TONOGENESIS IN KHMER

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0 Introduction

Physiological constraints of the articulatory and/or auditory mechanisms have been proposed as the source of sound changes for some time (e.g., Hombert 1977 and references therein, Ohala 1971, 1974, 1981b, 1989, 1993). As pointed out by Hombert (1977), these explanations imply that the speaker's pronunciation may not be perceived as intended. The distortion may occur due to articulatory and auditory constraints, which affect the way the sounds are produced and perceived by listeners. Ohala (1993) reviews many sound changes and proposes a typology of sound change in which variation in speech due to coarticulation (among other things) can fail to be corrected by the listener (hypo-correction) or corrections can be erroneously applied (hyper-correction). As coarticulations or reductions are greater in faster speech (e.g., Guion 1998, Moon, Lindblom & Lame 1995, Lindblom 1990), one might expect more hypo-correction in fast speech forms. Preliminary evidence for such a proposal was given in Guion (1998) in which faster speech forms were found to be more similar acoustically to post sound change forms than citation speech forms.

The goal of this paper is to report on tone development in Khmer (Cambodian). Based on previous research, it will be proposed that this development is largely phonetically motivated. Moreover, we propose that the sound change has its origins in faster, colloquial speech.

1 Tone Development in Khmer

Recently, Thach (1999) has reported a sound change in dialects of Khmer spoken in Vietnam in which consonant + [r] clusters in onset position of main syllables lose the [r] and gain a falling tone on the following vowel (e.g., [krɒː] > [kɒ̀ː] 'poor'). The sound change is quite advanced in these dialects, especially among younger speakers. Through this sound change, tone has been introduced and there are now minimal pairs such as [kɒ̀ː] 'poor' (from [krɒː]) and [kɒː] 'neck'. Additionally, Thach (1999) reports that the trill [r] has become a glottal fricative [h] in syllable initial position in main syllables. Informal observation of the Khmer spoken in Cambodia suggests that a similar sound change is happening there as well.

The sound change in Khmer spoken in Cambodian to be investigated here involves monosyllabic words[1] with a consonant cluster onset. The first consonant in the cluster is an obstruent and the second member is an alveolar trill [r]. This sound change occurs only in colloquial pronunciation, but not careful reading pronunciation. In colloquial pronunciation, the alveolar trill [r] in a voiceless obstruent + [r] sequence is dropped or becomes a fricativized voiceless aspirated [r]. In most cases, the initial voiceless unaspirated stop also changes into a voiceless aspirated stop. If the vowel involved is a

Ratree Wayland, John Hartmann & Paul Sidwell, eds. *SEALSXII: papers from the 12th meeting of the Southeast Asian Linguistics Society (2002)*. Canberra, Pacific Linguistics, 2007, pp.145-152.

short low front [a] vowel, it becomes the diphthong [ea]. More importantly, a distinct rising pitch contour is also evident in words having undergone the changes.

2 Acoustic Analysis

The goal of this analysis is to determine acoustically whether or not the above mentioned sound changes have indeed occurred. To this end, an acoustic analysis of a subset of words undergoing these changes is undertaken.

2.1 *Method*

Speaker: A male native speaker of Khmer from Phnom Penh served as the speaker. He is in his 40's and has been living in the United States for approximately 5 years at the time of recording. No known speech or hearing impairment was reported.

Stimuli: Stimuli were 13 Khmer words (see Appendix) elicited from the speaker. Nine out of the thirteen words begin with a voiceless stop consonant, three with a voiceless affricate and one with a voiceless fricative. The speaker was instructed to read the words from the wordlist at a normal speaking rate. For comparison purposes, the speaker was instructed to first say the word as he normally would if he were to read it from a book (spelling or reading pronunciation), and second as he would in a conversation to another Khmer speaker (colloquial pronunciation). Each word was repeated three times in random order.

2.2 *Procedure*

Recording of the wordlist was digitized on a Kay Elemetrics CSL station (Model 4300B) at a sampling rate of 25 kHz. Each word was edited and stored as a separate file for further analysis using Cool-Edit (www.syntrillium.com). Subsequent acoustic analyses were performed using Kay Elemetrics MultiSpeech. Acoustic measurements included voice-onset-time (VOT) for words with stop initials, frication duration for words with affricate initials, vowel fundamental frequency (F_0) and frequencies of the first and second formants (F1, F2).

2.3 *Results*

VOT: Mean VOT duration of initial stop consonants for both modes of pronunciation is shown in Table 1. With the exception of [krɒ:] 'poor', VOT duration of initial stops in colloquial speech was generally longer than that of the reading pronunciation (mean = 44 vs. 27 ms). Result of a paired t-test supported this observation ($t = 2.06$, $p < .0001$, $df = 26$). This finding confirmed that, in most cases, a voiceless stop [p, t, k] initials in reading pronunciation became aspirated in colloquial pronunciation.

Table 1: *Mean VOT duration (in ms) for stop initials in reading and colloquial modes of pronunciation.*

Word	Colloquial	Reading
[pram] 'five'	39	13
[praə] 'use'	31	15
[prap] 'tell'	34	13
[pruəy] 'sad'	42	33
[priəy] 'spirit'	34	21
[trɨw] 'correct'	52	45
[kru] 'teacher'	51	36
[krɒː] 'poor'	50	51
[krŏən] 'enough'	66	21
Mean	**44**	**27**

Fricative Noise Duration: Mean fricative noise duration after the burst of a voiceless affricate initial is shown in Table 2. As expected, for all three words, fricative noise duration was longer for colloquial than for reading pronunciation (mean = 82 vs. 66 ms.). This difference was significant in a paired t-test (t = 2.31, p <.01, df = 8). This finding suggested that a voiceless affricate [t͡ɕ] in reading pronunciation became a voiceless aspirated affricate [t͡ɕ^{h}] in colloquial speech.

Table 2: *Mean fricative duration (in ms) of voiceless affricate [t͡ɕ] in reading and colloquial pronunciation.*

Word	Colloquial	Reading
[t͡ɕroʊt] 'harvest'	82	69
[t͡ɕrɨw] 'deep'	80	62
[t͡ɕrŏəm] 'muddy'	84	67
Mean	**82**	**66**

As for [s] in [srəy] 'female', an auditory as well as a spectrographic examination (Figure 1 and 2) suggested that, in most cases, it became a voiceless aspirated affricate [t͡ɕ^{h}].

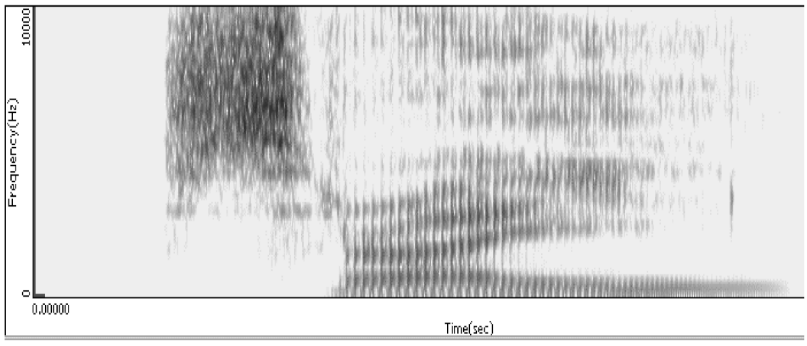

Figure 1: *Spectrogram of [srəy] 'female' in reading pronunciation.*

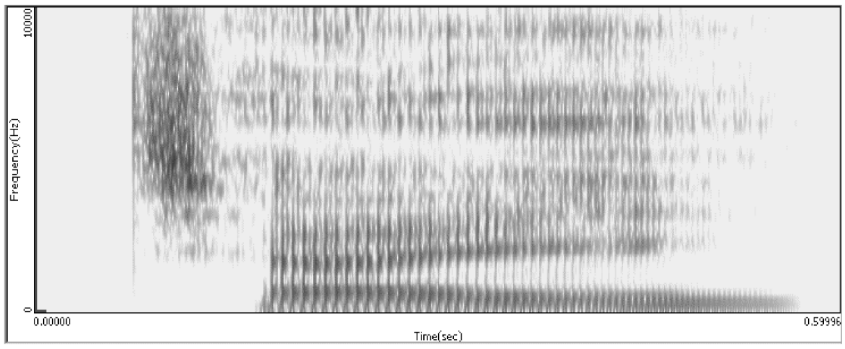

Figure 2: *Spectrogram of [srəy] 'female' in colloquial pronunciation.*

It should be mentioned, however, that the replacement of the alveolar trill [r] with aspiration was not always complete. In some cases, it became a fricativized voiceless aspirated [r].

F_0 Contour: F_0 contours (in Mels) for colloquial and reading pronunciation averaged across all words is illustrated in Figure 3. In general, F_0 values at vowel onset (182 vs. 181 mels) and at vowel offset (244 vs. 249 mels) are comparable in both types of pronunciation. However, while F_0 continues to rise in reading pronunciation, there is a sharp decrease in F_0 value at 50% in the vowel for colloquial speech pronunciation (t = 2.18, p <.006, df =12). Thus, while rising pitch contour is the characteristics of reading pronunciation, colloquial pronunciation is best characterized with a falling-rising contour.

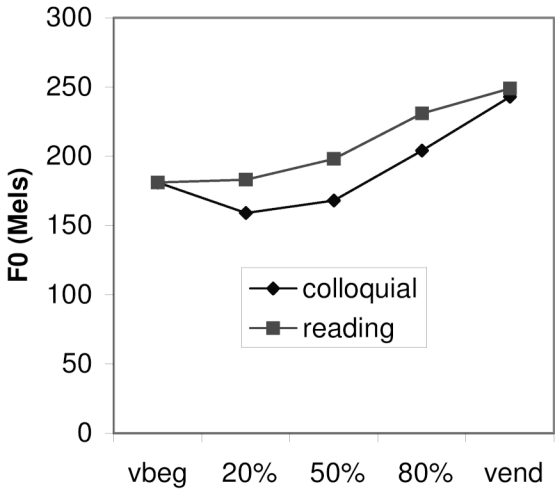

Figure 3: *Normalized F_0 contours for reading and colloquial pronunciations.*

A Vowel Quality Change: The change from [a] to [ea] is evident in the spectrograms derived from the two different pronunciations of [prap] 'to tell' included in Figure 4 and 5. The locations and movements of the first two formants of the vowels in the two spectrograms clearly showed a change from a monophthong [a] to a diphthong [ea].