



Incipient tonogenesis in Phnom Penh Khmer: Acoustic and perceptual studies



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ABSTRACT

Unlike many languages of Southeast Asia, Khmer (Cambodian) is not a tone language. However, in the colloquial speech of the capital Phnom Penh, /r/ is lost in onsets, reportedly supplanted by a range of other acoustic cues such as aspiration, a falling- or low-rising f₀ contour, breathy voice quality, and in some cases diphthongization, e.g. /kra:/ 'poor' > [kʰə], [kʰə̃], [kə̃], /kru:/ 'teacher' > [kʰu:], [kʰū:], [kʰu:]. This paper presents the results of production and perception studies designed to shed light on this unusual sound change. Acoustic evidence shows that colloquial /CrV/ forms differ from reading pronunciation forms in terms of VOT, f₀, and spectral balance measures, while a pair of perceptual studies demonstrate that f₀ is a sufficient cue for listeners to distinguish underlying /CrV/-initial from /CV/-initial forms, but that F1 is not. I suggest that this sound change may have arisen via the perceptual reanalysis of changes in spectral balance, coupled with the coarticulatory influence of the dorsal gesture for /r/.

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1. Introduction

Khmer, the national language of Cambodia, is notable for being a non-tonal language in what may be the most 'tone-prone' area of the world (Matisoff, 1973). However, an incipient tone contrast has been reported in the colloquial speech of the capital Phnom Penh (henceforth PP) for at least 50 years, albeit in a highly restricted context: in words containing /r/ in onset position such as /kru:/ 'teacher' or /rien/ 'to learn', the /r/ is reportedly supplanted by aspiration and some type of f₀ contour, resulting in pronunciations such as [kʰū:] or [hien]. Since Khmer contrasts plain and aspirated stops in onsets¹ (see Table 1), this suggests that the contrast in PP between forms like /kru:/ 'teacher' and /kʰu:/ 'old', or between /rien/ 'to learn' and /hien/ 'to dare', may now be maintained colloquially by a difference in pitch. Setting aside the analytic issue of whether or not this constitutes a phonemic use of f₀, it is extremely interesting for researchers interested in the process of tonogenesis, as such a pathway has not been described for any other language.

While this phenomenon has been noted in the literature for some time, existing descriptions are inconsistent. The earliest accounts (Huffman, 1967; Noss, 1966) describe a (low) rising tone and a deleted or spirantized trill, e.g. /kru:/ > PP [kʰu:], /rien/ > PP [hien]. Pisitpanporn (1994, 1999) reports loss of /r/ in PP as accompanied by increased post-release aspiration in addition to a falling–rising pitch contour, transcribing the PP pronunciations of Standard Khmer forms like /kru:/ as [kʰū:]. Post-release aspiration of colloquial /CrV/ forms was also found by Wayland and Guion (2005) in an acoustic study of the speech of two male speakers of PP Khmer. While one speaker displayed a falling–rising f₀ contour, the other showed low-rising f₀ in colloquial forms.

In addition to pitch and aspiration, vowel quality differences may also accompany loss of /r/ in PP Khmer. Forms containing the low vowels /a a: / have been described as being produced with diphthongs [ea] and [ɔa], e.g. /tra:/ 'seal, stamp' > PP [tʰeǎ], /kra:/ 'poor' > PP [kʰɔǎ], while the diphthong /ae/ may be produced as a monophthong /e:/ or /ɛ:/, e.g. /sraek/ 'shout' > PP [sɛ:k] (Pisitpanporn, 1994, 1999; Wayland & Guion, 2005). Filippi and Vicheth (2009) transcribe PP variants of Standard Khmer forms such as /kra:/ and /kru:/ as [kə̃] and [kʰu:], suggesting that breathy voice quality, previously an important feature of Khmer pronunciation and one still preserved in some conservative dialects (Wayland & Jongman, 2003), may also play a role in colloquial PP Khmer.

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¹ Despite the existence of a large number of minimal pairs supporting a classical phonemic distinction between aspirated and unaspirated voiceless initial stops, traditional accounts (e.g. Henderson, 1952; Huffman, 1967; Pinnow, 1980) analyze these forms as a sequence of stop + /h/, citing alternations such as /tʰom/ 'big' ~ /tomhom/ 'size' or /kʰəŋ/ 'angry' ~ /kamhəŋ/ 'anger' as evidence for the separability of the stop and /h/ by the nominalizing infix -Vm-.

Table 1

Three types of onsets in Standard Khmer: plain stops, aspirated stops, and stop +/r/ clusters.

/pi:/	'two'	/p ^h i:/	'grandly'	/pri:/	'plug'
/ta:/	'grandfather'	/t ^h a:/	'to say'	/tra:/	'seal, stamp'
/ku:/	'pair'	/k ^h u:/	'old'	/kru:/	'teacher'

Thus, the first goal of the present study is to provide a thorough analysis of the acoustic realization of both standard and colloquial PP Khmer /CrV/ forms, in order to compare their acoustic properties to one another as well as to /CV/ and /C^hV/ forms. The focus here is on acoustic measures of aspiration (VOT), pitch (f0), vowel quality (F1/F2), voice quality (H1*–H2* and H1*–A3*), and the realization of /r/.

The second goal is to assess the perceptual salience of likely cues to colloquial /CrV/ forms. While words such as /ka:/ 'neck' and /kra:/ 'poor' may indeed be produced with differences in fundamental frequency and/or vowel height, it has not been demonstrated that the magnitudes of these differences are actually salient to native listeners. In order to determine whether, and to what degree, listeners can use differences in f0 or F1/F2 to identify colloquial /CrV/ forms, a pair of perceptual identification task was conducted in which f0 or F1/F2 was systematically manipulated along with other potentially salient acoustic cues.

The third goal of this study is to use the production and perception findings to assess potential explanations for this unusual sound change. Two possibilities are considered here. Wayland and Guion (2005) suggest an articulatory–aerodynamic explanation, based on the cross-linguistic tendency for trills to devoice in faster or colloquial speech (McGowan, 1992; Solé, 2002). Their idea is that the high rate of airflow necessary for trilling may have led to a higher rate of vocal fold vibration at the onset of the vowel, subsequently conditioning a greater drop in f0 relative to forms not containing a trill. If the trill were to devoice, this increased airflow may have then been reinterpreted either as /h/ or as aspiration on the preceding consonant, and the resulting pitch contour could have been reinterpreted as a tonal feature of the vowel. The diphthongization of low vowels is hypothesized to be a coarticulatory effect of the trill, presumably motivated by the observation that the dorsal gesture associated with /r/ results in a raised tongue body resembling vowels such as /ɪ/ or /ɔ/ (Gick, Campbell, Oh, & Tamburri-Watt, 2006; Gick, Kang, & Whalen, 2002).

Variation in the realization of /r/ raises another possibility, however. Trills are often found to vary cross-linguistically with taps, approximants, and especially fricatives, both voiced and voiceless (Ladefoged & Maddieson, 1996; Solé, 2002). If the resulting frication noise was to extend into the onset of the nucleus, this could cause vowels in /CrV/ contexts to be perceived as breathy (Klatt & Klatt, 1990). Breathiness frequently co-occurs with low f0 (Ohala, 1973) and can perceptually condition F1 lowering (Lotto, Holt, & Kluender, 1997); as such, it has often been implicated in the diachronic development of both diphthongization patterns and 'register' systems, where a language's vowels are separable into groups differing in height, pitch, and/or voice quality (Denning, 1989; Huffman, 1976). The process by which Khmer acquired its sizeable inventory of vowels almost certainly involved a stage of contrastive voice quality (Ferus, 1992; Henderson, 1952; Wayland & Jongman, 2002), and some scholars have proposed that the canonical path to tone is similarly mediated by phonation type contrasts (Diffloth, 1989; Pulleyblank, 1978; Thurgood, 2002). If fortition or devoicing of /r/ does condition the percept of breathy phonation, the development of both f0-based contrast and diphthongization would be consistent with this more general hypothesis.

One means of assessing these hypotheses is to look for evidence of the relevant phonetic precursors in standard/careful productions of /CrV/ forms. The articulatory–aerodynamic hypothesis predicts that, if the source of the pitch contour and diphthongization in colloquial forms are coarticulatory effects induced by /r/, these effects should be present to a greater degree in standard /CrV/ forms compared to /CV/ and /C^hV/ forms. The breathiness hypothesis is more difficult to test directly. However, synchronic variation in the realization of /r/, or evidence that voice quality plays a significant role in the production and/or perception of colloquial /CrV/ forms, would be consistent with such an evolutionary trajectory.

The remainder of the paper is organized as follows. Section 2 provides the relevant details of Khmer phonetics and phonology. Section 3 presents the results of the production study. Colloquial PP forms are found to be characterized by increased post-release aspiration and breathy phonation in addition to previously described differences in f0 and F1. Furthermore, considerable variation in the realization of /r/ is also observed, including frication as well as devoicing. Section 4 demonstrates that f0 is a sufficient cue for listeners to distinguish underlying /CrV/ from /CV/ forms, but that other cues may serve to enhance this contrast. Conversely, listeners do not appear to use variation in F1 as a cue to lexical identity. Section 5 discusses the implications of these findings in the broader context of the evolution of tone and register systems.

2. Khmer language

Khmer is the sole member of the Khmeric branch of the Mon-Khmer group of Austroasiatic languages. It is spoken natively by around 13 million people in Cambodia as well as over a million ethnic Khmers in Vietnam. Northern (Surin) Khmer, spoken in Thailand, claims at least another half million speakers (Diffloth, 2003). There are also sizeable Khmer diaspora in Canada, China, France, Laos, and the United States.

Most varieties of Khmer have the consonant inventory /p b m w t d s n l r c ɲ j k ŋ h ʔ/ (and, arguably, an aspirated stop series /p^h t^h c^h k^h/; see Diffloth, 2003 and footnote 1 above). Of these, only /b d r s/ are prohibited word-finally. Implosion of /b d/ > [ɓ ɗ], while possibly canonical, is non-contrastive. While we focus here only on /Cr-/ clusters, Khmer admits a large number of complex onsets (Huffman, 1972).

/r/ has alternately been described as a 'lingual roll' (Henderson, 1952), a retroflex flap (Huffman, 1970), and an alveolar trill (Huffman, 1967; Wayland & Guion, 2005). The palatal plosive /c/ is generally realized as a palato-alveolar affricate [tʃ] (Wayland & Guion, 2005). The realization of the semivowel /w/ may vary considerably: Henderson (1952) reports variation between [w], [v] and [u], while Filippi and Vicheth (2009) transcribe it as [β] in onsets but as [i] in codas.

The vowel inventory of Khmer is a matter of considerable debate and varies with dialect, but proposals are invariably large (Diffloth, 2003; Headley et al., 1997; Huffman, 1970). Here we adopt the notation of Huffman (1970), who suggests that a minimally accurate system must contain no fewer than 31 nuclei: 10 long vowels /i: e: ɛ: i: ə: a: u: o: ɔ:/, 8 short vowels /i e i ə a ɔ u o/, 10 long diphthongs /iə iə uə ei əi ou ae əə ao ɔə/ and 3 short diphthongs /eə uə ɔə/.

As noted above, Khmer vowels are usually described as falling into one of the two 'registers', the consequence of a historical process of initial obstruent devoicing which resulted in a doubling of the previous vowel inventory (Pinnow, 1980). The original laryngeal contrasts are thought to have

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