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# In rhetoric the passage from A to B is not equal to passage from B to A

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# AN ACOUSTIC STUDY OF NORTHERN KHMER VOWELS

David Thomas & Wanna Tienmee

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0. Introduction: Northern Khmer Phonology

Northern Khmer is spoken in northeastern Thailand in the provinces of Buriram, Surin, and Sisaket by perhaps 500,000 people. It is closely related to Central Khmer of Cambodia, 80-85% cognate on a 270-word basic list. This study is based on the speech of Mr. Kheuan Singkhanipa of Ban Khokrapeu, 5 km. south of Surin City.

Northern Khmer has typical Mon-Khmer consonant and syllable structure, with  $p\ t\ c\ k\ ?\ \beta\ \delta$ ,  $ph\ th\ ch\ kh$ ,  $m\ n\ \eta\ \eta$ ,  $w\ l\ r\ y$ ,  $s\ h$  as initial/medial consonants and  $p\ t\ c\ ?$ ,  $m\ n\ \eta\ \eta$ ,  $w\ l\ r\ y$ ,  $h$  as final consonants. Final  $-?$  sometimes varies to  $-k$ .

The vowel system contains 14 pure vowels and 3 offglided vowels (Table 1), as has been described by Smalley (1976) and Dhanan & Chartchai (1978). Each of these 17 vowels has contrasting long and short varieties. All 17 long vowels can occur in closed syllables, and all but uwa in open syllables. (And the uwa slot will probably be filled soon with loans from Thai.) All 17 short counterparts are pronounceable and distinguishable, but i, u, u are in nearly free variation with ɛ, ɤ, ɯ.

In terms of universals of vowel systems (Crothers 1978), Northern Khmer is atypical in both the number of basic vowels and their positions. By Crothers' typology Northern Khmer would be classified as 14:4, that is 14 basic vowel positions and 4 interior vowels (excluding a). The highest inventory in his sampling is Pacoh 12:3, which, not surprisingly, is also a Mon-khmer language. Or even if we take only the short vowel solid contrasts as basic, Northern Khmer would be rated 11:3, second only to Pacoh.

Crothers' universal no.12 states that the number of height distinctions in front vowels is equal to or greater than the number of distinctions in back vowels. But Northern Khmer has fewer front vowels (4) than back vowels (5).

ia	wa	ua
i	w	u
ɿ	ɥ	ʉ
e	ə	o
ɛ	ʌ	ɔ
	a	ɒ

Table 1. Northern Khmer Vowel System

### 1. The Experiment

Using a Kay Sonagraph model 7029A at Mahidol University we made spectrograms at four sessions over a period of several months using the same informant.

At first we tried using both narrow and wide band filters, but later switched entirely to the wide (300 Hz) filter.

We varied the range between 20-2000, 40-4000, and 80-8000 Hz. The 80-8000 range was most useful for the higher formants (F<sub>3</sub> and higher) but made it harder to get precise readings on F<sub>1</sub> and F<sub>2</sub>. The 20-2000 range was most useful with the back vowels, whose formants tended to smear together at the other ranges. The 40-4000 range was most useful in general for our purposes, so the majority of our spectrograms were made at this range.

The data consisted of the informant pronouncing monosyllables with the 17 vowels in the environments pVV, pVVp, pVp. Some of these monosyllables were meaningful morphemes, others were hypothetical but phonologically correct. The informant had no hesitation reading any of them, using a writing system adapted from Smalley (1976). We decided to include the open syllable pwwa, though that is presently a vacant hole in the phonological system, since wwa, is present elsewhere in the system, and loans from Thai are starting to fill this hole. And we included the short pɿp, pɥp, pʉp, as they are clearly phonetically distinct though their phonemic status is marginal. We decided to keep the environments identical to facilitate comparison, and chose [p] as the consonant before and after the vowel.

In reading the spectrograms we estimated the middle of a formant band, then using the calibration markings on the spectrogram estimated the frequency to the nearest 100 (or sometimes 50) cycles. The frequency estimates were naturally more precise at the 20-2000 range than at 80-8000, but the band centers were sometimes harder to ascertain at 20-2000.

The results cited in section 3 are averages of the figures obtained as described above, so they should be taken with the caution that they are not as precise as it might appear. The number of (decipherable) utterances of a particular syllable ranged from about 4 to 8 utterances on open syllables, and from about 2 to 7 on closed syllables.<sup>2</sup>

## 2. Results

Average frequencies of  $F_1$  and  $F_2$  in open syllables are given in Table 2 and diagrammed in Figure 1.<sup>1</sup>

	$F_1$	$F_2$		$F_1$	$F_2$		$F_1$	$F_2$
ia	380	2350		435	1485		500	780
	725	1675	( <i>uwa</i> )	660	1380	<i>uua</i>	760	1360
ii	320	2450	<i>uw</i>	330	1550	<i>uu</i>	385	775
ɛɛ	385	2350	ʏʏ	485	1450	ʊʊ	505	790
ee	500	2250	əə	550	1420	oo	520	875
εε	600	2100	ʌʌ	650	1400	ɔɔ	610	960
			aa	825	1475	ɔɔ	785	1120

Table 2. Average Frequencies of  $F_1$  and  $F_2$  in Open Syllables

The actual (approximate) readings varied quite a bit from spectrogram to spectrogram due to differences of fundamental frequency with each recording, and due to natural error in reading the spectrograms. But the distances between  $F_1$  and  $F_2$  remain roughly the same, thus showing a consistent vowel quality. The diagram in

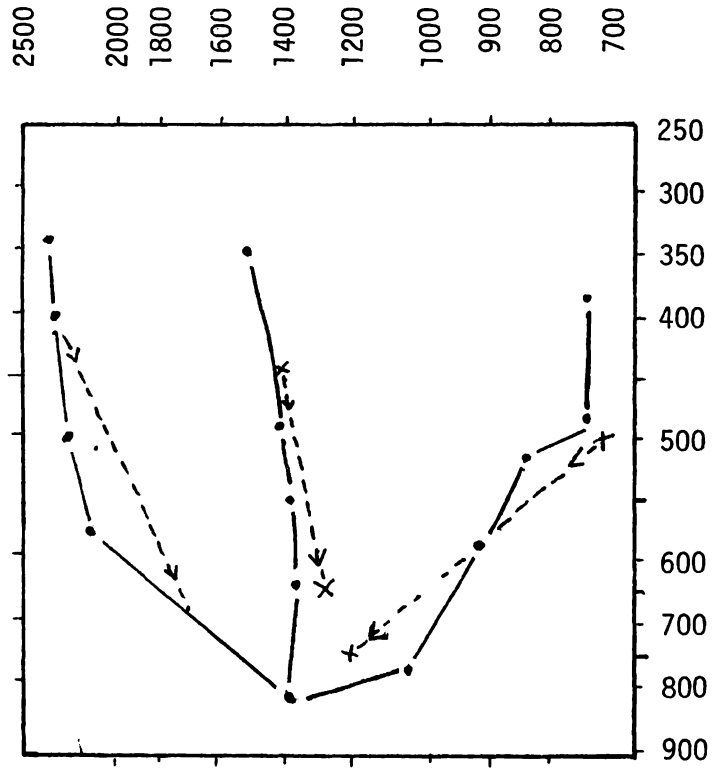


Figure 1. Vowels in open syllables



Figure 2. shows the scatter on the 14 open syllable pure vowels. (We have plotted the scatter on a linear scale rather than a logarithmic scale because it shows better the normal scatter from a center which results from reading linear scale spectrograms.) Apart from the large overlapping of  $\text{əə}$  with its neighbours, the vowel areas are generally discrete, even with this crowded 14-vowel system.

The scatter of the long closed vowels generally agrees with that of the open syllable vowels. But the scatter chart of the short closed vowels shows the front vowels tending to move about 200 Hz toward central, and the high central vowel lowering by about 100 Hz.

The offglides show a wide scatter in both beginning and ending points (because there are only three offglides in the vowel system). The beginning points tend to center near /ʌ/, /ɤ/, and /ʊ/, and the end points are somewhere near /a/. There is a slight tendency for the short offglides to start lower and end higher than the long or open offglides.

We may conclude from this study that the 14 Northern Khmer lower vowel qualities are as acoustically contrastive as they are phonologically contrastive. Only /əə/ has large overlap with its neighbours. And it may be noted that the offglides tend toward [a] rather than [ə].

### Footnotes

1. The first author is primarily responsible for the Northern Khmer data, the second for the spectrography, and both jointly for the conclusions. This preliminary version of the paper was presented at the 15th Sino-Tibetan Conference, Beijing, China, Aug. 17-19, 1982.
2. Through an oversight we got only two samples of  $\text{pɛɛ}$ , but the  $\text{pɛɛp}$  data generally confirmed the  $\text{pɛɛ}$  findings.

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