

THE INTERACTION BETWEEN PITCH AND PHONATION TYPE IN MON:
PHONETIC IMPLICATIONS FOR A THEORY OF TONOGENESIS

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ABSTRACT

To investigate the interaction between pitch and phonation type, fifteen word pairs (thirty test tokens) said by eight speakers of Mon were chosen for acoustic analysis. They were divided into ten groups according to the phonation types of the vowels and initial consonants.

The results of the measurements show that first register (tense) vowels have higher average F_0 values than second register (lax) vowels, and that prevocalic consonants perturb the F_0 of the following vowels in different ways. This is due to the combinations of the phonation types of the prevocalic consonants and the following vowels. The difference between the average F_0 values of the tense-voice and lax-voice vowels is statistically significant ($p < .001$), whereas pitch differences caused by the perturbation of the prevocalic consonants are not statistically significant ($p < .001$), except when a tense-voice vowel is preceded by a voiceless nasal. The tonogenetic mechanism in Monic languages is discussed.

1. Introduction

The Monic branch of the Mon-Khmer language family comprises only two languages: Nyah Kur (Chao Bon) and Mon (Diffloth, 1984). The phonetic realization of the register distinction in Mon has been observed by many Mon-Khmer specialists: Blagden (1910), Shorto (1962, 1966 and 1967), Sakamoto (1974), Huffman (1976), Bauer (1982) and Diffloth (1984). Lee (1983) investigated the acoustical parameters governing the register distinction in Mon and the relative significance of these parameters. Four parameters were looked at: vowel duration, frequencies of the first two formants, fundamental frequency, and distribution of spectral energy. He concluded that for citation forms, only two of these parameters indicated that significant differences exist between the two registers. The second register vowels had longer duration and lower pitch level. No consistent difference could be found between the two registers with respect to vowel quality or phonation type. Mon is a quasi-tonal language (Lee, 1983:95). The same phonetic parameters were examined again by Theraphan (1987b). A brief account of her acoustical study of a Mon dialect can be given as follows:

Sixteen word pairs said by eight native speakers of Thai-Mon were used for the acoustical measurements. After investigating all of the wideband spectrograms of the test words, the labels "modal voice vowels" vs. "breathy voice" were discarded. The choice of the labels "tense-voice vowels" vs. "lax-voice vowels" seems to be more appropriate. Although most speakers pronounced first register vowels with modal (clear or normal) voice and second register vowels with breathy voice, in some cases some speakers do not make this type of phonation distinction. The types of distinction can be as follows:

1st register (tense voice)	2nd register (lax voice)
less breathy voice	more breathy voice
creaky voice	breathy voice
creaky voice	breathy-creaky voice

In addition, four phonetic parameters were examined carefully: distribution of spectral energy, fundamental frequency (F_0), vowel duration, and frequencies of first formant (F_1) and second formant (F_2). To detect phonation type differences, the difference in dB between the amplitude of the fundamental and intensity of the second harmonic was measured. For the eight speakers, the mean for tense voice is 2.834 dB with a standard derivation of 4.17. The mean for lax voice is -3.228 dB with a standard derivation of 5.293. The difference is highly significant ($p < .0005$, $t = 15.378$, $df = 128$).

Narrowband spectrograms were made and measured. The 32 test words were divided into four sets based on phonation-type differences and syllable types: CVC, CVC̣, CV(C) and CṾ(C). The results of the measurements show that the difference in fundamental frequency at the beginning, the mid point, and the end point of the harmonics is statistically significant. Tense-voice vowels have higher F_0 values than lax-voice vowels.

Vowel length in Mon is not linguistically significant, however, both short and long vowels can be heard. The mean duration of vowels in CVC and CVC̣ syllable types (checked syllables) of the eight speakers is 155.14 Msec, with a standard deviation of 23.22, and 193.08 Msec, with a standard deviation of 36.61, respectively. Thus the duration difference between tense-voice and lax-voice vowels in checked syllables is statistically significant ($p < .0005$, $t = 10.824$, $df = 64$). In CV(C) and CṾ(C) syllable types (open syllables and syllables with voiced finals, i.e. nasals and semivowels), the mean duration of tense-voice and lax-voice vowels is 328.84 Msec and 331.70 Msec, with a standard deviation of 92.76 and 93.14, respectively. This difference is so minute that it is not

statistically significant.

Regarding formant frequencies, the F1 difference between the two registers is statistically significant ($p < .05$) only for i/\dot{i} , o/\dot{o} (in CVC and CVC syllable types), $\epsilon/\dot{\epsilon}$ and o/\dot{o} (in CV(C) and CV(C) syllable types). With respect to the F2 difference between the two registers, it is significant for $\epsilon/\dot{\epsilon}$ (in CVC and CVC syllable types), e/\dot{e} and u/\dot{u} (in CV(C) and CV(C) syllable types).

Thus, from the acoustical and statistical points of view, Mon may be classified as "a register (phonation-type) language," or "a tonal language." If Mon is becoming a tonal language, it is interesting to investigate how the tones in Mon have developed.

On the basis of historical data on development of tones, many scholars of Southeast Asian linguistics, such as Haudricourt (1954, 1972), Matisoff (1973), Li (1966), Henderson (1982), Egerod (1971), etc. have discussed the effect of prevocalic and postvocalic consonants on pitch of the following or preceding vowel, i.e. voiced consonants lower the pitch and voiceless consonants raise the pitch. Their hypothesis has been well attested by experimental phoneticians, such as Erickson (1975), Gandour (1974), Hombert (1978), Maddieson (1984), etc.

2. Hypothesis

Does a non-tonal SEA language become a tonal language only via the contribution of the phonetic features of the prevocalic and postvocalic consonants? From investigating the register complex in many register languages of the Mon-Khmer language family, I would like to hypothesize that tones or lexically contrastive pitches have developed primarily from voice register governing the whole syllable. The phonation types of the consonants -- voice and voiceless, play a less important role. Their contribution is to add more tones to the tonal system (high vs. low) which already exists.

3. Procedure

To test the above hypothesis, an experiment was conducted. Mon was chosen as the representative of register languages. Many Mon-Khmer languages have two types of syllable: tense-voice syllable and lax-voice syllable. In general, tense-voice syllable has higher pitch than lax-voice syllable. In other words, lax voice lowers the pitch of the syllable, and the tense voice raises the pitch of the syllable. The vowel, the nucleus of the syllable, has been affected the most. (See Figure 1.)

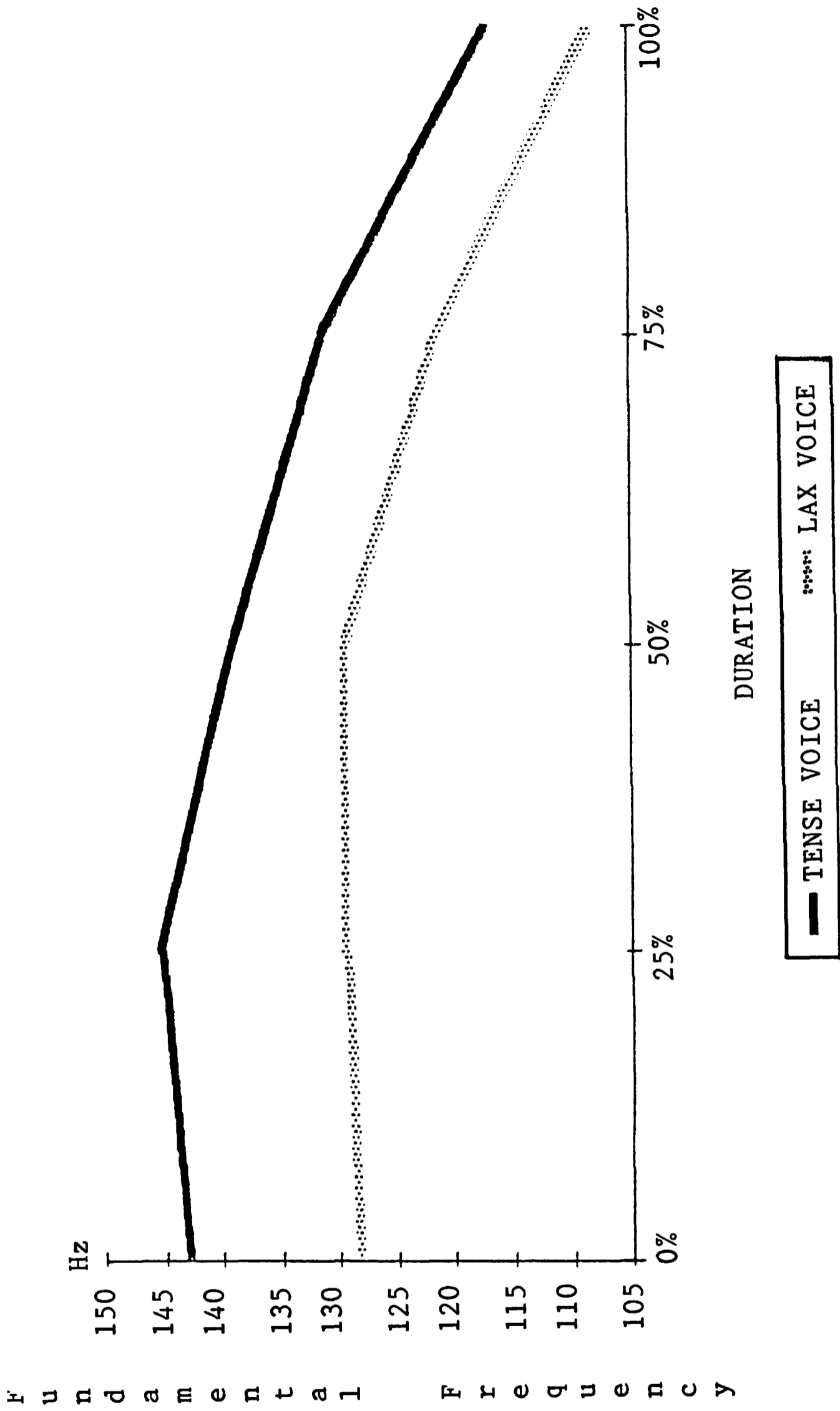


Figure 1: Average F0 contours for the two voice registers (8 speakers).

This seems to be the usual phenomenon in many Mon-Khmer languages that have register distinction. (See more details in Theraphan, 1987a.) The Mon language is not an exception.

Fifteen pairs of test words were chosen for acoustical analysis. They are as follows:

First register (Tense) Second register (Lax)

Obstruents

Aspirated :	phɛŋ	'split bamboo'	phɛŋ	'marijuana'
	tho	'wasp'	tho̥	'straight'
	thot	'forcefully'	thot̥	'to deepfry'
Voiceless :	cə	'to shield'	cə	'to bump into'
	cu	'steep'	cü	'to stop (in order to rest)'
Voiced :	to	'handle'	to	'to throw at'
	bi	'river'	bi̥	'you (impolite)'
	ɗaŋ	'expensive'	ɗaŋ	'king posts'
	bɔŋ	'to give birth'	bɔŋ	'bamboo tube for smoking'

Nasals

Voiced :	ɛnɛŋ	'laths, battans'	ɛnɛŋ	'to bring'
	hənon	'fishhook'	hənon̥	'chopping board'
	ənɑm	'to boil (i.v.)'	ənɑm̥	'a name'
Voiceless :	ŋaŋ	'candle'	ŋaŋ	'a kind of fish trap'
	nok	'itchy'	nok	'big'
	ŋɑn̥	'cheek'	ŋɑn̥	'waist'

Eight Mon speakers from Nakhon Chum Village, Baan Pong District, Rajaburi Province were brought to Bangkok. To elicit the fifteen test words, they were interviewed in the recording studio of the Linguistics Research Unit, Faculty of Arts, Chulalongkorn University. The tapes were edited later. Narrowband spectrograms were made (at the Phonetics Lab, Department of Linguistics, UCLA) and measured at three points : at the onset of the vowel (zero Msec), 50 Msec and 100 Msec. The normalized Fo contours indicating the mean Fo values of the vowels following each class of prevocalic consonants were plotted. The Macintosh computer programmes, Excel and Stat-View, were used for plotting the average Fo contours and handling the two-tail paired t-Test which indicates the

significance or non-significance of the F_0 perturbations, respectively.

4. Results

The results of the acoustical measurements indicate that tense-voice vowels have higher average F_0 values than lax-voice vowels as shown in Figure 2, and that different types of prevocalic consonants perturb the F_0 of the following vowels in different ways as shown in Figure 3. This is due to the combinations of the phonation types of the prevocalic consonants and the following vowels. The degrees of pitch raising and lowering can be summed up as follows:

	TENSE VOICE	LAX VOICE
HIGHEST PITCH	Voicless nasal	Voicless unaspirated plosive
	Voiced nasal	Voicless nasal
	Voicless aspirated plosive	Voiced nasal
	Voiced implosive	Voicless aspirated plosive
LOWEST PITCH	Voicless unaspirated plosive	Voiced implosive

The difference between the average F_0 values of the tense-voice and lax-voice vowels is statistically significant ($p < .001$). See details in Table 1.

Pitch (F_0) differences caused by the perturbation of the prevocalic consonants are not statistically significant ($p < .001$), except when a tense-voice vowel is preceded by a voiceless nasal. An example can be found in Table 2.

5. Discussion

Statistical evidence tells us that there are three significant pitches in Mon, namely High, Mid and Low. A voiceless nasal raises the pitch of the following tense-voice vowel the most. The same phenomenon also occurs in Nyah Kur (Chao Bon), the only sister language of Mon, as shown in Figure 4. Based on the characteristics of the interaction between pitch and phonation type, I would like to predict that some day in the future, Monic languages (Mon and Nyah Kur) will have

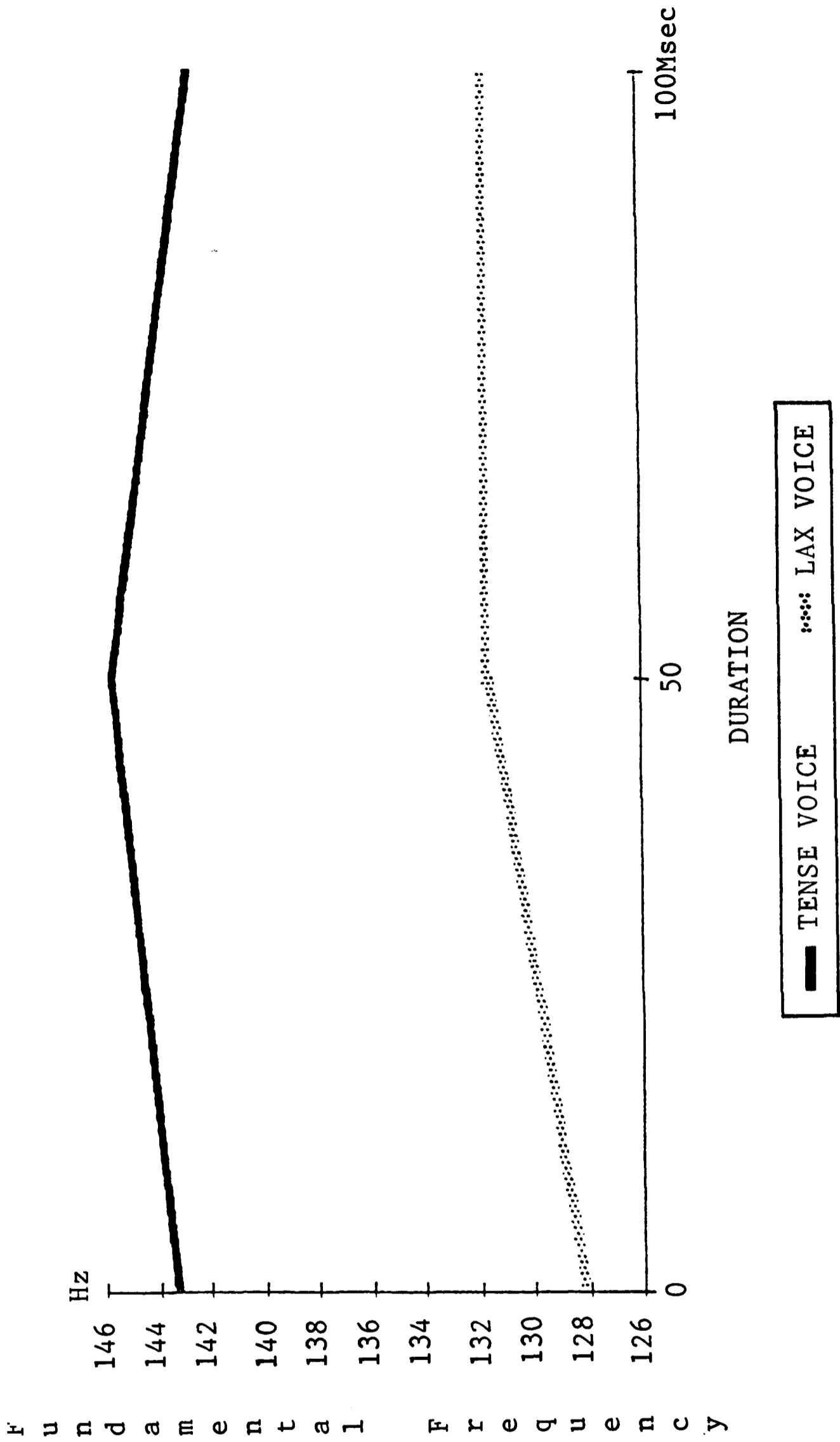


Figure 2: Mean F0 values of tense-vowels and lax-voice vowels (8 speakers).

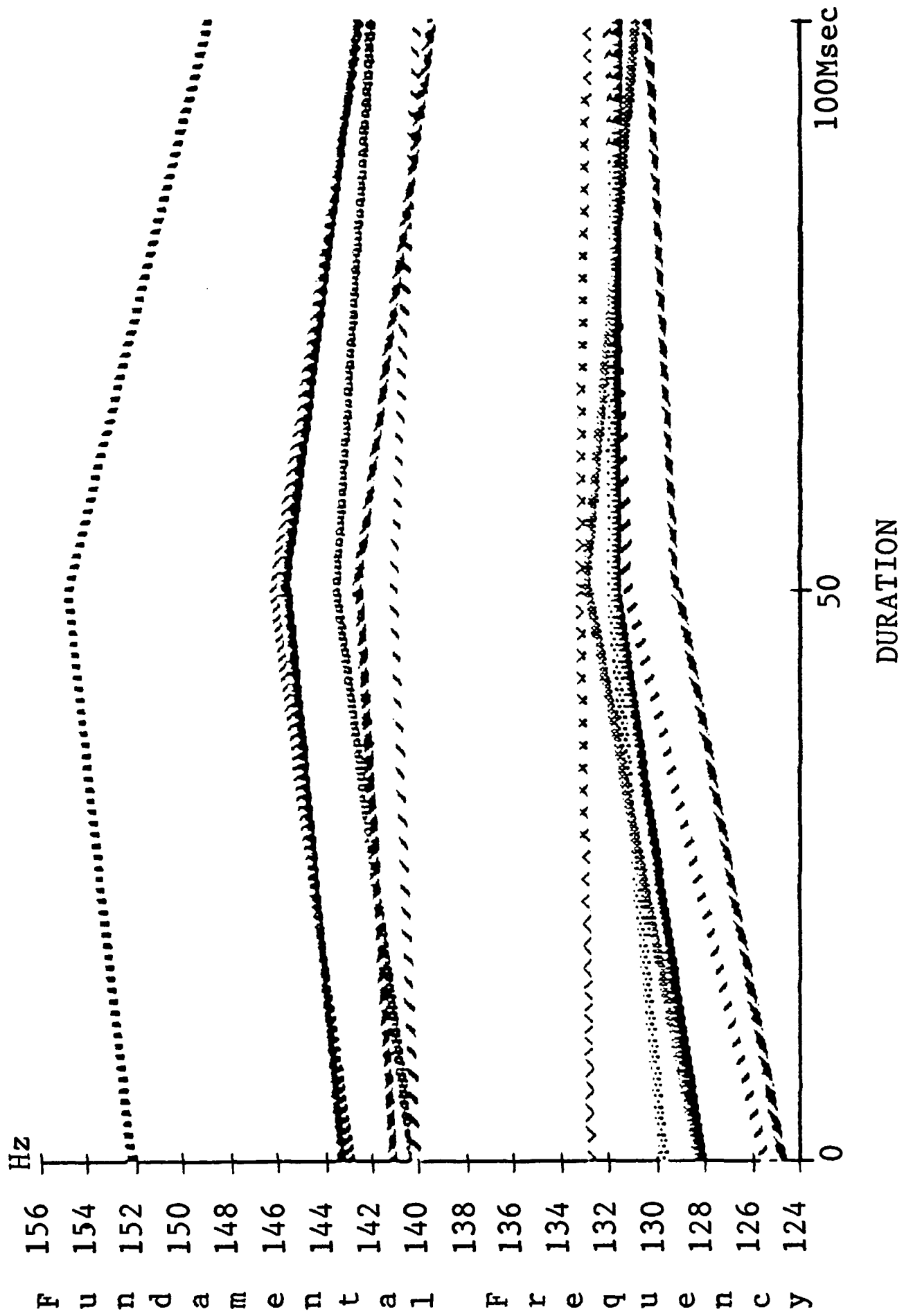


Figure 3: Average F0 contours of vowels following different types of prevocalic consonants (8 speakers)

	Tense	Lax	T	LSTTT	DF
0 Msec	Mean = 143.374 S.D. = 43.824	Mean = 128.141 S.D. = 39.563	12.066	0.001=3.373	119
50 Msec	Mean = 145.678 S.D. = 42.997	Mean = 131.69 S.D. = 38.253	11.908	0.001=3.373	119
100 Msec	Mean = 142.626 S.D. = 42.018	Mean = 131.611 S.D. = 38.712	9.649	0.001=3.373	119

Table 1 : Mean Fo values (in Hertz) of tense-voice vowels and lax-voice vowels measured at 0 Msec, 50 Msec and 100 Msec (8 speakers).

	Vd.implo.	Vl.nasal	T	LSTTT	DF
0 Msec	Mean = 141.135 S.D. = 47.645	Mean = 152.175 S.D. = 44.668	-4.733	0.001=3.767	23
50 Msec	Mean = 142.645 S.D. = 44.565	Mean = 154.842 S.D. = 44.753	-5.465	0.001=3.767	23
100 Msec	Mean = 139.394 S.D. = 43.259	Mean = 148.983 S.D. = 43.143	-3.922	0.001=3.767	23

Table 2 : Mean Fo values (in Hertz) of tense-voice vowels following voiced implosives (ɓ, ɗ) and voiceless nasal (ɲ) measured at 0 Msec, 50 Msec and 100 Msec (8 speakers).

three tones:

PREVOCALIC CONSONANT		VOWEL		TONE
Voiced sonorants	+	tense-voice	=	High
Voiced obstruents	+	tense-voice	=	Mid
Voiced sonorants				
Voiced obstruents				
Voiced sonorants	+	lax-voice	=	Low
Voiced obstruents				

The above prediction is reasonable because similar types of evidence can be found in Assamese and Chinese. Henderson (1982:14) says that her Assamese informant felt that the difference between /phal/ 'to tear' and /phal/ 'good', /thai/ 'flower' and /thai/ 'nurse', etc. lay in the voicing of the initial consonants. The writing system of Assamese actually blinds him. She comments:

--- Phonetically, however, the difference between the two sets of words lies not in the voicing of the initial, but in the presence or absence of 'murmur' and the relative pitch of the whole syllable. We have here, in fact, the beginnings of a tone system -- a process which may have taken place historically many times in different language families.

What precisely is happening in the throat in 'murmured' utterances is still only imperfectly understood. It is obviously very difficult to observe directly what is happening in the larynx in the course of natural speech. It may, however, turn out to be misleading to describe the initial stops of murmured syllables as 'voiceless'. Perhaps we need three categories, voiced, voiceless (thought of as a positive term), and murmured.

(Henderson, 1982:14)

Egerod (1971) also points out that on the basis of the rhyming system, the origin of tones in pre-Ancient Chinese may be interpreted as phonation types, not final consonants.

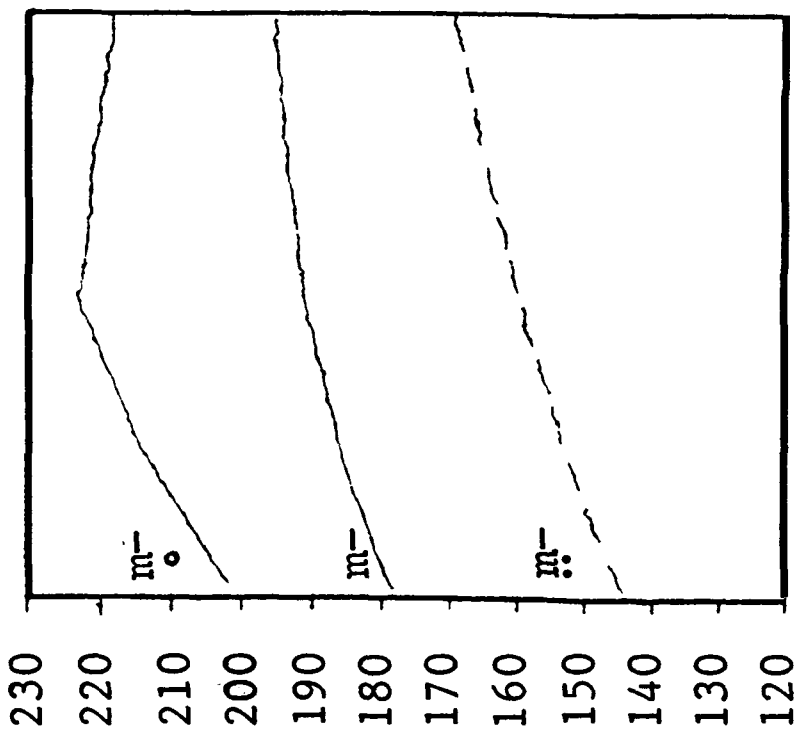
6. Conclusion

At present, Mon can be regarded as a register language. However, the acoustical measurements and statistics tell us that both pitch and phonation-type differences in Mon are significant. Partly through language contact with tone languages, such as Thai, Burmese, Karen, etc., it is possible that Mon will become a tone language. The origin of the first two tones in Mon will be voice registers or phonation types governing the whole syllable. The phonation types of the prevocalic and postvocalic consonants will add more pitch heights and contour shapes, then more tones, to the system. For example, voiceless nasals raise the pitch of the following tense-vowels in an obvious way, as illustrated in Figure 4. This will give birth to the third tone in Mon.

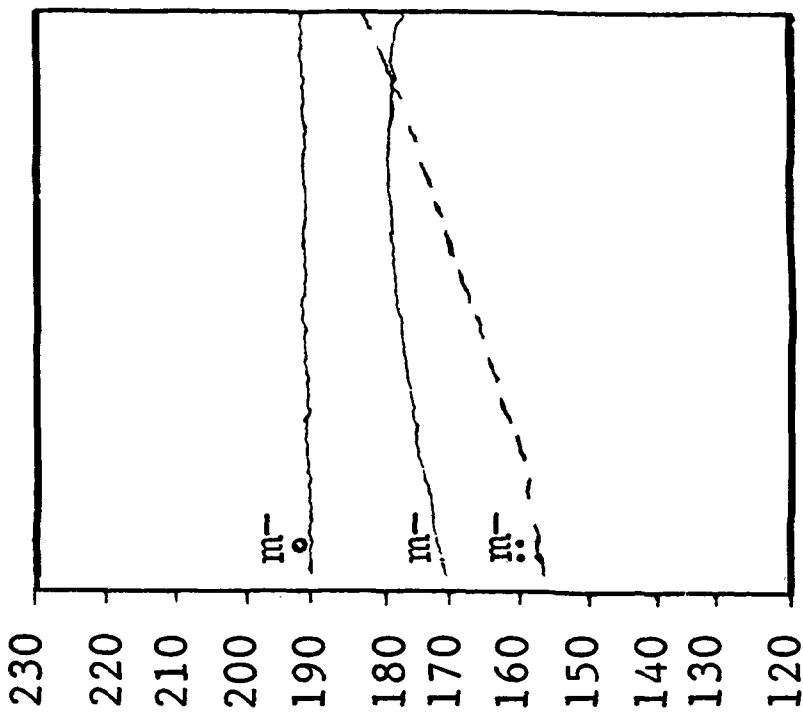
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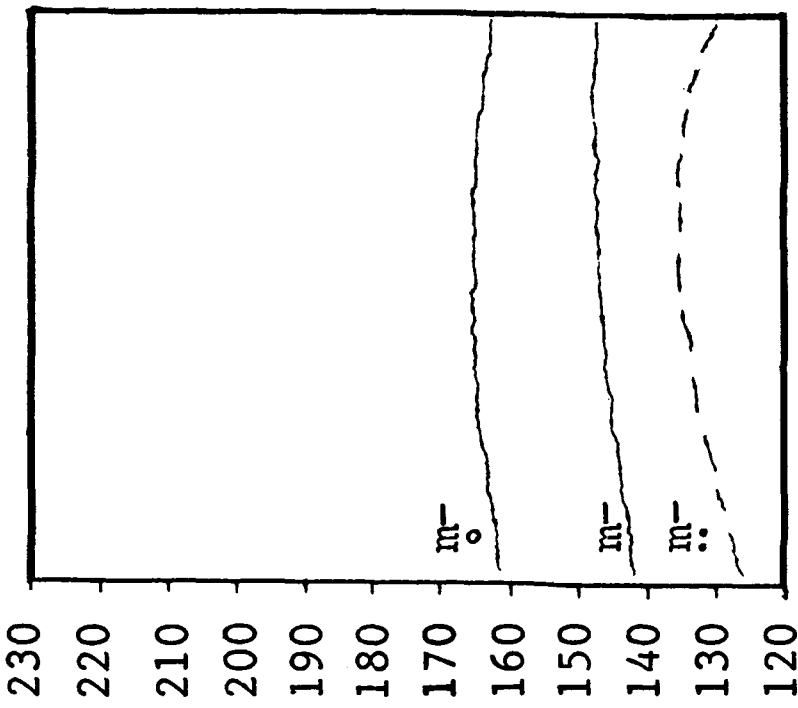
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Time 75 Msec. (S 1)



Time 75 Msec. (S 2)



Time 75 Msec. (S 3)

Figure 4: Average F_0 values (in Hertz) of vowels following prevocalic consonants $hm[m]$, $m[m]$ and $m[i:]$ in Nyah Kur (Chao Bon) (three individual speakers)

————— clear voice vowels

- - - - - breathy voice vowels

(Adapted from Theraphan, 1982.)

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