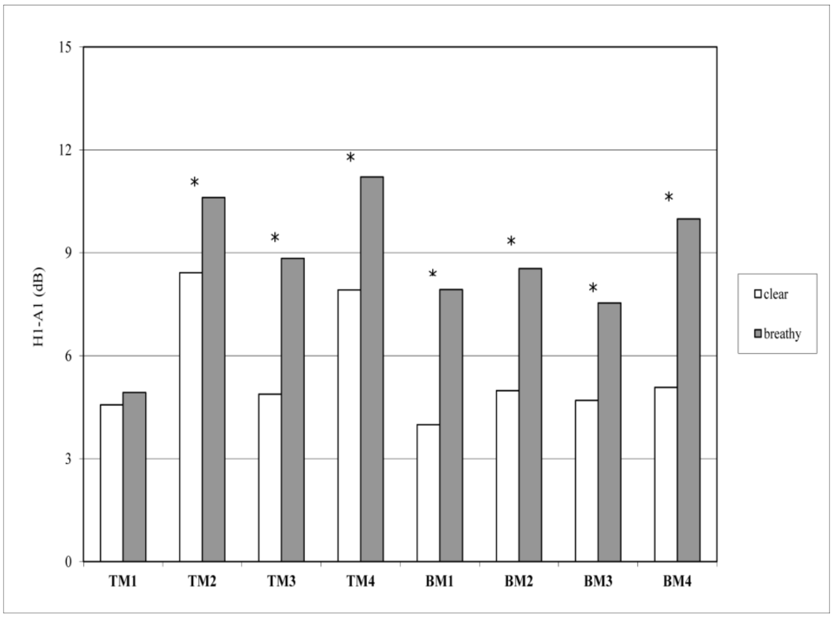
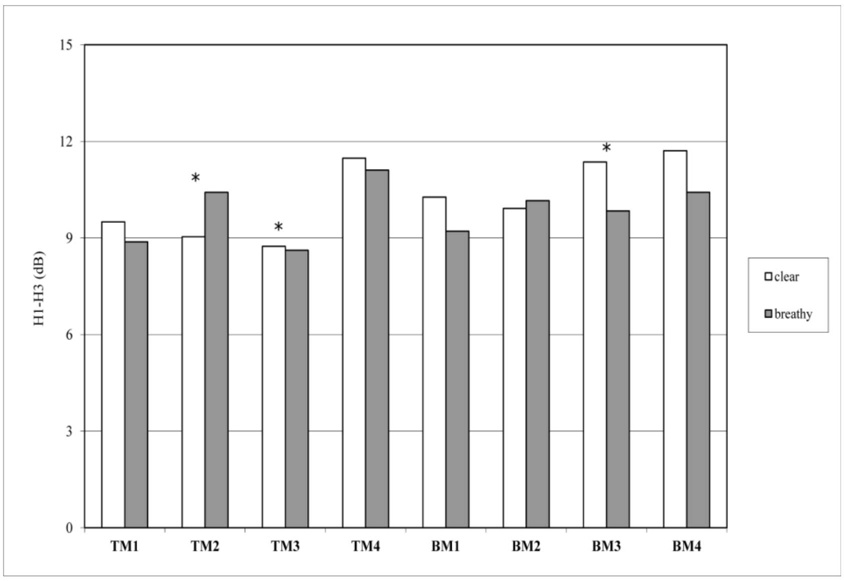
Mean values of H1-H2, H1-H3 and H2-H4 (in dB) at 75% from four Thai Mon and four Burmese Mon varieties with clear vs. breathy vowels. (An asterisk indicates the values that are significantly different.)







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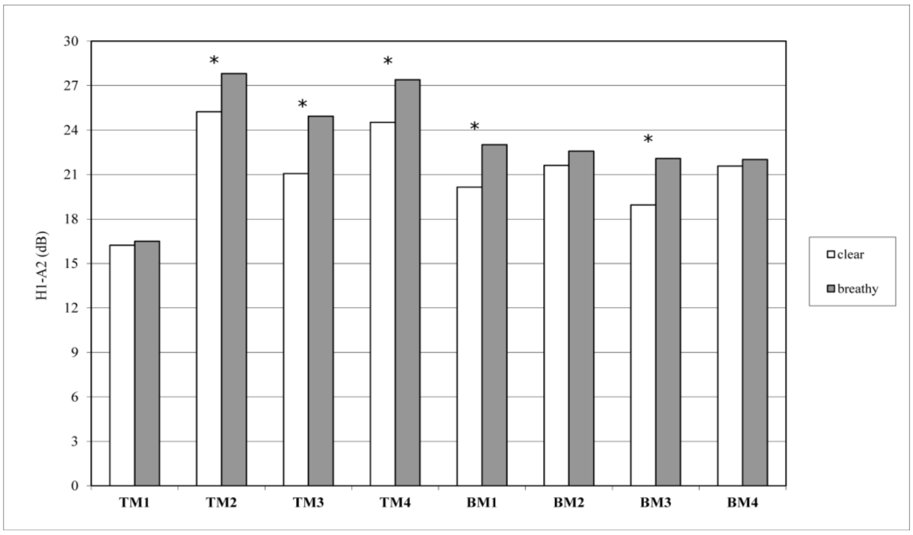
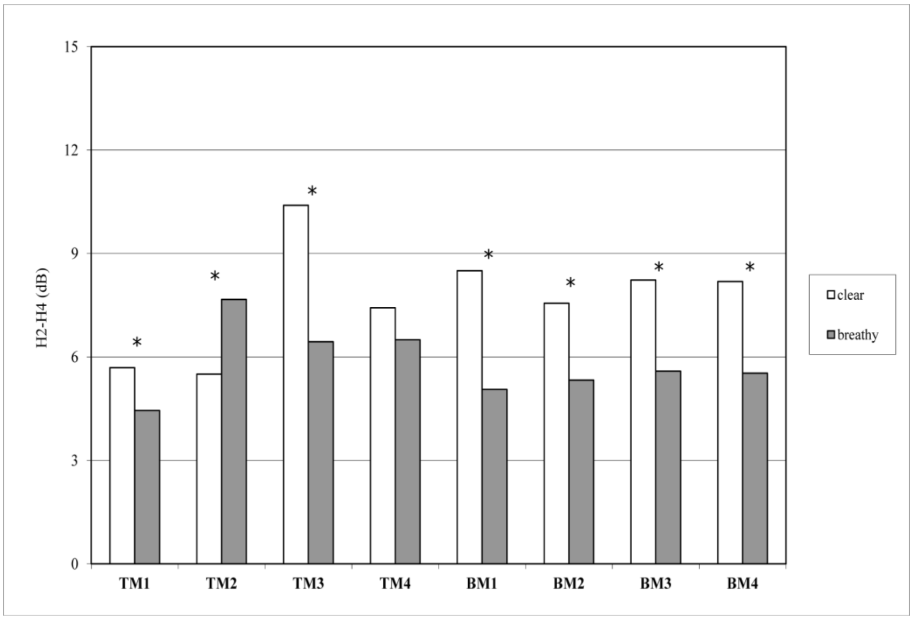
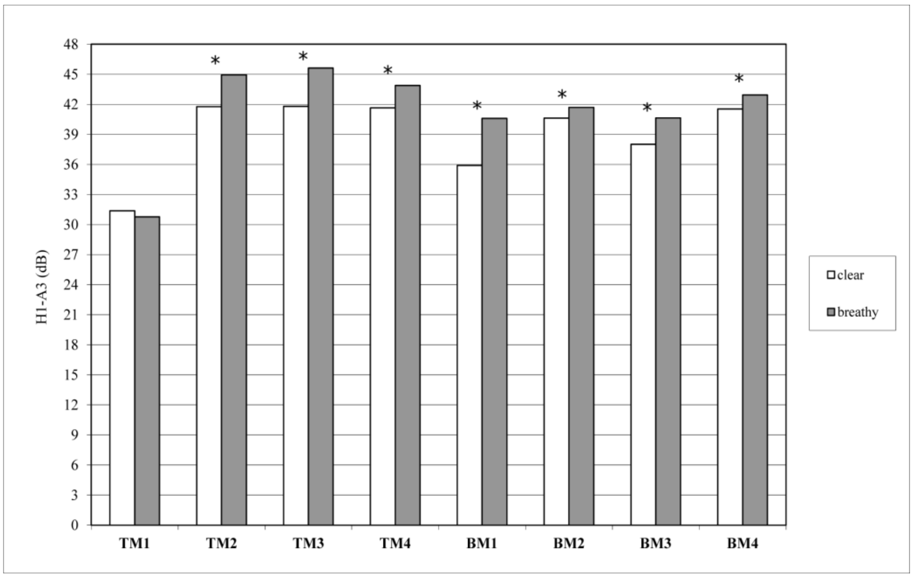
Mean values of H1-A1, H1-A2 and H1-A3 (in dB) at 75% from four Thai Mon and four Burmese Mon varieties with clear vs. breathy vowels. (An asterisk indicates the values that are significantly different.)







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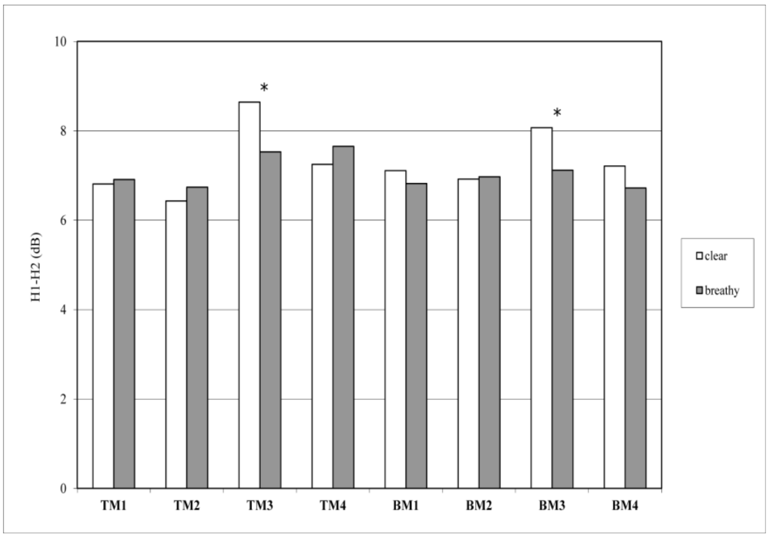
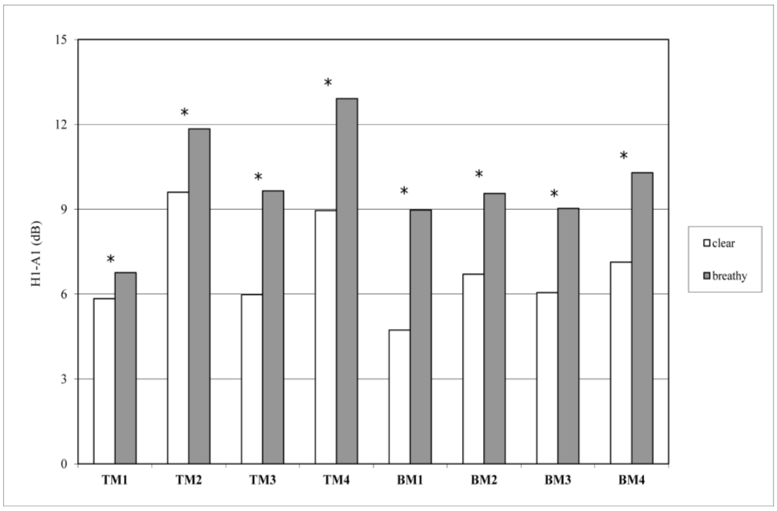
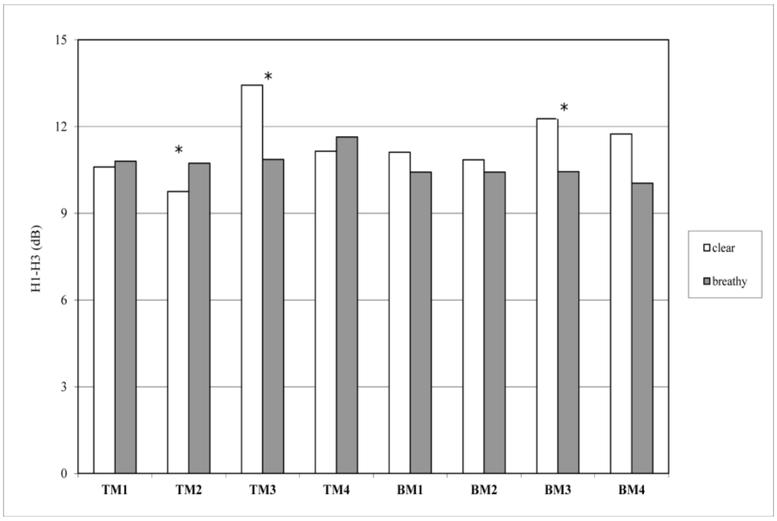
Mean values of H1-H2, H1-H3 and H2-H4 (in dB) 100% from four Thai Mon and four Burmese Mon varieties with clear vs. breathy vowels. (An asterisk indicates the values that are significantly different.)







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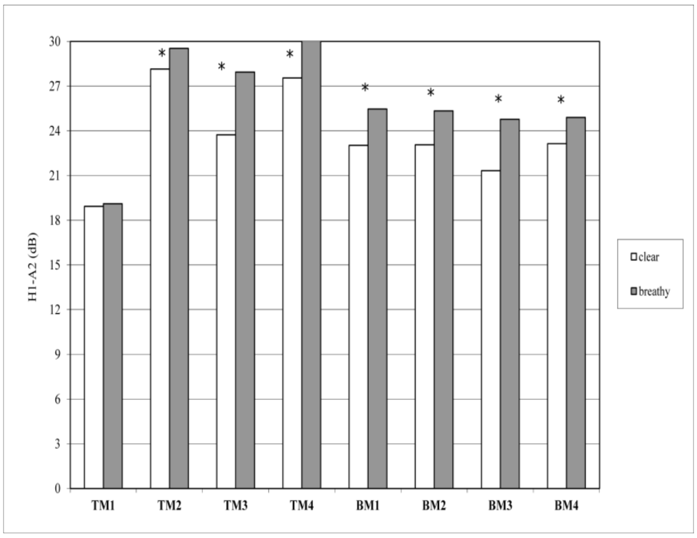
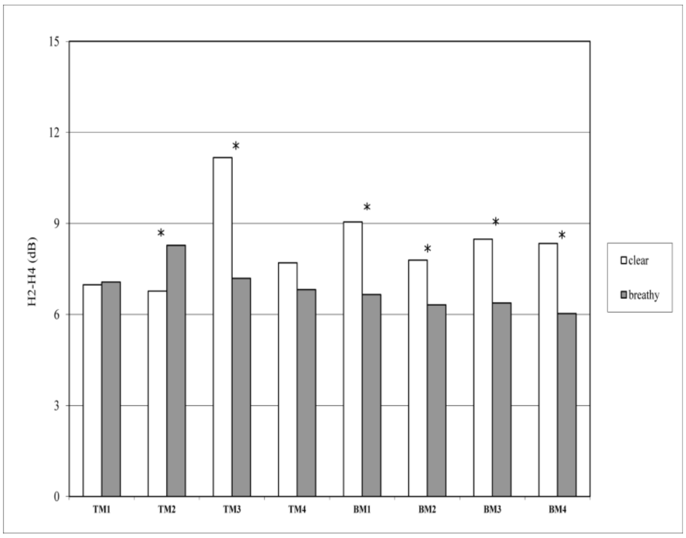
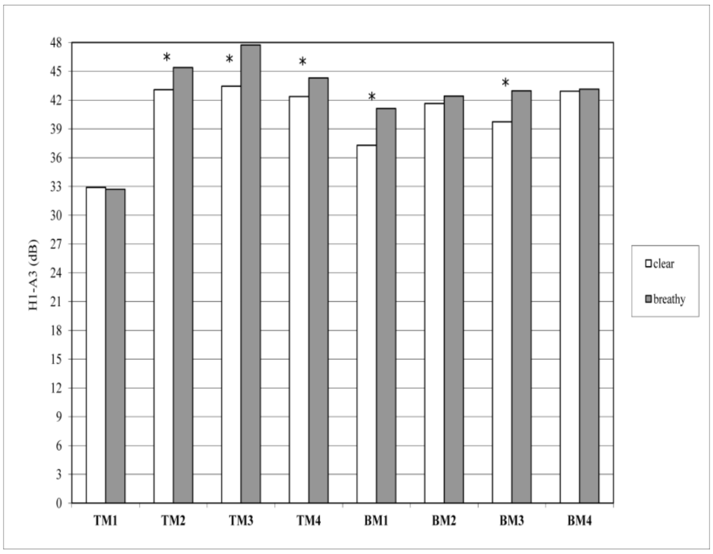
Mean values of H1-A1, H1-A2 and H1-A3 (in dB) 100% from four Thai Mon and four Burmese Mon varieties with clear vs. breathy vowels. (An asterisk indicates the values that are significantly different.)







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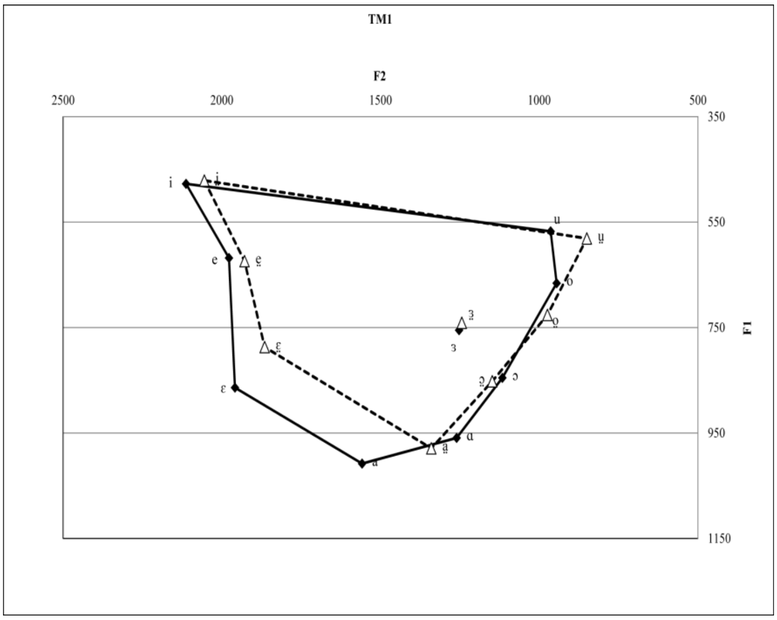
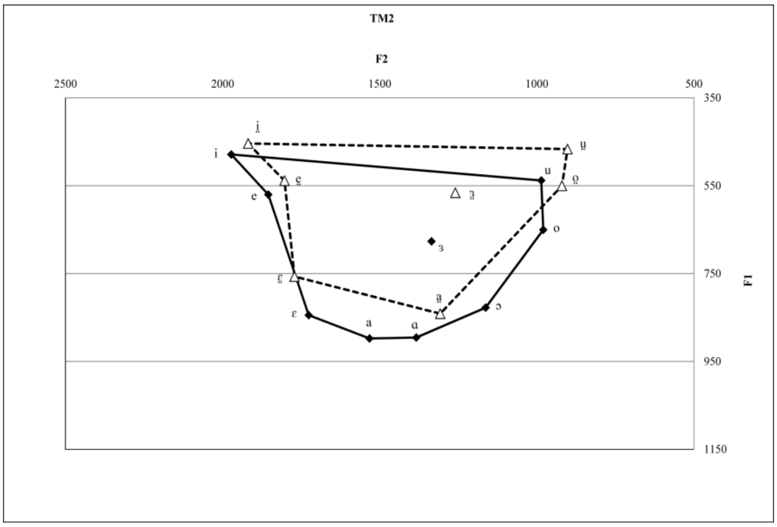
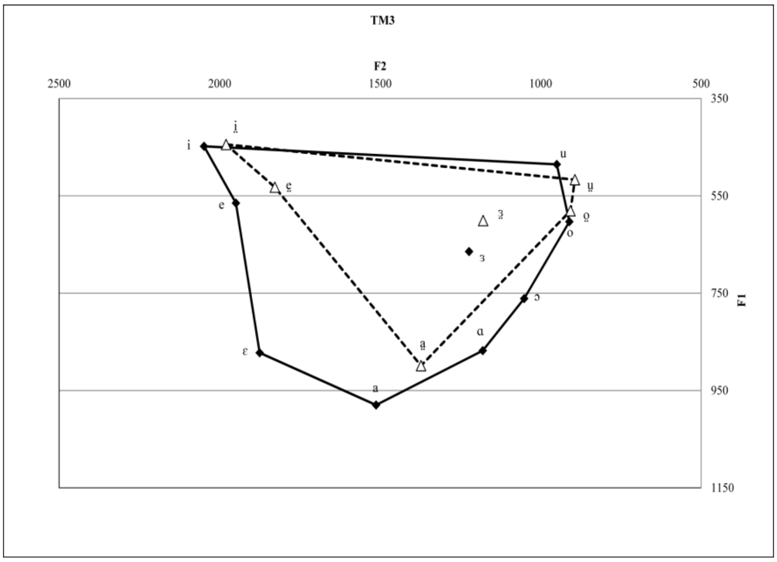
Appendix 2

Vowel space of clear vowels and breathy vowels in four Thai Mon and Burmese Mon varieties







______ clear vowels
------- breathy vowels

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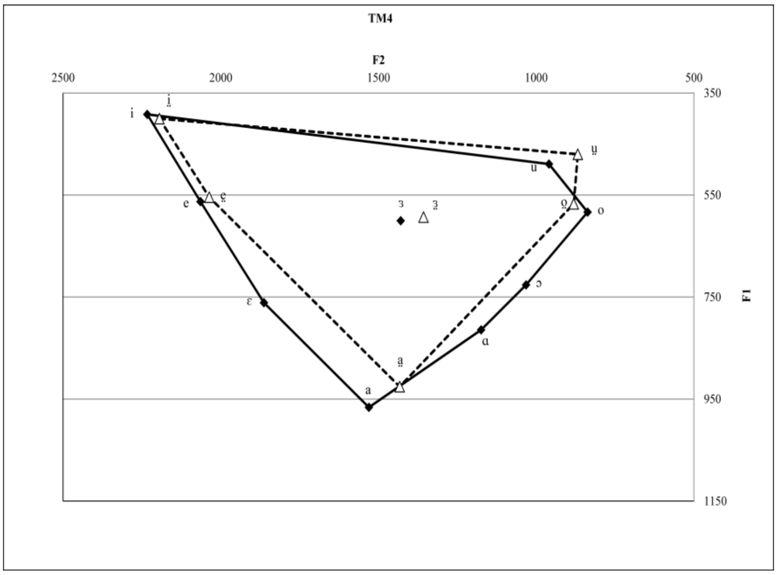

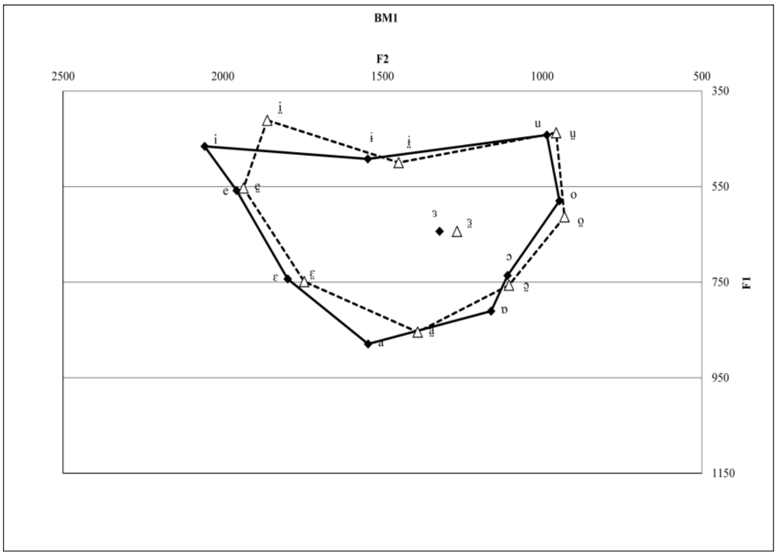

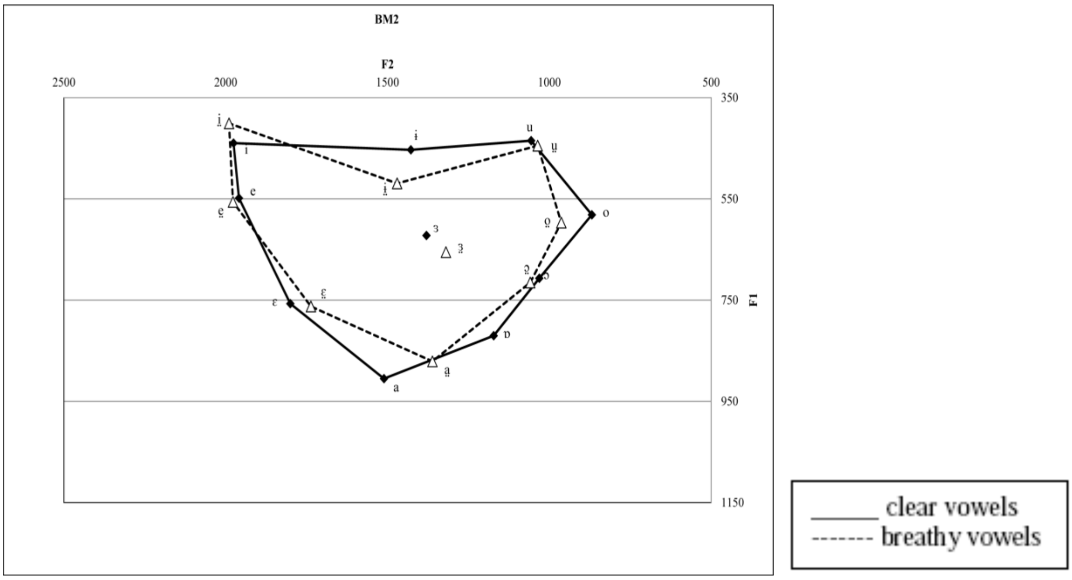

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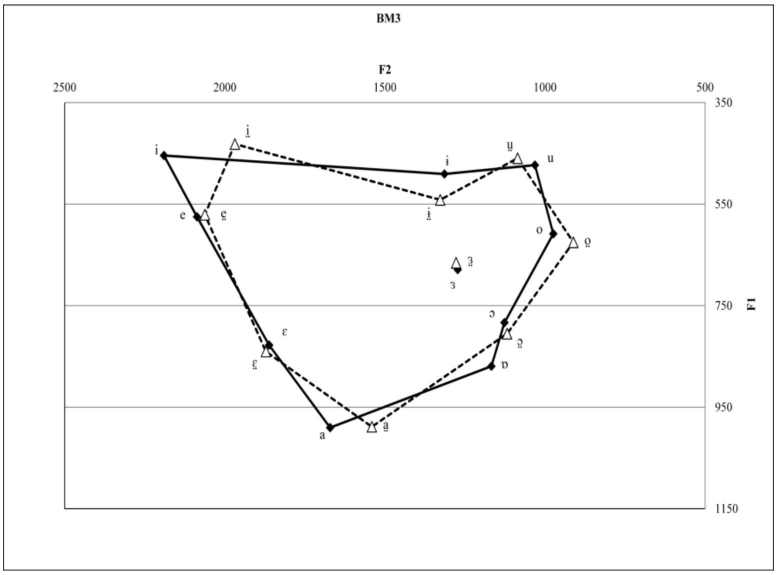

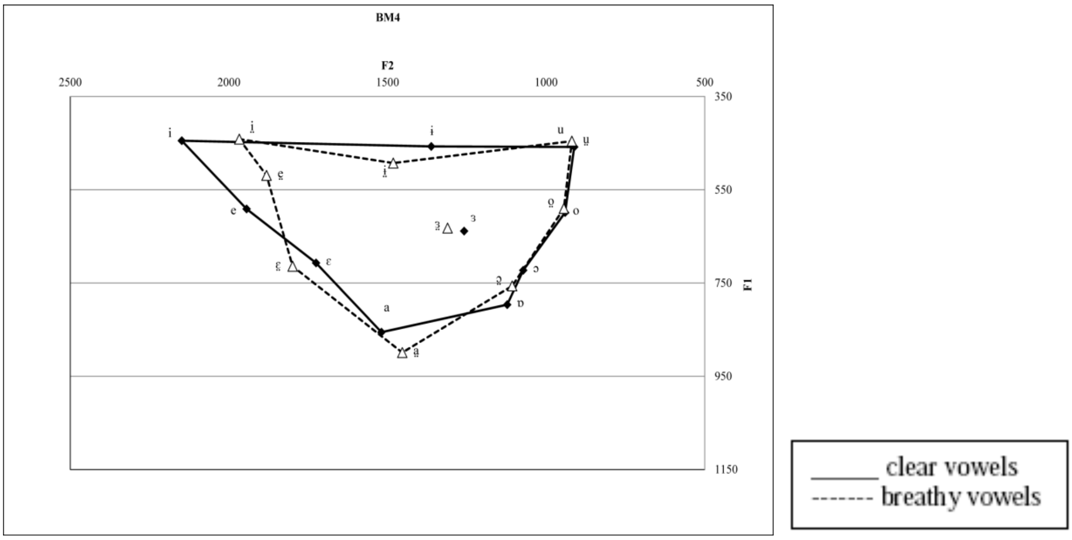

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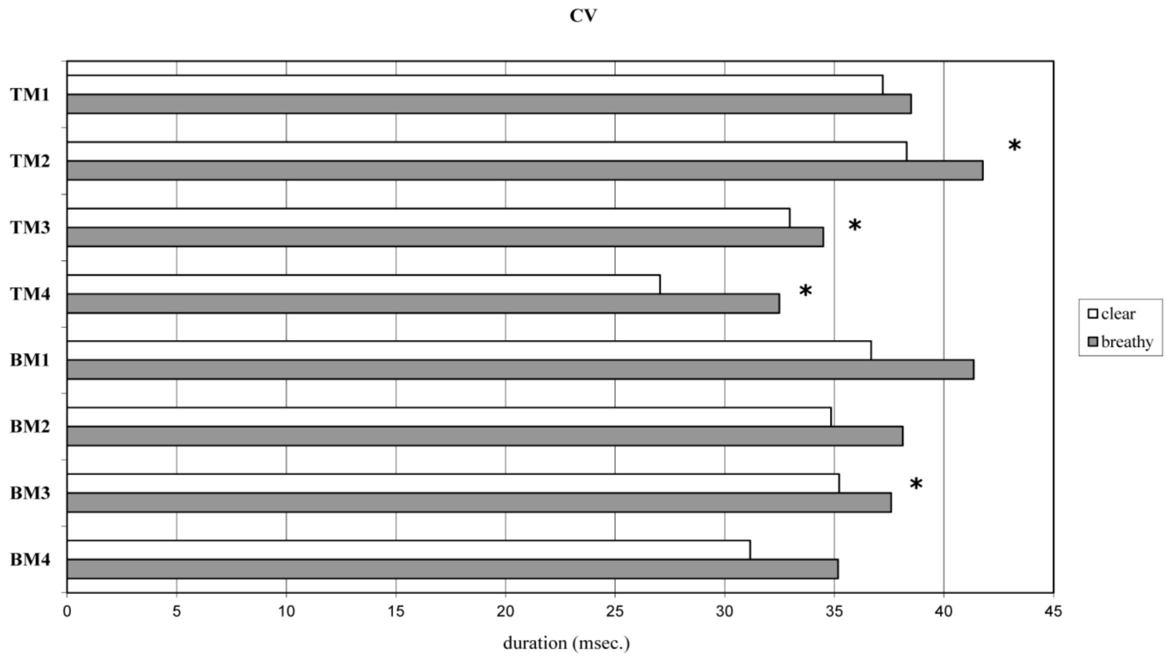
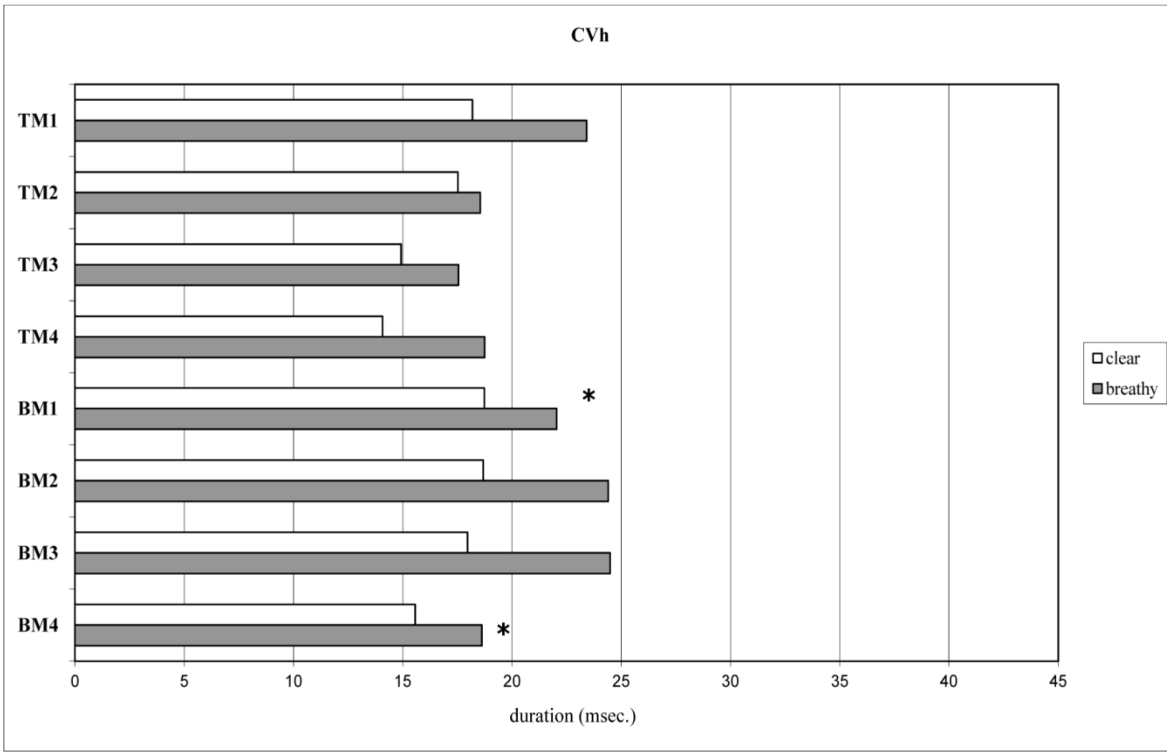
Appendix 3

Duration of clear vowels and breathy vowels in CV, CVh, CVT and CVN syllable types in four Thai Mon varities and four Burmese Mon varieties. (An asterisk indicates the values that are significantly different.)





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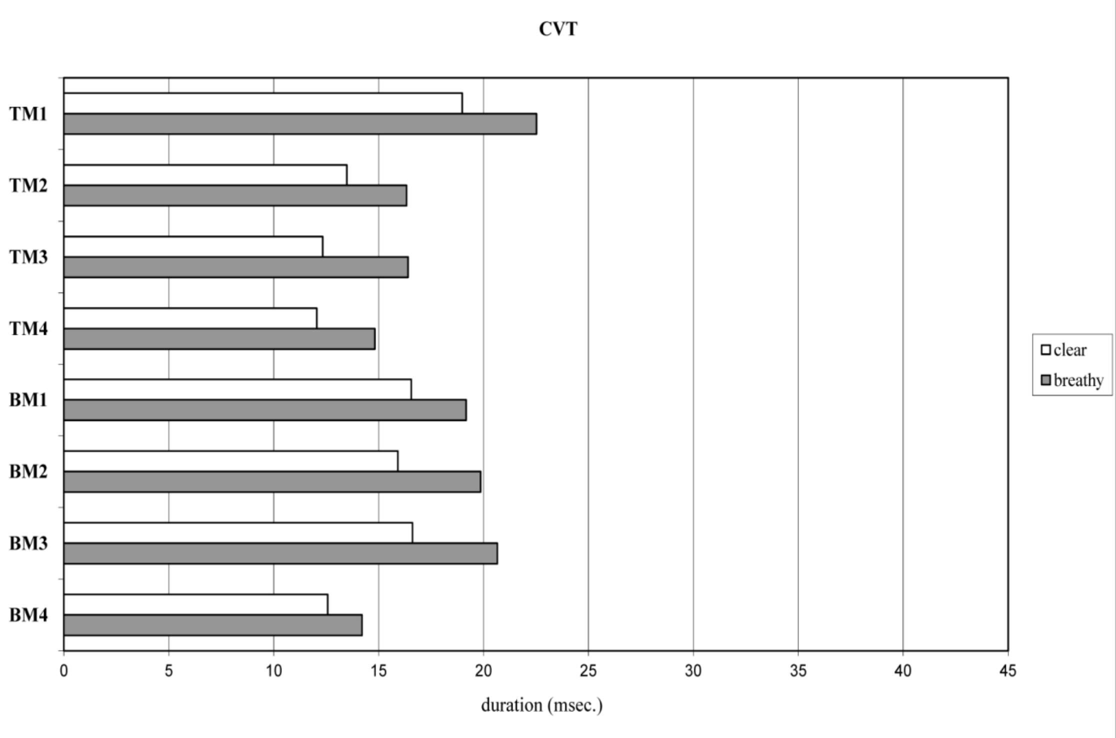

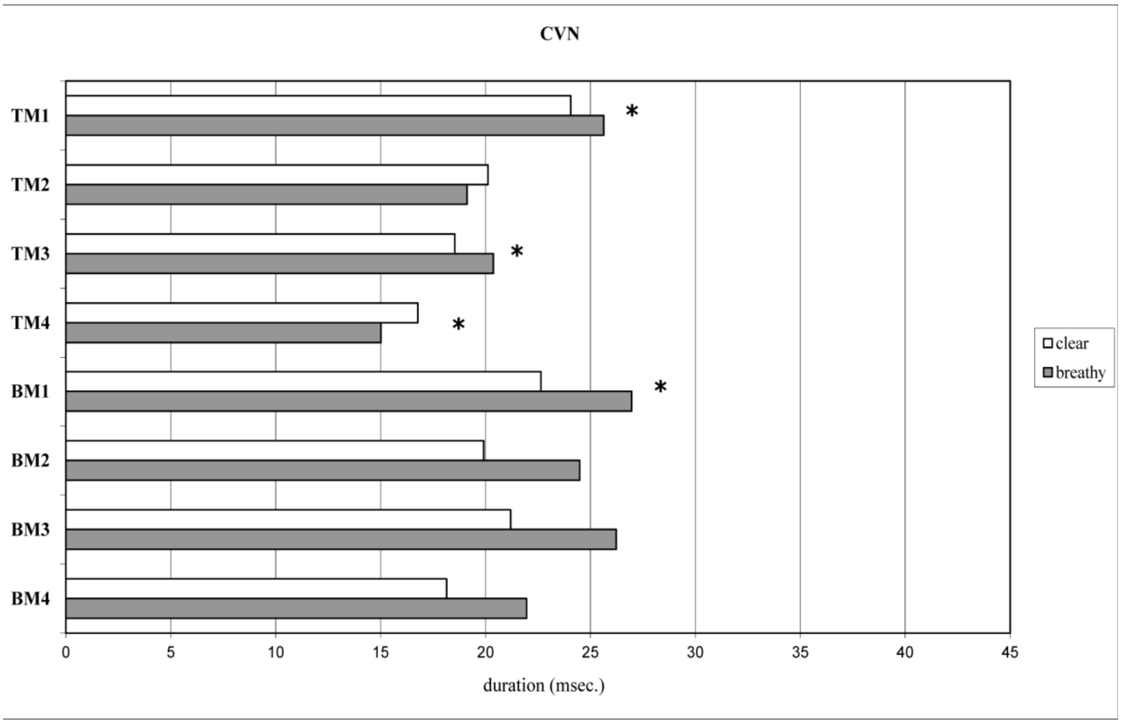

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