PHONETIC VARIATION IN IU-MIEN VOWELS

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ABSTRACT

The study presents an acoustic analysis of the phonetic variation in Iu-Mien vowels, not only for modal voice, but also for creaky and pharyngealized vowels. Our findings are contrasted with those of Purnell [1, 2] and Bruhn [3].

Keywords: Vowel variation, acoustic properties, creakiness, pharyngealization

1. INTRODUCTION

The purpose of this study is to present an acoustic analysis of Iu-Mien vowels from three perspectives: First, the vowels are located in acoustic space, and compared to earlier studies by Purnell [1, 2] and Bruhn [3]. Second, vowel laryngealization is analyzed. Third, the vocalic influence of the quite rare pharyngealization is examined.

1.1. Iu-Mien language and speakers

Iu-Mien is a Hmong-Mien language, spoken in southern China, Vietnam, Laos, and Thailand. Thirty years ago the first Mien speakers arrived in the United States as refugees. A large concentration of roughly 35,000 Mien people can be found in Northern California, particularly in the Sacramento area [2].

1.2. Iu-Mien tone pitches and phonation

Iu-Mien has six tones [1]. The description of these tones together with the way they are marked are given in Table 1 ([1, 2, 3]). In the orthographic convention, except for the unmarked mid tone, each tone is indicated by a letter placed at the end of the word.

Table 1: Iu-Mien tones

Description of tone pitches:	Orthographic tone symbol:	Chao numbers:
high rise (-fall)	-v	45
mid level	---	33
mid fall	-h	31
low rise	-x	23
low level	-c	21
low rise-fall	-z	232

Purnell [1] notes that vowels occurring with the low rise-fall 232 tone are pharyngealized and vowels occurring with the low level 21 tone are creaky. In the present study the terms creaky and laryngealized will be used interchangeably, but see [4].

1.3. Iu-Mien vowels

Interpretations of Iu-Mien vowel system differ somewhat. Purnell [1] distinguishes eight vowels, Purnell [2] distinguishes nine vowels (plus vowel /ʉ/ that does not occur in Iu-Mien and is only needed to write Thai and Lao borrowings), and Bruhn [3] distinguishes ten vowels (Fig. 1). All the notational systems differ slightly. The main difference between Purnell's earlier and later work is the introduction of the long vowel [a:]. Also instead of [ɛ], a lower front vowel [æ] is used. The vowels /ə/ (in Purnell's chart) and [ɜ] (in Bruhn's chart) occur only in Chinese loan words. Where Purnell [1, 2] chooses between [ɛ] and [æ], Bruhn [3] treats the two vowels as different and uses both of them. Another difference is in the treatment of [a]. Purnell [2] contrasts the short [a] with the long [a:]. Bruhn [3], on the other hand, contrasts [a] with [ɐ]. Finally, instead of [ɔ], a lower back vowel [ɒ] is used by Bruhn.

Figure 1: Iu-Mien vowels.

Purnell [1]			Purnell [2]			Bruhn [3]		
i		u	i	(ʉ)	u	i		u
e		o	e	ə	o	e		o
ɛ	ə	ɔ			ɔ	ɛ	ɜ	
	a		æ			æ	ɐ	ɒ
				a a:			a	

2. AN ACOUSTIC ANALYSIS OF VOWELS

2.1. Subjects

Two Iu-Mien speakers, a female and a male, were recorded. They were in their 50s, and came to the US from Laos via Thailand when they were 18 and 20, respectively. They live in the Sacramento area, speak Iu-Mien at home, and are involved in language preservation in the Mien community.

2.2. Recordings and measurements

The recordings were made in a quiet room on a Mac using Sound Studio software (version 3.0.4) and a

head mounted Telex H-831 mic. The recordings are of words produced in isolation, and thus represent vowel qualities in clear citation forms. Except for the vowel [ɜ] for which there were only three tokens, for the remaining vowels, from 15 to 29 tokens were measured per speaker; all together 398 tokens were analyzed.

The analyses were performed using Macquirer software. The words were first sampled at 11,025 Hz, and then the measurements of formant frequencies were taken in the middle portion of the vowel, using the spectrographic displays and FFT and LPC spectra calculated over a 30 ms window using 12 or 14 coefficients. The duration of [a:] was also measured and compared with the duration of [ɐ].

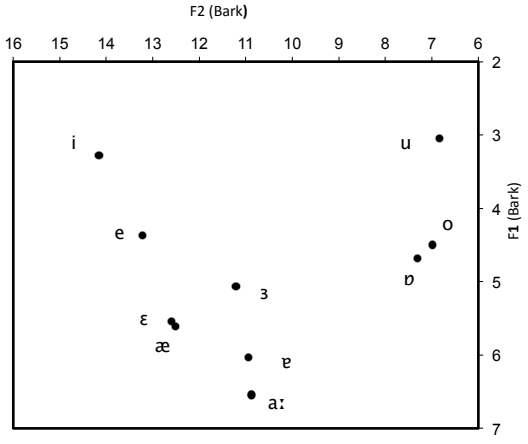
2.3. Vowel qualities

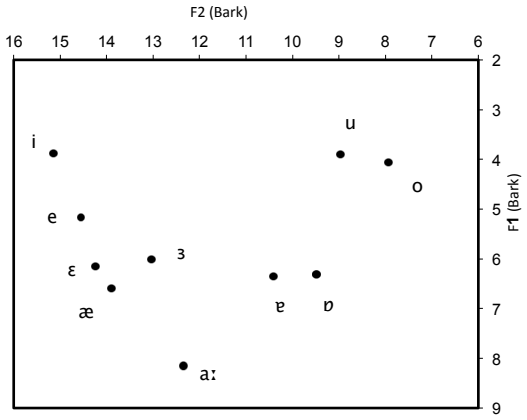
The mean formant frequencies are shown in Table 2. The vowels of Table 2 are presented on the F1/F2 plots with Bark scales in Fig. 2. The first plot is for the male speaker, the second for the female speaker.

Table 2: Mean frequencies of Iu-Mien vowels.

	F1		F2		F3	
	Female	Male	Female	Male	Female	Male
[i]	404	338	2778	2363	3542	3154
[e]	550	458	2521	2037	3506	3232
[ɛ]	670	603	2393	1810	3262	3173
[æ]	728	594	2266	1851	2936	2651
[ɜ]	654	538	1980	1502	3395	2809
[ɐ]	696	655	1334	1442	2286	2952
[a:]	945	720	1784	1432	2678	3210
[u]	405	313	1073	758	3505	3037
[o]	424	473	914	778	3425	3152
[ɒ]/[ɔ]	691	494	1162	825	3259	2909

Figure 2: The vowels of Table 1 on a Bark F1/F2 plots: (a) male speaker and (b) female speaker.





The most salient findings appear to be in the production of the male speaker. The mean F1 and F2 values for [æ] are not differentiated from [ɛ]. A one-way ANOVA shows the differences in the first formant frequencies not to be significant with $F(1,16)=.319$ and $p>.01$, and, similarly, it shows differences in the second formant frequencies not to be significant with $F(1,16)=1.012$ and $p>.01$. Also the male speaker's vowel [ɒ] is much higher than expected, and should be classified as the vowel [ɔ].

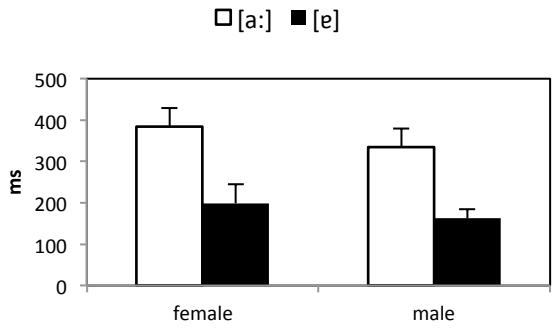
For the female speaker, the vowels are differentiated well on the basis of the first two formants. There is an interesting variation in the pronunciation of the vowel [o]. Of the 17 tokens analyzed, [o] was pronounced as a monopthong eight times, with the mean values given in Table 2 and illustrated in Fig. 2 above. The remaining nine tokens show that [o] can also be diphthongized. Measured in the middle of the first element, the mean formant frequencies values are 701 Hz for F1 and 1142 Hz for F2, and for the second element, 413 Hz for F1 and 913 Hz for F2. The formant frequencies of the two elements are equivalent to those of the two monophthongal vowels [ɒ] and [o]. Clearly, the vowel [o] can also be pronounced as the diphthong [ɒo].

Our study shows quality differences between [a:] and [ɐ]. For the male speaker, [ɐ] is higher than [a:], and for the female speaker, it is not only higher but backer.

2.4. Vowel duration

The duration of [a:] is a matter of debate (see Fig. 1). In our study [a:] was found to be significantly longer than [ɐ] ($p<.001$). No difference in duration was found between the modal [a:] and, discussed later, creaky [a̰:] and pharyngealized [aˤ:]. In closed syllables of words produced in isolation and regardless of phonation, [a:] averaged 359 ms, while [ɐ] averaged 180 ms. Fig. 3 presents the duration for the two vowels separated by the two speakers.

Figure 3: Comparison of [a:] and [ɐ] duration.



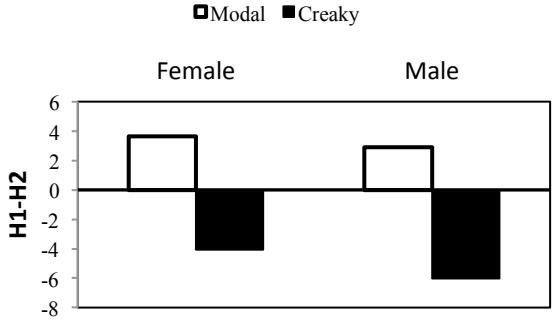
3. IU-MIEN VOWELS AND PHONATION

3.1. Vowel creakiness

The spectrograms of vowels occurring with tones 21 and 232 show irregularly spaced periods and decreased acoustic intensity when compared to the same vowels occurring with other tones. The spectral tilts of vowels occurring with tones 21 and 232 show the amplitude of the second harmonic (H2) to be greater than that of the fundamental (H1). Both observations point to the creakiness of the vowels occurring not only with tone 21, as observed by Purnell [1], but also with tone 232.

H1 and H2 measured and compared for the low vowels, [ɐ] and [a:], for which the frequency location of F1 is far enough from H1 not to influence the amplitude of H1 [5, 6], show that when the vowels are produced with tones 21 and 232, the amplitude of H2 is greater than that of H1, and when with tones 45, 33, 31, the amplitude of H1 is greater than that of H2 (Fig. 4). When the creaky vowels are produced, the mean H1-H2 amplitude differences show that H2 is 4 dB above H1 for the female speaker, and 6 dB above H1 for the male speaker. In contrast, when the modal counterparts are produced, H1 is 3.6 dB above H2 for the female speaker, 2.9 dB above H2 for the male speaker.

Figure 4: Differences in H1-H2 amplitude



In the literature, laryngealization has been associated with vowel quality differences [7]. Table 3 shows mean F1 and F2 values for the creaky vowels given below the mean F1 and F2 values for the modal counterparts repeated here for the ease of comparison. In the recordings an accidental gap occurred for the creaky [i].

Of particular interest are the changes in the two low vowels. With regard to F1 and vowel height, for the female speaker, the creaky vowels are higher than modal vowels rather than lower. Her [ɐ̰] is on average 281 Hz higher than [ɐ], and [a̰:] is on average 534 Hz higher than [a:]. F2 values indicate that, in her production, [a̰:] shifts further back by average 454 Hz. As a result, [ɐ̰] and [a̰:] do not differ in quality from one another when laryngealized.

For the male speaker, the creaky low vowels are produced lower than the modal counterparts: [ɐ̰] is on average 167 Hz lower than [ɐ], and [a̰:] is 152 Hz lower than [a:]. F2 values are different only for [ɐ̰] that has shifted back by average 170 Hz.

Creakiness has the most striking acoustic effect on [æ] produced by the female speaker, making this vowel sound like a completely different vowel. In her pronunciation, [æ̰] becomes a mid back vowel.

Table 3: Modal vowels and creaky counterparts

	Female speaker		Male speaker	
	F1	F2	F1	F2
[e]	550	2521	458	2037
[ḛ]	420	2519	471	1964
[ɛ]	670	2393	603	1810
[ɛ̰]	642	2422	573	1885
[æ]	728	2265	590	1869
[æ̰]	354	796	499	1954
[ɐ]	696	1334	655	1442
[ɐ̰]	415	1310	822	1612
[a:]	945	1784	720	1432
[a̰:]	411	1330	872	1496
[u]	405	1073	313	758
[ṵ]	405	879	344	626
[o]	424	914	473	778
[o̰]	500	973	360	594
[ɒ]/ [ɔ]	691	1162	494	825
[ɒ̰]/ [ɔ̰]	597	1167	427	645

3.2. Vowel pharyngealization

Vowel pharyngealization reported in Purnell [1] (but not in Purnell [2], nor in Bruhn [3]) can be heard in the male speaker's pronunciation. However, pharyngealization in his pronunciation does not correlate with a particular tone as suggested by Purnell [1], but rather with some tokens of the long vowel [a:]. In the collected data, of the 29 tokens of [a:], 13 of them (44.9%) were produced with modal voice, 10 of them (34.5%) with creaky voice, and 6 of them (20.6%) were pharyngealized.

Formant frequency differences for the three variants of [a:] (Table 4) show not only differences between modal and creaky [a:] discussed earlier, but

also between [a:] and [a̰:], on the one hand, and [a:ˤ], on the other. What clearly separates [a:ˤ] from [a:] and [a̰:] is the rightward shift (lower F2), a trend also observed by Evans [8] in his analysis of pharyngealized vowels in Hongyan Qiang.

Table 4: Acoustic variation of [a:].

	F1	F2	F3
[a:]	720	1432	3251
[a̰:]	872	1496	3419
[a:ˤ]	792	1296	3246

4. DISCUSSION

The present study on the acoustics of Iu-Mien vowels has shown that all the vowels given in Table 2 are well differentiated on the basis of mean F1 and F2 values, except for the vowels [ɛ] and [æ] in the production of the male speaker. Also his vowel [ɒ] is much higher than expected, and is classified as the vowel [ɔ]. The study has also shown that [a:] is in fact a long vowel, different from [ɐ] not only on the basis of vowel qualities but also on the basis of duration. Finally, diphthongization [o] to [ɒo] has been found in the female speaker's production. In summary, the acoustic realizations of Iu-Mien basic vowels by the male speaker agree with the system used in Purnell [1, 2]. However, the acoustic realizations of Iu-Mien basic vowels by the female speaker agree with the system used in Bruhn [3].

Creaky vowels have been observed to occur not only with tone 21, as noted in Purnell [1], but also with tone 232. The acoustic analysis has shown that creaky phonation has the most striking acoustic effect in the production of the female speaker. In her pronunciation, [ḛ] and [a̰:] do not differ in quality from one another when laryngealized. The only difference between [ḛ] and [a̰:] is duration. Also her [æ] becomes a completely different vowel when laryngealized.

Pharyngealization occurs rarely. The analysis has shown that it does not correlate with a particular tone as noted in Purnell [1], but rather with just some occurrences of the long vowel [a:] in the production of the male speaker. Pharyngealized [a:ˤ] is characterized by a rightward shift (lower F2).

5. FINAL REMARKS

The study of the two speakers of Iu-Mien has shown that Purnell's and Bruhn's phonetic interpretations of the Iu-Mien vowel system are in fact supported. The study has shown that laryngealization and pharyngealization are present, but pharyngealization is sparse.

The next step in the research on Iu-Mien vowels would be to analyze the younger generation of Iu-Mien speakers, a generation that came to the US when they were teenagers. The purpose would be not only to study their vowel system, but also to see whether laryngealization is in tones 21 and 232, and whether any remnants of pharyngealization can be found in their speech.

6. REFERENCES

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