A Comparison between the Speech of Brass-coiled Necked and Non-brass-coiled Necked Kayan Speakers: An Acoustic Study

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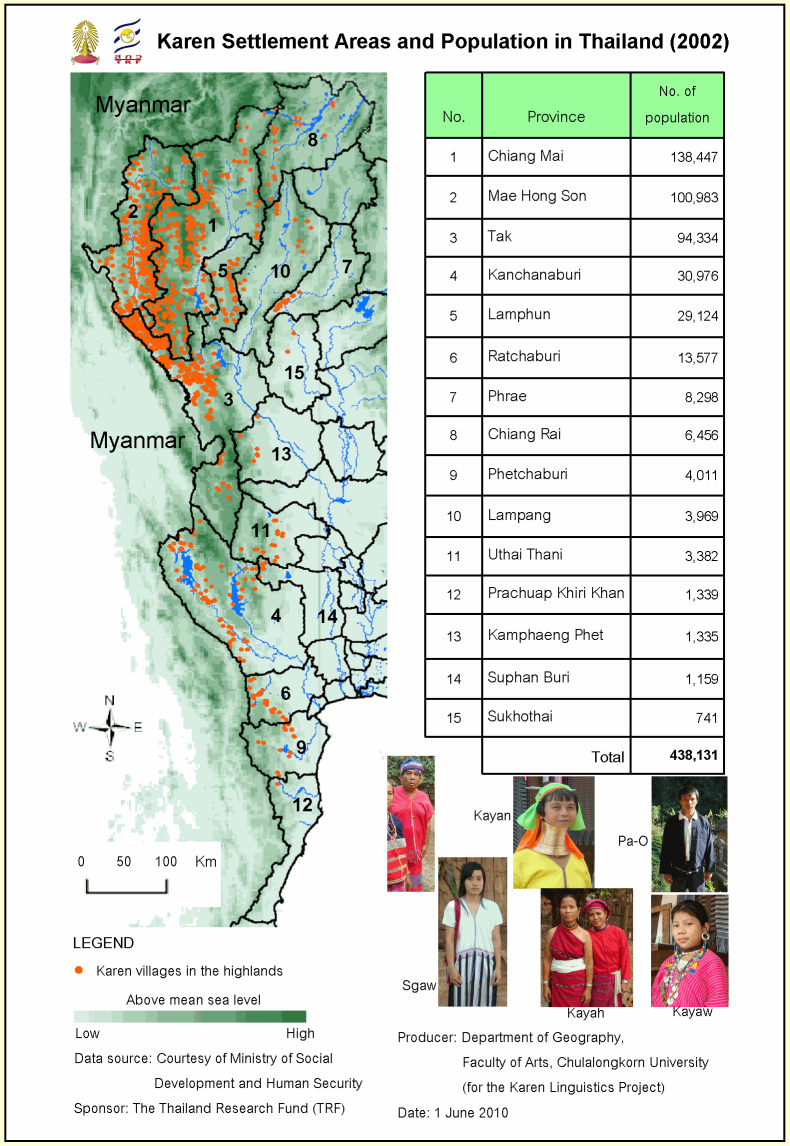
Background (1)

- Sub-project of the “Karen Linguistics Project”
- Three-year project (1 July 2009 – 30 June 2012)
- Supported by the Thailand Research Fund (TRF)

Background (2)



No.	Province	No. of population
1	Chiang Mai	138,447
2	Mae Hong Son	100,983
3	Tak	94,334
4	Kanchanaburi	30,976
5	Lamphun	29,124
6	Ratchaburi	13,577
7	Phrae	8,298
8	Chiang Rai	6,456
9	Phetchaburi	4,011
10	Lampang	3,969
11	Uthai Thani	3,382
12	Prachuap Khiri Khan	1,339
13	Kamphaeng Phet	1,335
14	Suphan Buri	1,159
15	Sukhothai	741
	Total	438,131

- *Karen population in Thailand:*
  438,131 (Ministry of Social Development and Human Security, 2002)

- *Kayan population in Thailand:*
  500 (Schiesinger,2000)
  2,800 (http://www.joshuaprojectnet/peoples.php?peo3=14250,15-Apr-2010)

- *Total Kayan population (Myanmar & Thailand):*
  60,000 (http://www.joshuaprojectnet/peoples.php?peo3=14250,15-April-2010)
  150,000 (Manson, 2007)
  85,000 (Bradley, 1997)
  41,080 (http://www.ethnologue.com/show language.asp?code=pdu,30-April-2010)

Figure 1 Karen settlements in Thailand (6 sub-groups)

Background (3)

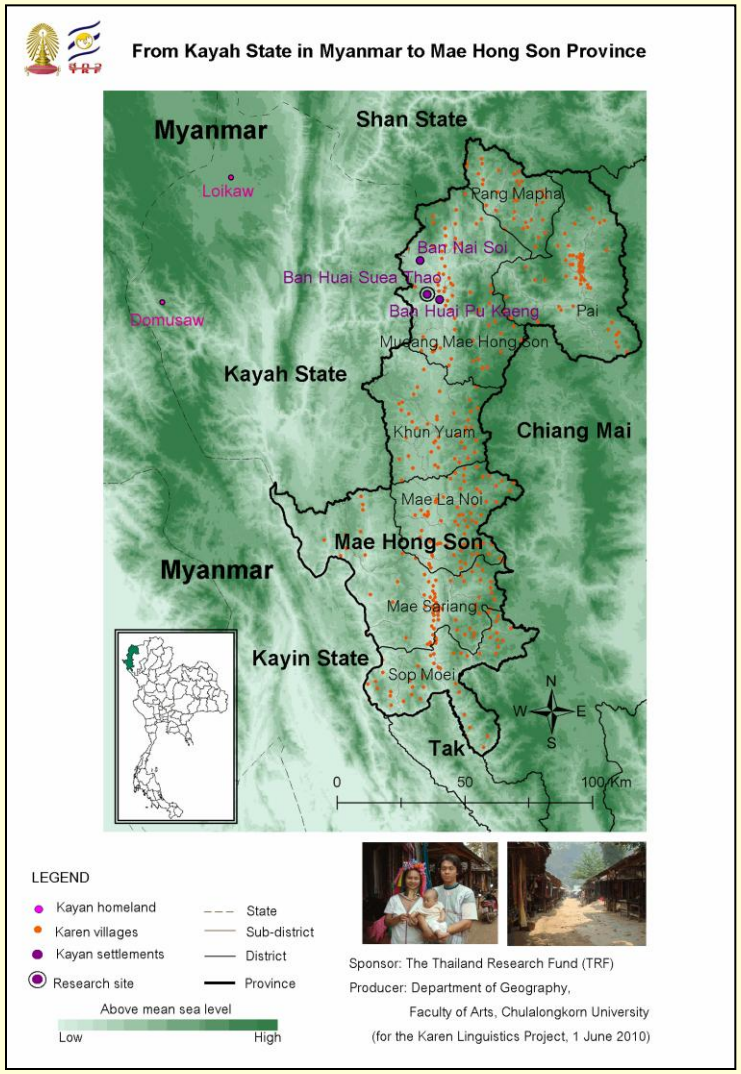


Figure 2 Migration from the Kayah (Karenni) State of Myanmar to the province of Mae Hong Son,Thailand

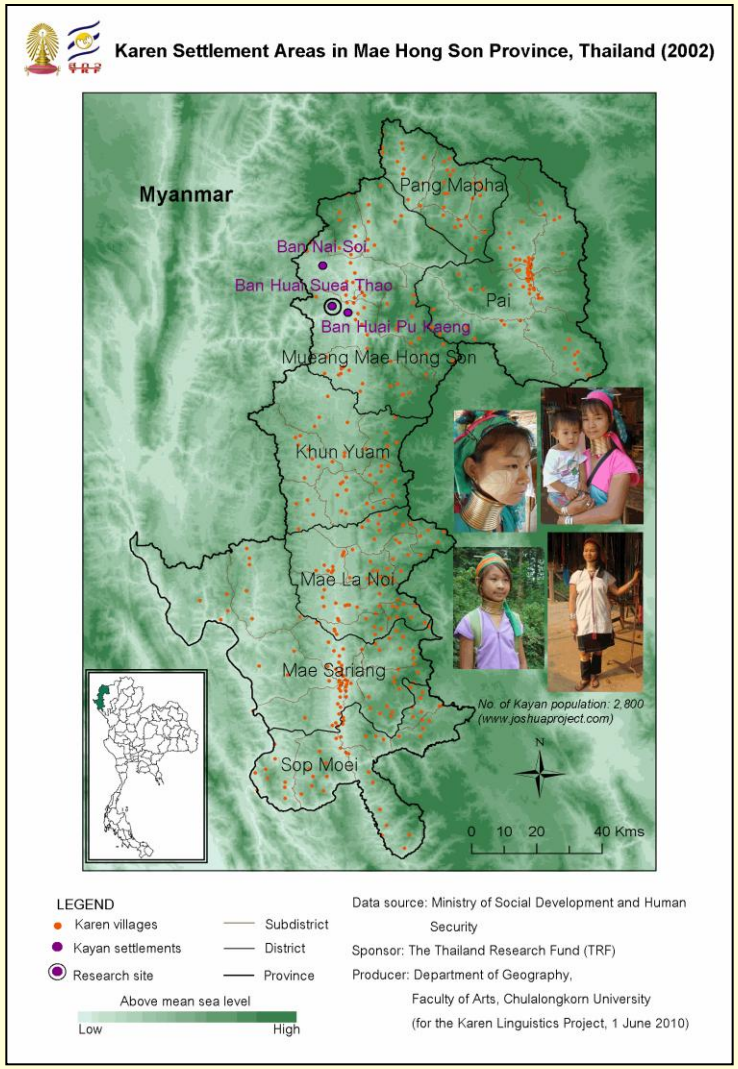


Figure 3 Area of habitation of the Kakhoun Kayan in Mae Hong Son province

Background (4)

- *Alternate names:* Kayang, Padaung (Padong), Kakaung (Kakhoun, Kakhon), Lae Kur (Lae Khoe), Long-neck people, Long-necked Karen

- *Linguistic classification:* Sino-Tibetan, Tibeto-Burman, Karenic

- *Kayan sub-groups in Myanmar:* Latha, Kakhoun (Kakhon), Kakhau (Geker), KaNgan (Yinbaw)

- *Kayan ethnic group in Thailand:* Padaung (Kayang, Kakaung)

Background (5)

More information on their history, clothings, crafts, houses and villages, agriculture and economy, society, myths, beliefs and rituals can be found in Schliesinger (2000), the Illustrated Encyclopedia of mankind (1978), Somsonge Burusphat & Sarinya Khammuang (1998, in Thai) and Somsonge Burusphat (1989, in Thai)

Objectives

- To analyse the acoustic characteristics of Kayan plosives (VOT/ laryngeal timing), vowel quality and length (F1, F2 and duration), tones and their length (F0 and duration of voiced segments)

- To compare the results of the above acoustic studies to help interpret the effects of the brass coils on speech production

Literature review (1)

- Ban Nai Soi Padaung (Long-necked Karen) phonology is studied and described in detail by Sarinya Khammuang (unpublished M.A. thesis, Mahidol University, 1998)

- Pekon Kayan (a variety of standard Kayan) phonology is analysed by Manson (unpublished research reports submitted to Payap University, 2003 and 2007).

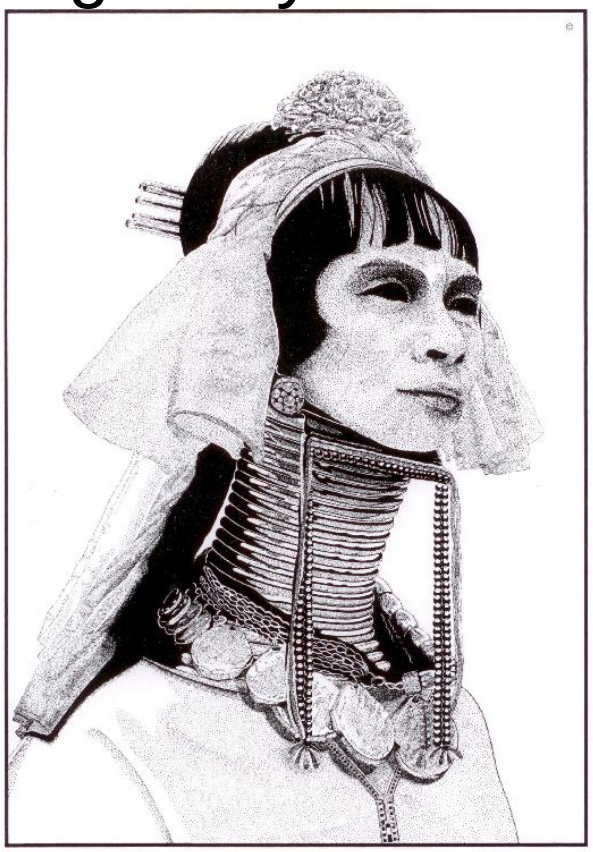
Literature review (2)

- Kayan-English word lists used for their phonological analysis is provided in the appendix of the research reports (Khammuang, 1998; Manson, 2007).

- Kayan-English-Burmese dictionary (KAYAN-ENGLE-KATAN NGO, 136 pp.) is available (Matthias U Shwe, Taunggyi-Myanmar, 1998).

Literature review (3)

- None of the previous research works discusses or mentions about the abnormality or distortion of the speech sounds produced by female Kayan speakers wearing many brass coils around their necks.



Research questions

- Are there any differences between the generalized acoustic characteristics of plosives, vowels and tones produced by brass-coiled necked and non-brass-coiled necked female speakers?

- Does the deformity of the anatomical areas from the mandible to the shoulders of the brass-coiled female speakers cause an abnormal sound production?

Methods (1)

- An English-Thai word list of 1,700 items was devised for data collecting at Huai Suea Thao village.
- Three field trips were conducted in March, May and November altogether about a month in the year 2009.
- Phonological analysis was done to be used as a base for acoustic studies and comparative purposes.

Methods (2)

- After rechecking all data, the other three word lists were devised for analysing tones (16 sets), vowels (22 sets), and plosives (12 sets).
- Six speakers (2 females with brass coils, 2 females without brass coils, and 2 males, 25-32 years old) were trained to perform properly before and during the recordings.

Methods (3)

- Each set of tones, vowels, and plosives were recorded 3 times to be used as the test tokens for acoustical measurements.
- The citation forms of 343 words produced with moderate speed were directly recorded onto a portable computer using a high-quality microphone and Adobe Audition version 3 with the sample rate: 16,000 Hz (mono 16-bit)

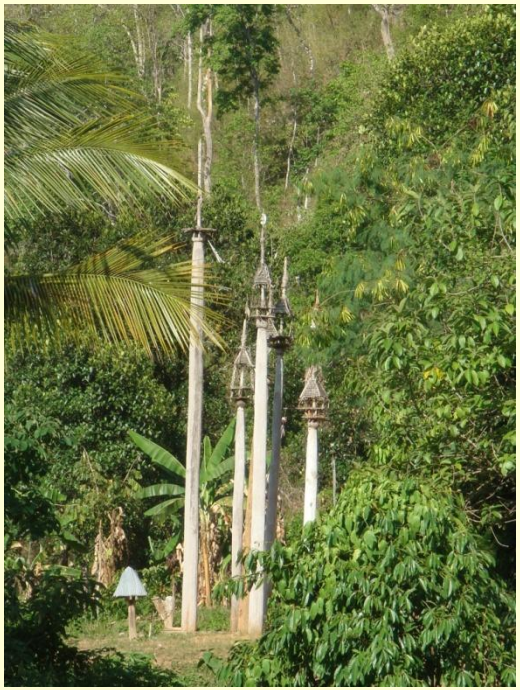
Methods (4)

- The 6,174 test tokens (343 words x 3 times x 6 speakers) were acoustically analysed using PRAAT version 4.5.06 and in some cases statistically tested (ANOVA, $F < .05$; t-Test, $p < .05$).
- Microsoft Excel 2007 and extra programmes, i.e. extractFeatures, Vowel plot and Polygon were used for calculating and plotting.

Methods (5)

- When plotting the acoustic characteristics of the 6 tones, the average F0 values were converted to semitone values:

$$\text{Semitone} = 3.32 \times 12 \times \text{LOG}\left(\frac{\text{Hz to be translated}}{\text{Hz reference level}}\right)$$



Methods (6)

- The results of the acoustical measurements (F0, F1-F2, duration, VOT) of each speaker were shown in tables and graphs.
- An interpretation of the acoustical findings and a physiological explanation of sound production was attempted to provide some suggestions for future research.

Results (1)

- The Kayan dialect spoken at Huai Suea Thao is different from the ones studied by Manson (2003, 2007) and compiled in the Kayan-English-Burmese Dictionary (1998).

Results (2)

A sketch of Huai Suea Thao Kayan phonology:

- *64 initial consonants:*

  p t c k ʔ ph th ch kh b d ɟ g m n ŋ θ h r l j

  pr kr phr khr pl kl phl khl bl

  pw phw bw tw thw dw cw chw ɟw kw khw gw ʔw mw nw ŋw θw hw rw lw

  pj phj bj tj thj dj cj chj kj khj ʔj mj ŋj lj

Results (3)

- 2 final consonants: ʔ ŋ
- 13 vowels: i e ɛ ɨ ə a u o ɔ əɨ ai au
- 4 tones in CVø and CVŋ syllable-types:
  T1 (mid) T2 (low)
  T3 (high-falling) T4 (mid-falling with glottal constriction in CVø)
- 2 tones in CVʔ syllable-type:

  T5 (high) / allotone of T3 T6 (low) / allotone of T2

Results (4)

- VOT / Laryngeal timing (1)

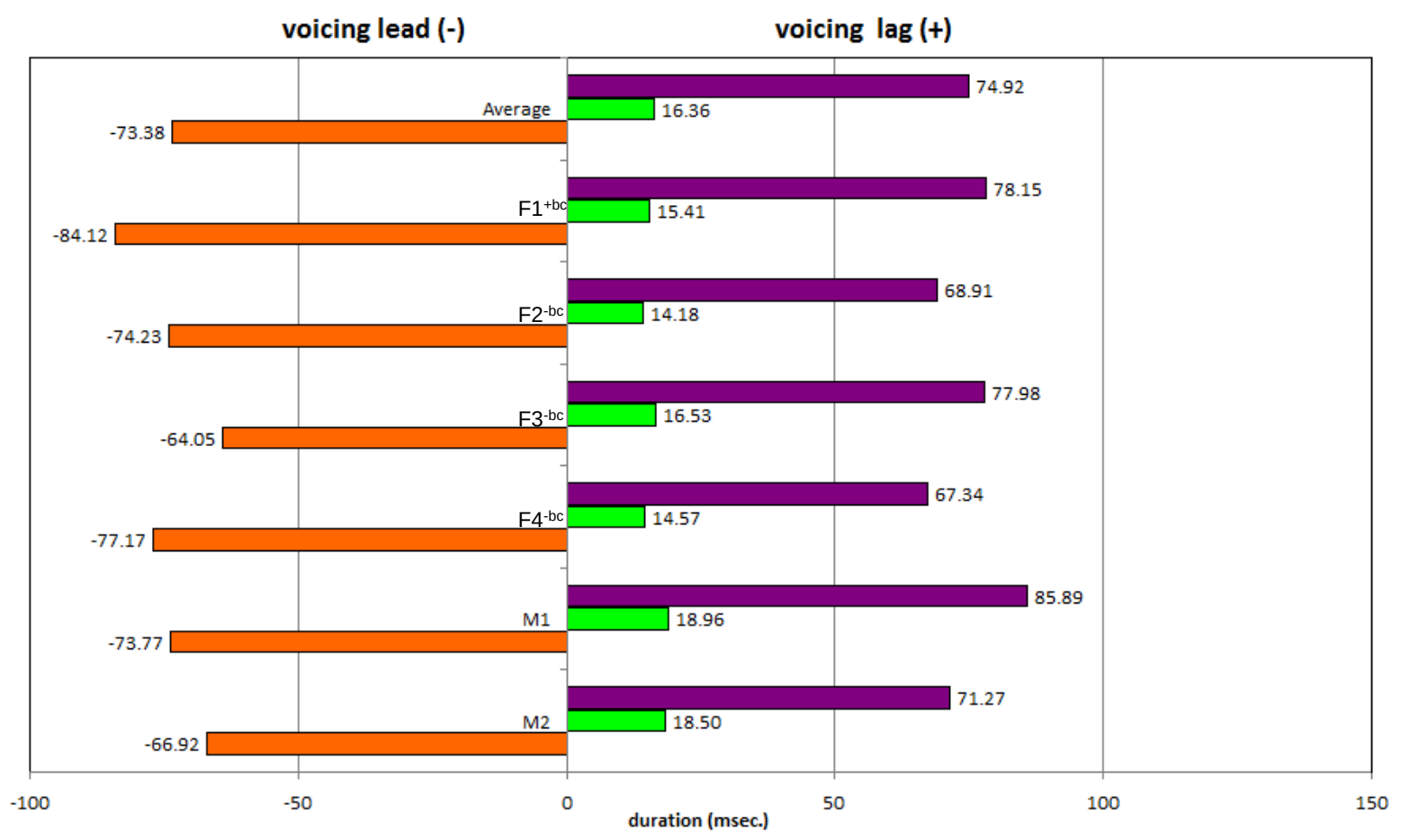


Figure 4 Average VOT values of the plosives of each speaker

b d g p t k ph th kh

Results (5)

- VOT / Laryngeal timing (2)

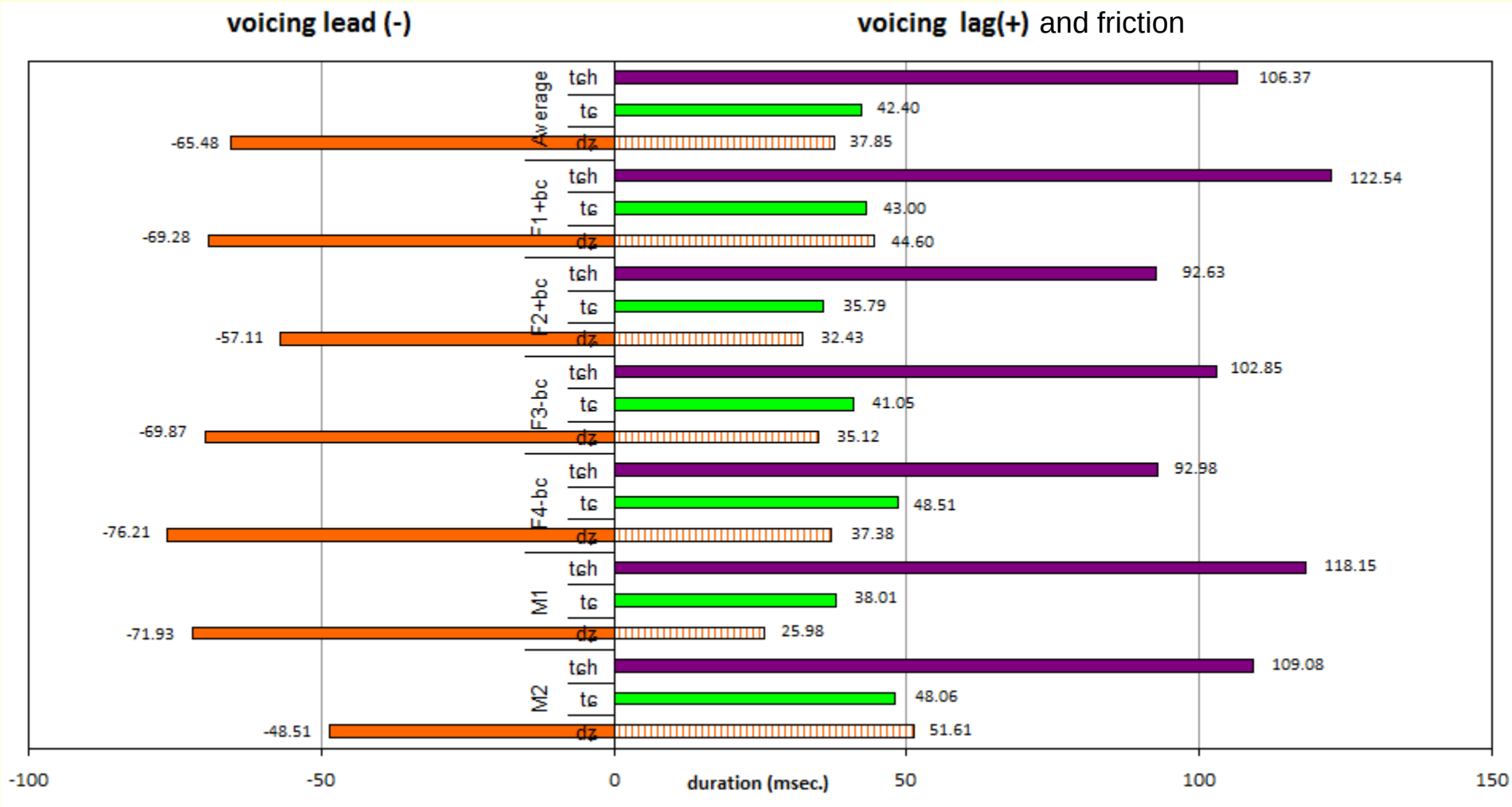


Figure 5 Average VOT values of the affricates of each speaker

ɟ [dʑ] c [tɕ] ch [tɕh]

Results (6)

- VOT / Laryngeal timing (3)

Table 1 Level of difference of the average VOT values of the plosives produced by the three groups of speakers

Speaker / Plosive	A-B	A-C	B-C	A-B&C	A&B-C
Voiced	.009*	.007*	.936	.001*	.099
Voiceless unaspirated	.644	.000*	.001*	.013*	.000*
Voiceless aspirated	.671	.014*	.004*	.226	.001*

* = significant difference (ANOVA, F < .05)

A = $F1^{+bc}$ $F2^{+bc}$ B = $F3^{-bc}$ $F4^{-bc}$ C = M1 M2

Results (7)

- VOT / Laryngeal timing (4)

Table 2 Level of difference of the average voicing-lag values of the voiceless plosives having different places of articulation (six speakers)

Voiceless unaspirated			Voiceless aspirated		
p-t	p-k	t-k	ph-th	ph-kh	th-kh
.770	.000*	.000*	.805	.000*	.000*

* = significant difference (ANOVA, F < .05)

Results (8)

- Tone / Fundamental frequency (F0)

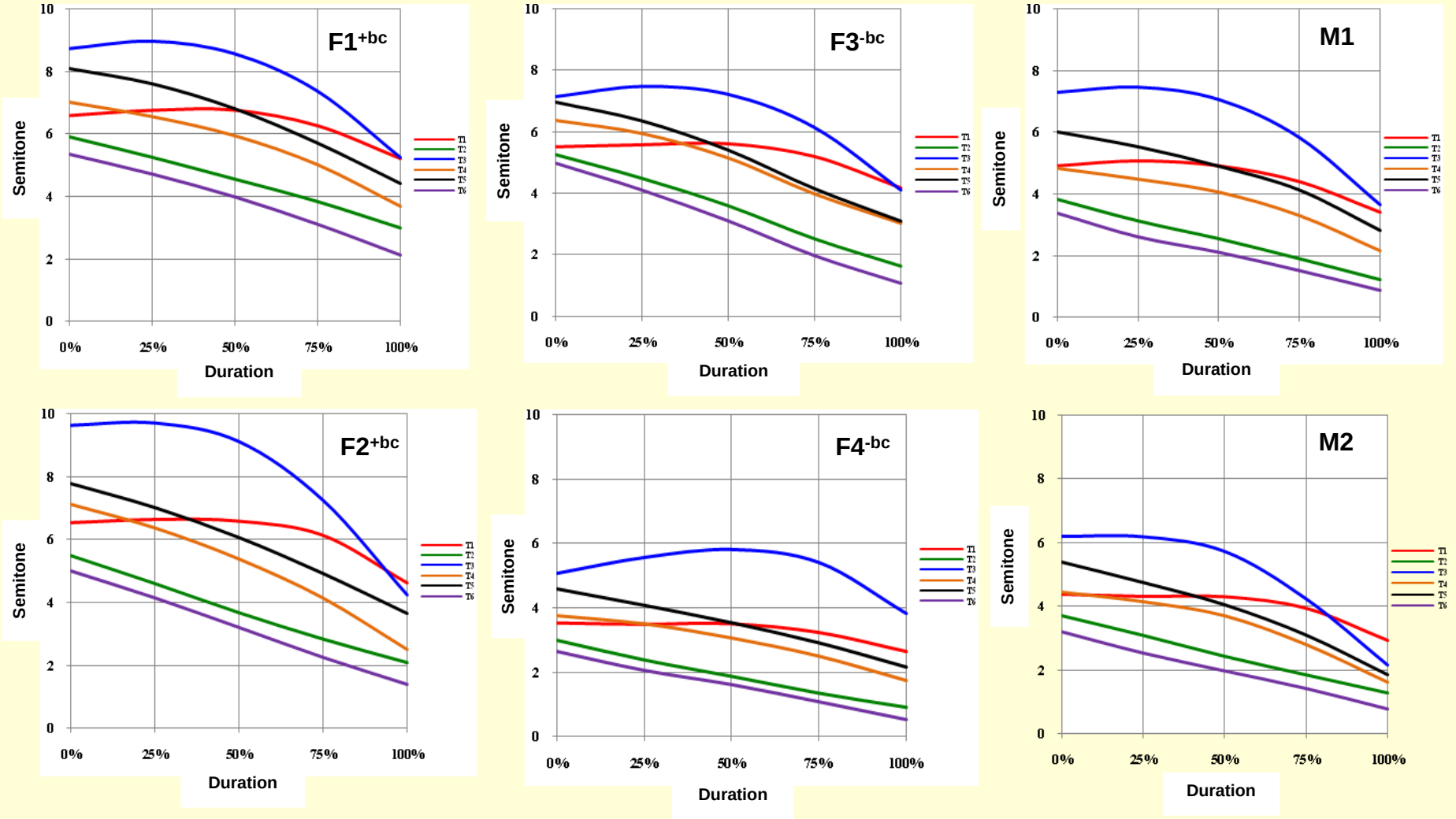


Figure 6 Acoustic characteristics of the tones of each speaker
F = female speaker M = male speaker $^{+bc}$ = with brass coils $^{-bc}$ = without brass coils

Results (9)

- Tone / F0 duration

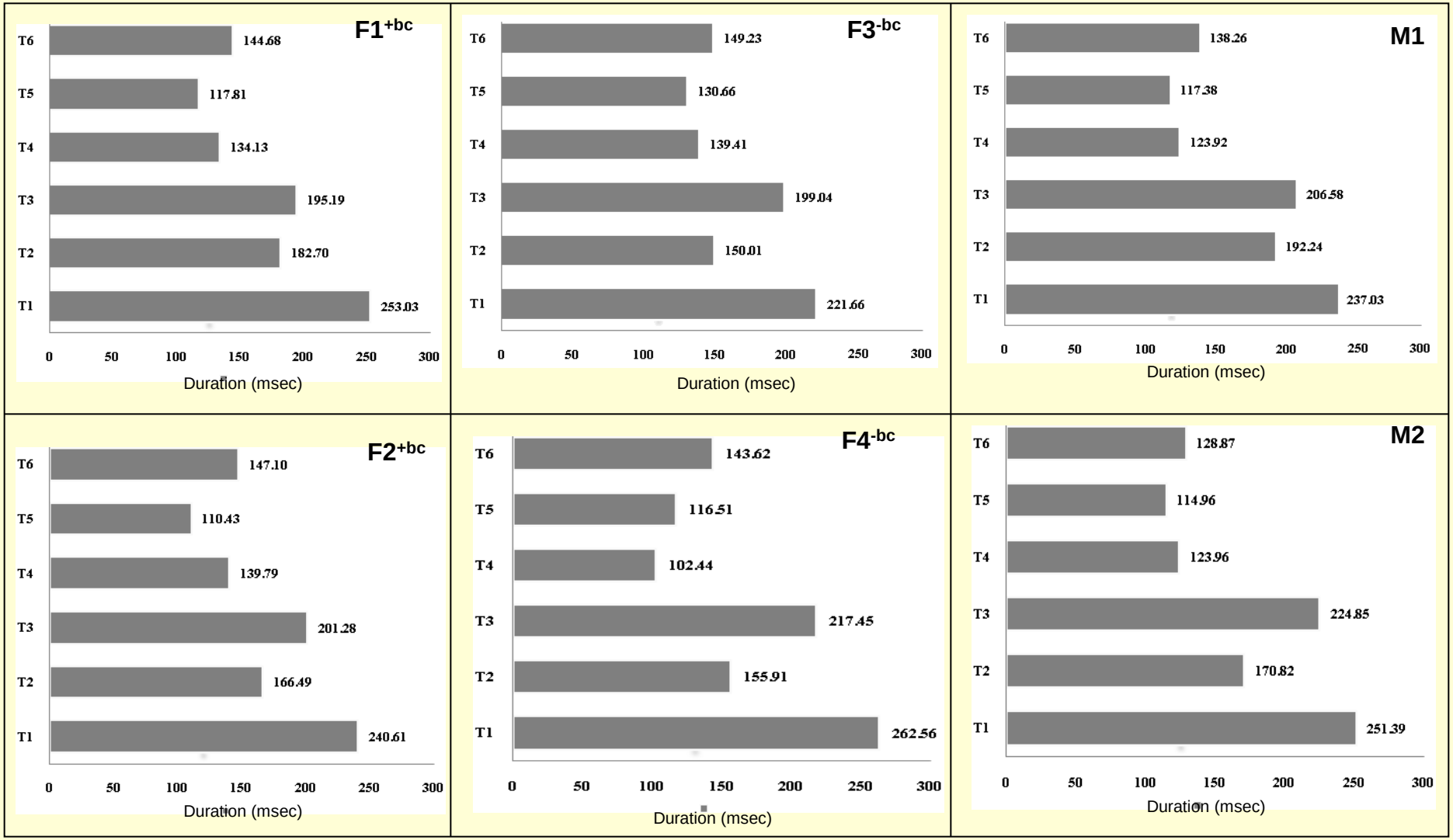
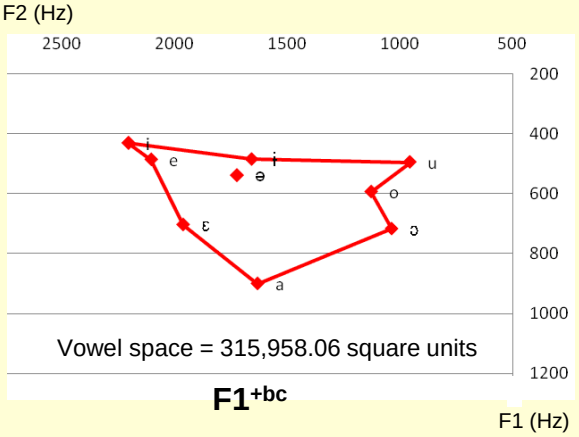
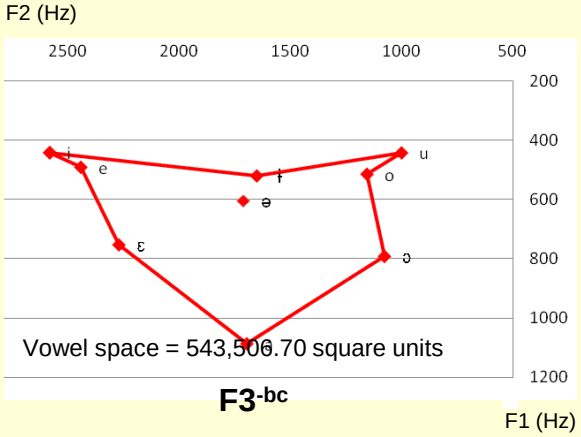
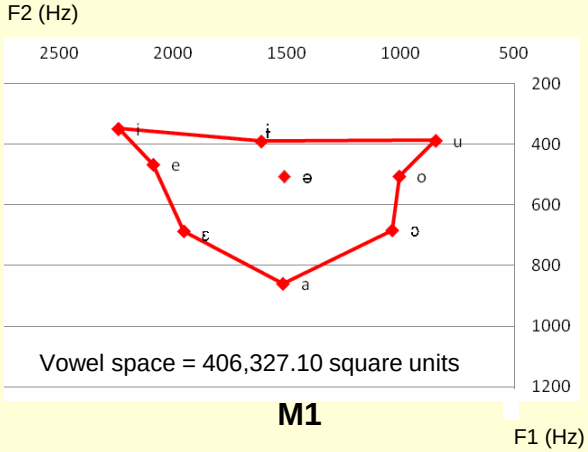


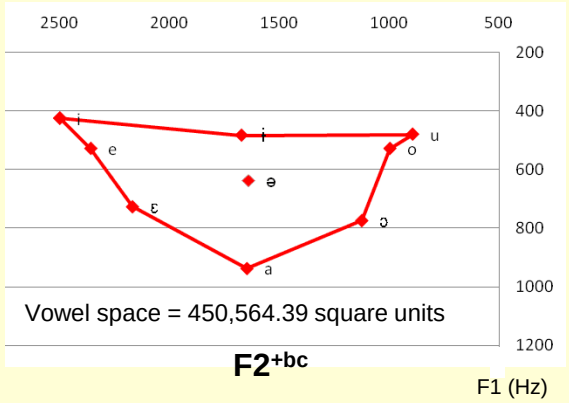
Figure 7 Durations of the tones of each speaker (F = female speaker M = male speaker +bc = with brass coils -bc = without brass coils; T1-T4 in CVø and CVŋ; T5-T6 in CVʔ)

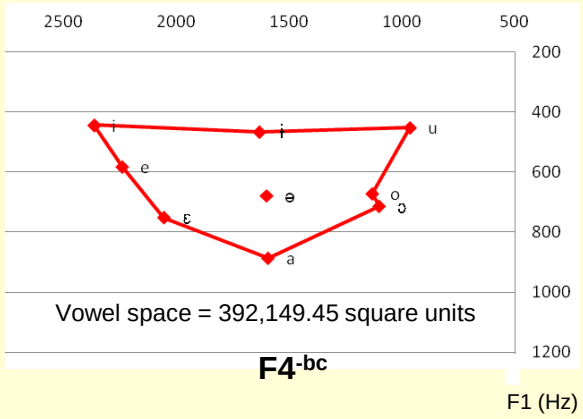
Results (10)











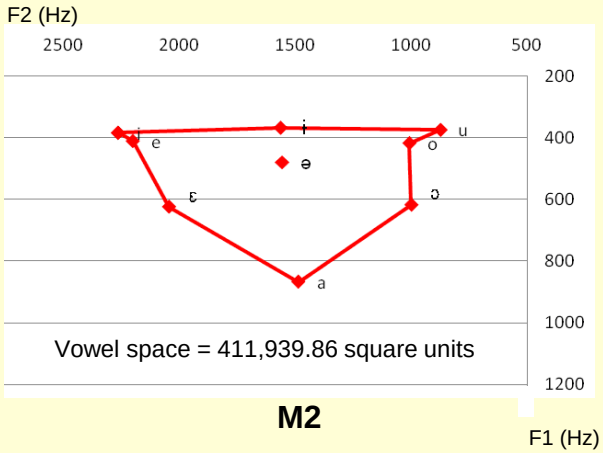
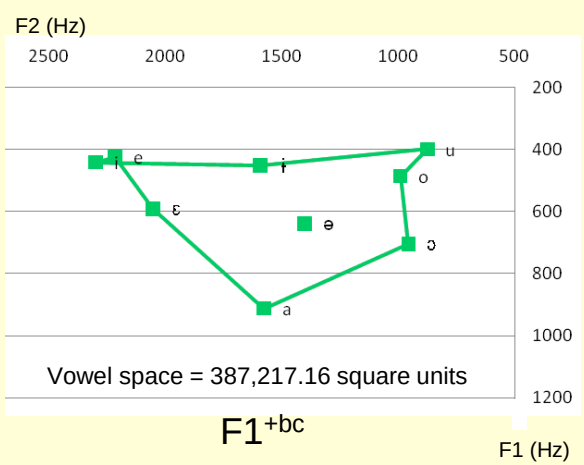


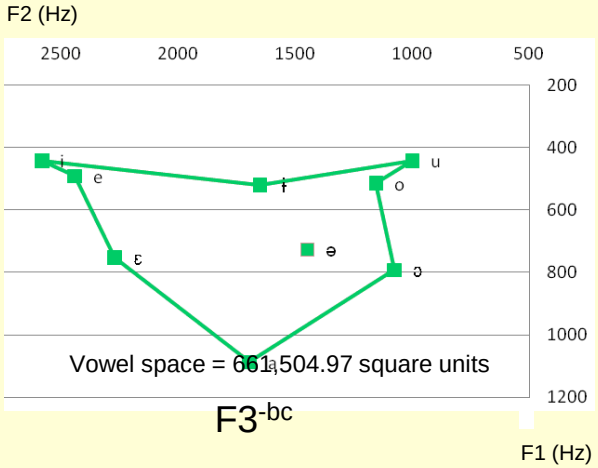
Figure 8 Overall vowel space of each speaker (CVø)

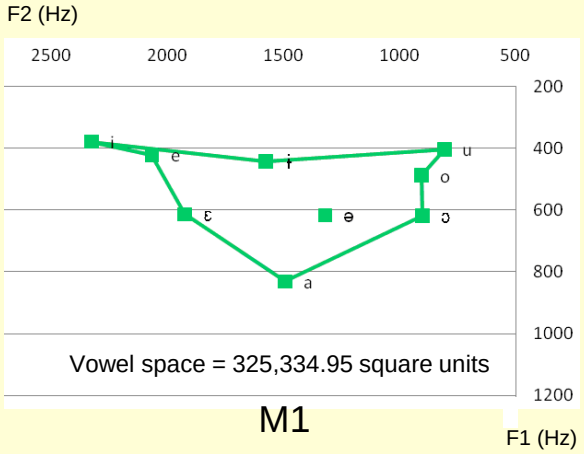
F = female speaker M = male speaker

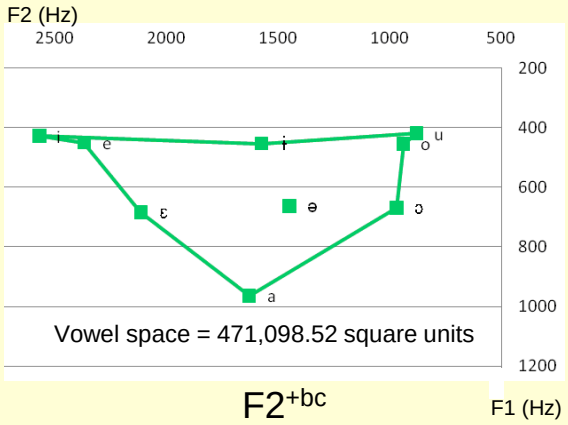
+bc = with brass coils -bc = without brass coils

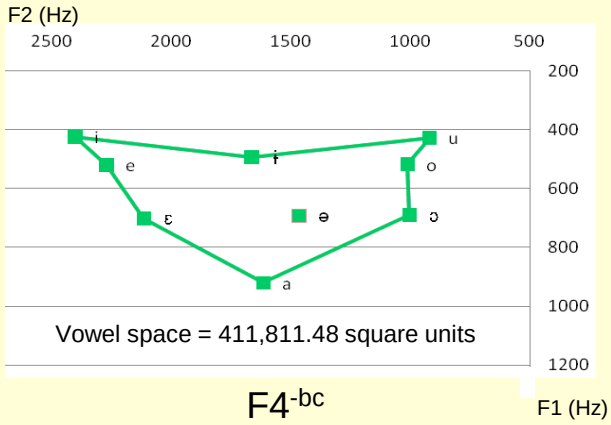
Results (11)











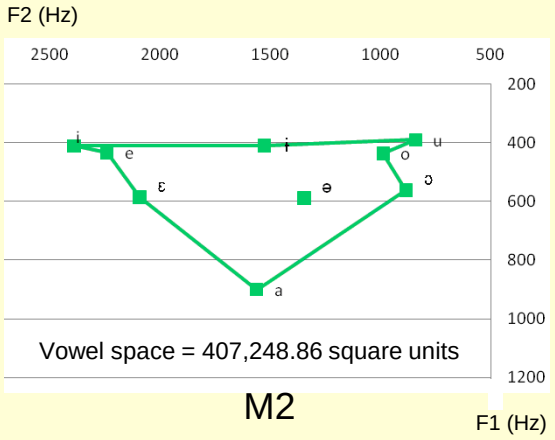
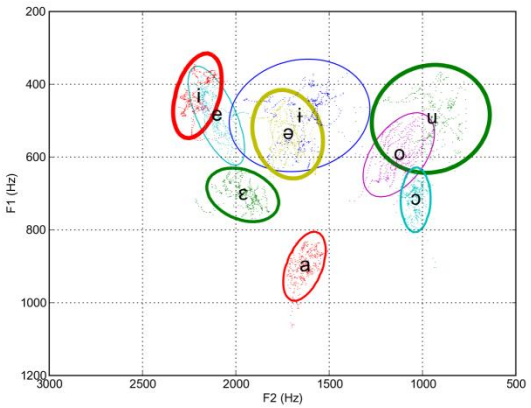


Figure 9 Overall vowel space of each speaker (CV?)

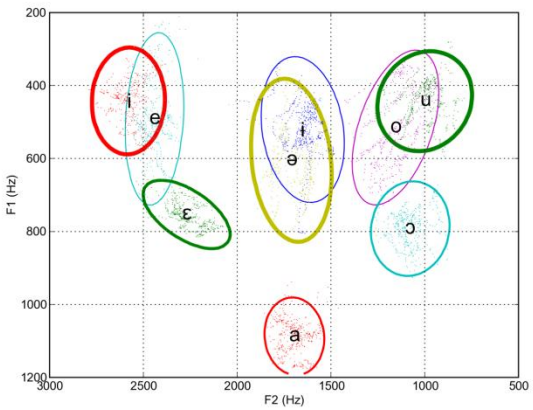
F = female speaker M = male speaker

+bc = with brass coils -bc = without brass coils

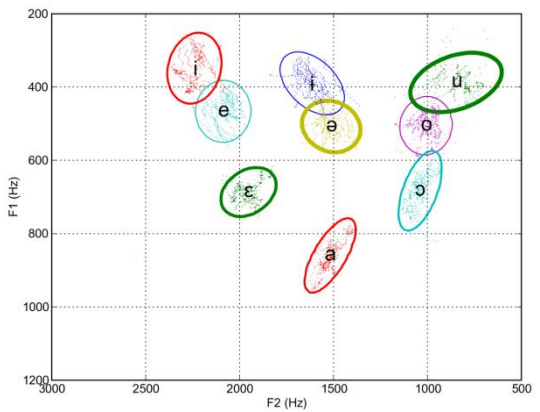
Results (12)



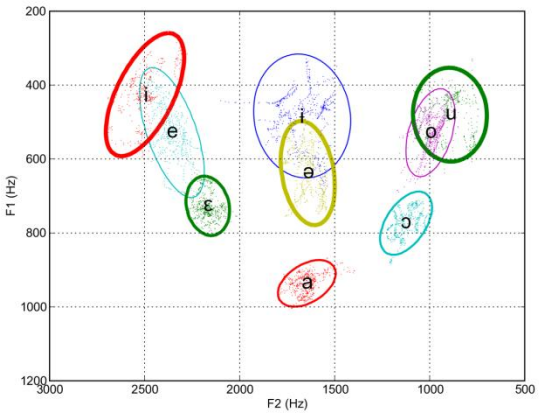
F1^{+bc}



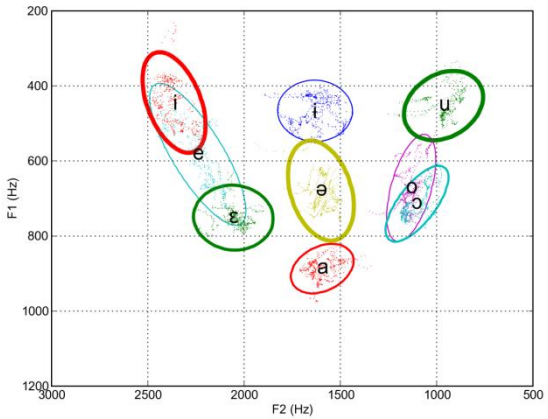
F3^{-bc}



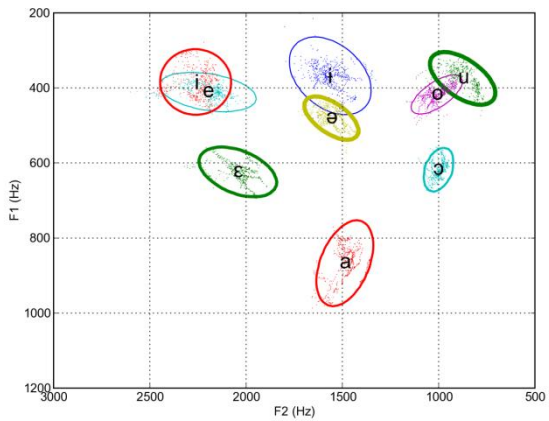
M1



F2^{+bc}



F4^{-bc}



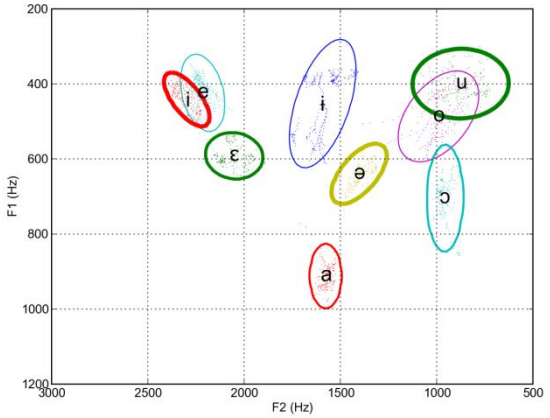
M2

Figure 10 Vowel space of each vowel of each speaker (CVø)

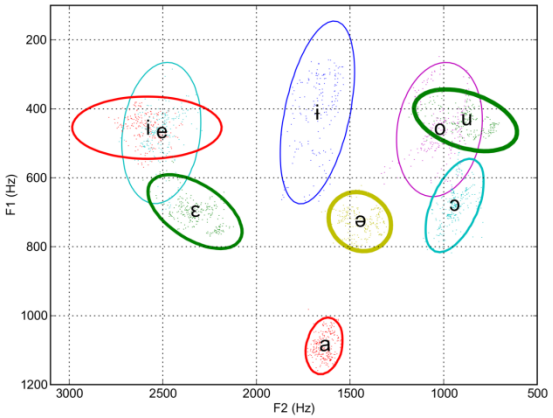
F = female speaker M = male speaker

+bc = with brass coils -bc = without brass coils

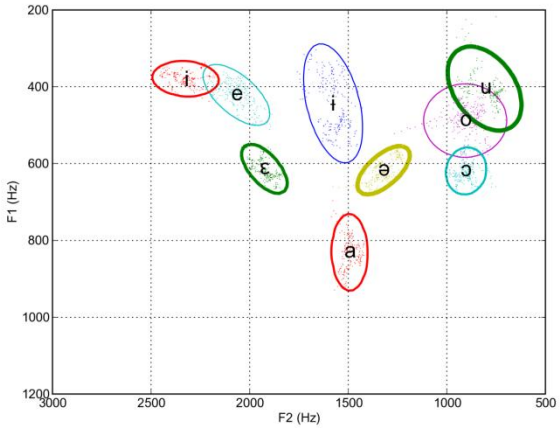
Results (13)



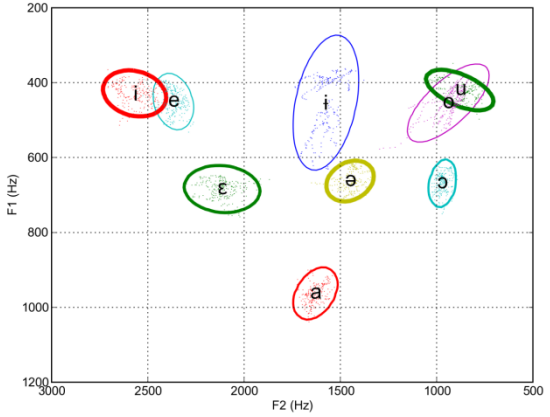
F1^{+bc}



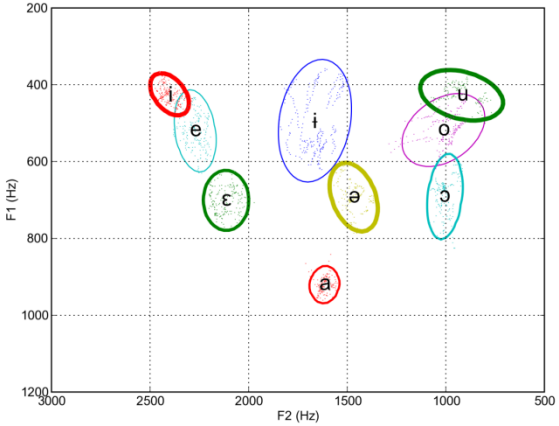
F3^{-bc}



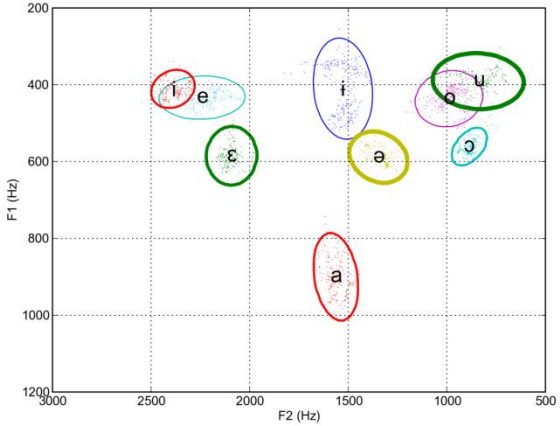
M1



F2^{+bc}



F4^{-bc}



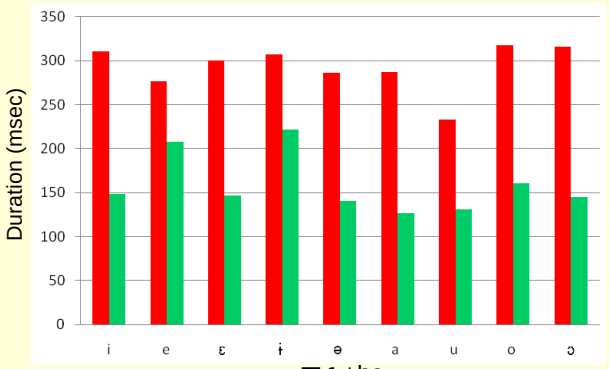
M2

Figure 11 Vowel space of each vowel of each speaker (CVʔ)

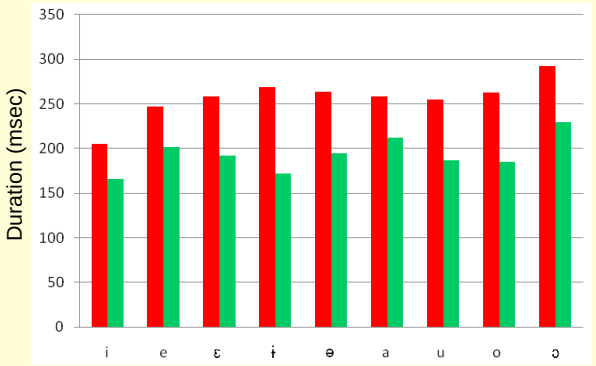
F = female speaker M = male speaker

+bc = with brass coils -bc = without brass coils

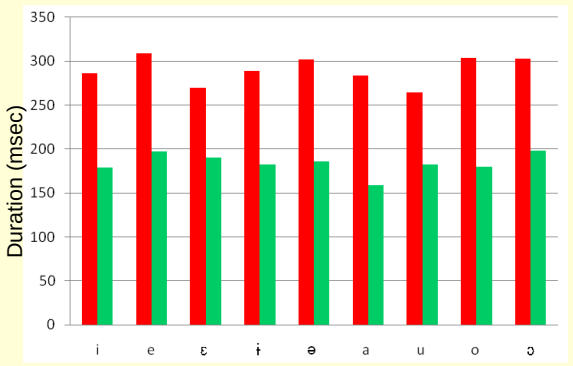
Results (14)



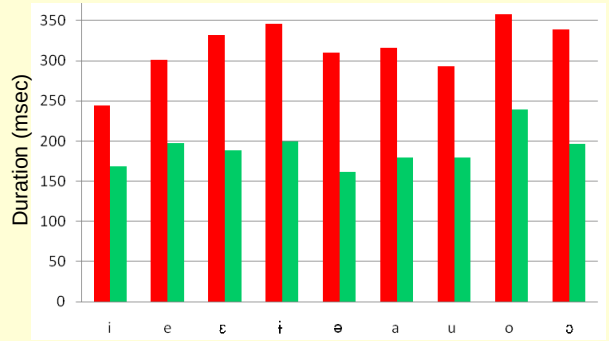
F1^{+bc}



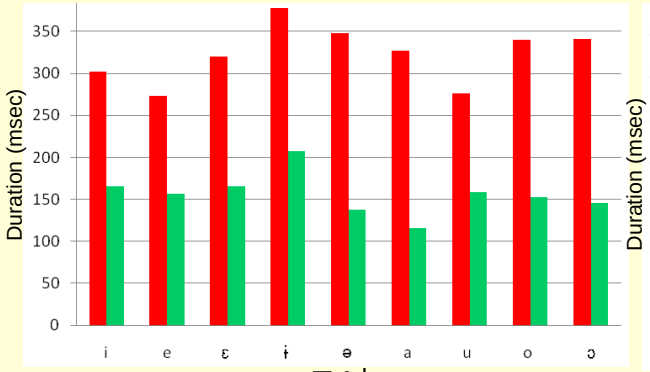
F3^{-bc}



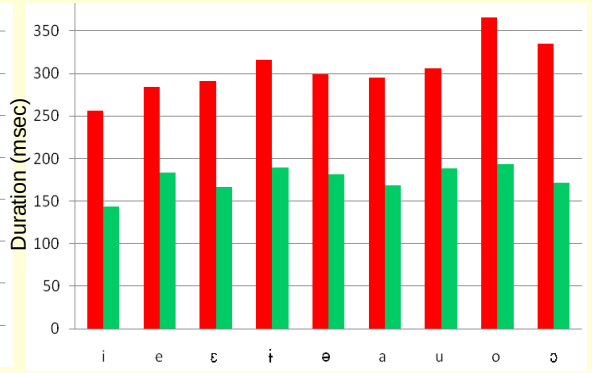
M1



F2^{+bc}



F4^{-bc}



M2

Figure 12 Average vowel durations of each speaker (CVø CVʔ)

F = female speaker M = male speaker

$^{+bc}$ = with brass coils $^{-bc}$ = without brass coils

Conclusions (1)

- **Tone/Fundamental frequency (F0)**

(1) The six tones produced by the three groups of speakers, i.e. two females wearing brass coils, two females no longer wearing brass coils and two males, seem to have similar F0 characteristics and durations.

(2) It is noticeable that when C- in all syllable types (CVø, CVŋ, CVʔ) voiceless aspirated plosive followed by high –V-, the F0 values are higher in the speech of all speakers.

Conclusions (2)

(3) T1, T2 and T3 in CVø and CVŋ syllable-types have longer durations than T4 (glottalized tone in CVø syllable-type), T5 and T6 in CVʔ syllable-type, the same behaviors in all speakers.

Conclusions (3)

- **VOT/Laryngeal timing in plosives**

(1) The laryngeal timing in plosives with three types of phonation, i.e. voice, voiceless and aspiration, seems to behave the same way in the three groups of speaker.

(2) With regard to the articulation places, the velar plosives have longer voicing lags than the labial and alveolar plosives, and the difference is statistically significant.

Conclusions (4)

(3) The phenomenon in (2) can be explained: “with a velar occlusion, there is a very small cavity behind it with a small volume of air enclosed; thus, it takes longer for the transglottal pressure to drop enough for phonation to happen” Abramson, e-mail communication) and Weismer (1980).

Conclusions (5)

- Normal F0 and VOT behaviors seem to indicate that female speakers both with and without brass coils have no problem in controlling their intrinsic laryngeal muscles.

Conclusions (6)

- **Vowel quality and length/ Formant frequency (F1, F2) and duration**

(1) The high vowels /i ɨ u/ and the lowest vowel /a/ of the male group have lower F1 values than those of the two female groups, brass-coiled neck and non-brass-coiled neck. The F2 values show nothing interesting.

(2) The above findings indicate that the vowels produced by the two male speakers are generally higher than those produced by all female speakers.

Conclusions (7)

(3) The behaviors of F1 and F2 of the vowels in the two female groups show no different patterns. There is an explanation for this, i.e. the two female speakers, $F3^{-bc}$ and $F4^{-bc}$, have recently taken off the brass coils for some benefits, so both female groups have more or less the same anatomy.

(4) The sizes of the overall vowel space of the female speakers seem to vary in comparison with those of the male speakers.

Conclusions (8)

(5) The results of acoustic studies suggest that the female speakers cannot raise their tongues as high as the male speakers during the high vowel production, or in other words, the female speakers, to a certain extent, have difficulty in moving their tongues vertically.
Some movements of the tongue are controlled by the extrinsic muscles of the tongue connected to the palate and to the hyoid bone.

Conclusions (9)

(5) In every speaker, both male and female, V in the open syllable has longer duration (length) than that in the checked syllable, with the ratio 2:1.

Discussions (1)

General problems

- It is difficult to find suitable informants for the task, due to a few limitations and conditions:

(1) Speakers with the age above 35 do not speak Thai.

(2) Kayan women are very busy selling handicrafts and entertaining tourists to earn their living and to be able to live in Thailand.

Discussions (2)

(3) Since our informants were reasonably paid for working with us, they wanted their relatives and close friends to replace them when they had other important obligations, therefore, we had less choices.

(4) No reliable details about the informants since they are not Thai citizens. The Kayan were brought to Thailand 10-15 years ago for tourism business.

Discussions (3)

- Unpleasant surrounding noises could not be avoided during the interviews and recordings.
- The whole working process made the informants feel bored, so quite often they lost their concentration.

Discussions (4)

Technical problems

- Even though the acoustic signals looked alright on the computer screen while recording at the research site, they did not show up well or none at all when they were analysed with Praat. Because of these defects, a few tokens could not be acoustically measured.

Discussions (5)

- Surrounding noises could not be completely eliminated, this fact could cause some interferences and even small errors in our acoustic analysis.
- The items could not be recorded at random. Without a definite set of words and a definite order of words within the set, the informants found it too hard to say fluently the words we wanted.

Discussions (6)

- The results of wearing heavy brass coils around the neck for many years can be:

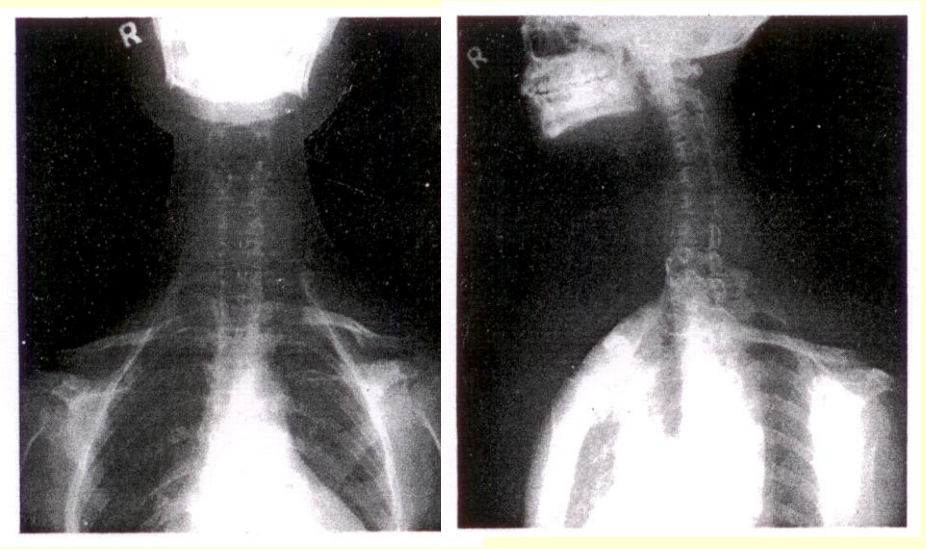
(1) The mandible (lower jaw) is constantly pushed up.

(2) The shoulders and the upper areas of the rib cage are pressed down.

(3) There is an atrophy of the shoulder muscles.

Discussions (7)

(4) The extrinsic muscles being involved in the neck, larynx and tongue moments can be affected due to constantly stretched neck.



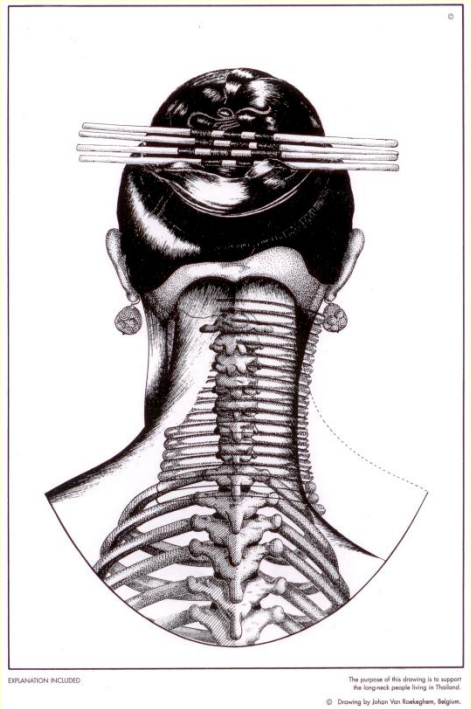


Figure 13 X-rayed pictures showing the skeleton of the neck and the upper thorax (left) and a drawing picture comparing the deformed shoulder with the normal one (right)

Discussions (8)

- Does the deformity caused by wearing heavy brass coils have any effects on the quality of the Kayan sounds produced by brass-coiled necked female speakers?
- In theory, there should be some effects. A decreased space of the upper thoracic cavity can effect breathing. As we know, speaking is a modified breathing. A suitable volume of lung air is necessary for continuously long and loud speech.

Discussions (9)

- However, a particular way of synchronisation of the organs of speech and the muscles involved in the speech sound production can compensate for a deformity caused by gradual adding more coils up to 32 at the most.
- When the brass wire is permanently removed, the shoulder muscles can develop and become normal again.

Discussions (10)

- To obtain solid answers, more detailed physiological studies are needed, especially a longitudinal study, i.e. from having less coils to more coils and then none, of the same group of female speakers.
- More information on the anatomy and physiology of speech can be found in Seikel, King and Drumnight (2009), Kaplan (1971), McFarland (2008), Raphael, Borden and Harris (2006), Zemlin (1997), etc.

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THANK YOU