Intrusive Schwa in Khmer

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1 Consonantal Phasing Relations

C-center Languages
- Consonants are anti-phased with each other
- All consonants are in-phase with the following vowel
  - Vowel onset is aligned with the durational midpoint of the consonants.
  - Timing lag between the rightmost consonant and the following vowel becomes shorter (Goldstein et al. 2007).

Simplex-timed Languages
- Consonants are anti-phased with each other
- Only the rightmost consonant is in-phase with the following vowel
  - Vowel onset is aligned with the durational midpoint of the rightmost consonant only.
  - Lag between the rightmost consonant and the following vowel remains constant, no matter the number of word-initial consonants.
- Schwa-like material often intervenes between the consonants, e.g. Tashlhiyt Berber (Ridouane and Forgeron 2011)

2 Khmer

1. Contains class of words that are claimed to have intrusive schwas

<table>
<thead>
<tr>
<th>Word Types</th>
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<tbody>
<tr>
<td>Monosyllables</td>
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<tr>
<td>Dissyllables and longer</td>
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<tr>
<td>Sesquisyllables</td>
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2. Has a large inventory of word-initial consonant sequences, which are claimed to be produced in various ways (Huffman 1972)

Khemer Consonant Clusters

3 Experimental Methods and Predictions

3.1 Method
- 18 Khmer speakers, ages 18 – 44 (µ = 27), recorded in Phnom Penh
- Word types include: CCVC/CcVC/CcVC: 20
  - ACCVC: 4
  - CcC: 13
- Randomized and produced in frame: [ni]ji [m] long size]
- 3 repetitions, 2nd repetition analyzed

3.2 Possible Outcomes

1. Voiced Underlap: Produced with an intrusive schwa ([ᴐ]) between C1 and C2, which is characterized by formant structure of the two consonants.
2. Voiceless underlap: Produced with non-harmonic material ([ᴐ]) between C1 and C2, (refer to Huffman (1972) as aspiration). Note that this can be obscured in the context of fricative noise.
3. No underlap: Gestures are overlapping or adjacent such that nothing intervenes between C1 and C2.

4 Results

4.1 Distribution of Intrusive Schwa

For non-sibilant C1s:
- All voiceless underlap follows a voiceless C1
- All voiced underlap follows a voiced C1, except for [pr] sequences

4.2 Duration

- Differences in consonantal context were controlled for using residuals resulting from a regression of durations by consonant types.
- Durations of voiced and voiceless underlap were compared with each other and with underlying unstressed [ᴐ].
- Underlap type is correlated neither with underlap duration nor the total duration of the CC sequence.
- In general, underlap is significantly shorter than [ᴐ].

4.3 Formants

- F1 values are significantly lower for voiced [ᴐ] than for [ᴐ] (p < 0.0001), although some overlap is present.
- F2 values for [b] have a wider distribution than F2 values for [ᴐ].
- Formant values for [b] are more affected by the preceding consonant than are formant values for [ᴐ].

5 Conclusions

- Intrusive schwa in Khmer is not durationally distinct from inter-consonantal aspiration, and its presence is highly predictable from consonantal context. This suggests that it is a voiced transition period, or underlap.
- Underlying [ᴐ] vowels are longer than intrusive schwa. Their F1 values are higher and their F2 values are less variable. This is consistent with intrusive schwa's status as a transition state without a gestural target.
- The pervasive presence of intrusive schwa/underlap suggests that Khmer is a simplex-timed language that does not exhibit the C-center effect, although articulatory tests are needed to verify this claim.