Testing the perceptual basis of laryngeal metathesis and rarity of preaspirated stops

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I. Introduction

- Observations about [hC] and [Ch] sequences:
  1. Cross-linguistically, postaspirated stops are more common than preaspirated stops (Silverman 2003)
  2. Laryngeal metathesis often results in [h] 'locking' on the stop release (Yoon 2012)

- Directional asymmetries in place assimilation: A perceptual account. In Elizabeth Hume & Keith Johnson (eds.), Predicting metathesis: The ambiguity/attestation model. Available as ROA-546 from the Rutgers Optimality Archive. Ohio State University, ms.

- An experimental and formal investigation of Sevillian Spanish metathesis (Clayton 1990)


- English: HC/C ~ CH/C
- French: HC/C > CH/C

II. Experiment Design

- ABX discrimination task
  - Trisyllabic nonce words with /aCa/ sequences
  - 3 conditions (C, HC, CH)
  - Acoustically manipulated to match within word sets (intonation contour, duration of [h])
  - Recorded by male native speaker of Turkish (has both CH and HC sequences)
  - Presented in all orders (ABA, ABB, BAA, BAB) with ISI of 500ms

- How perceptible is [h] before a stop? /aCa/ lan`a-ya lan`a-ya lan`a-ya (ABA)
- How perceptible is [h] after a stop? /aCa/ lan`a-ya lan`a-ya lan`a-ya (ABA)

- 20 native-speaker listeners of Arabic (Levantine varieties), English (U.S.) and French (France), recruited on Prolific (excluded for low accuracy on controls)
- Languages differ in presence and phonological status of HC and CH sequences

<table>
<thead>
<tr>
<th>Language</th>
<th>HC</th>
<th>CH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arabic</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>English</td>
<td>No</td>
<td>Yes – Asp. Stop</td>
</tr>
<tr>
<td>French</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Hypothesis 1: Perceptual optimization

- Perception of [h] is perceptually weaker before a stop than after a stop

Hypothesis 2: Language-specificity

- Perception of [h] depends on native language experience (e.g., Worker & Tsoi 1984; Dupoux et al. 1999)
- Listeners perceive sequences that exist in their language better than sequences that do not

Selected References


III. Results

- Linear mixed-effects models (posthoc tests with emmeans [Lenth 2020])

Language group x Condition

<table>
<thead>
<tr>
<th>Arabic</th>
<th>HC/C ~ CH/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>HC/C &gt; CH/C</td>
</tr>
<tr>
<td>French</td>
<td>HC/C &gt; CH/C</td>
</tr>
</tbody>
</table>

Condition x Language group

<table>
<thead>
<tr>
<th>Arabic</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>HC/C</td>
<td>HC/C</td>
</tr>
<tr>
<td>/h/</td>
<td>/h/</td>
</tr>
</tbody>
</table>

- Results are contrary to those expected under the perceptual optimization hypothesis

|h| is either:
(a) easier to hear before a stop than after a stop (French)
(b) equally perceptible in both locations (Arabic, English)

- Results support language-specific perception

<table>
<thead>
<tr>
<th>Language</th>
<th>Properties</th>
<th>Result</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arabic</td>
<td>Phonemic /h/ as a coda</td>
<td>HC/C &gt; CH/C</td>
<td>Familiarity with both types of sequences, with /h/ as a contrastive phoneme</td>
</tr>
<tr>
<td>English</td>
<td>/h/ is phonemic, not allowed as coda</td>
<td>HC/C &lt; CH/C</td>
<td>Experience with aspirated stops helps perception of CH sequences, but not enough to put them above HC sequences</td>
</tr>
<tr>
<td>French</td>
<td>Has neither CH nor HC sequences</td>
<td>HC/C = CH/C</td>
<td>Maybe: Mapped [h] to phonemic French /w/ &gt; good discrimination, since contrast interpreted as /w/2 /C/ (Perceptual Assimilation Model, Buck &amp; Tyler 2007)</td>
</tr>
</tbody>
</table>

IV. Discussion & Conclusions

- High accuracy on HC sequences for all groups, contrary to findings in Mielke (2003) (methodological differences?)
- In line with other recent studies on [h] perception
  - Clayton (2010): [h] is not harder to perceive in HC than in CH for Gaelic (has HC and CH) or Polish (has neither HC or CH) listeners
  - Only English listeners have more difficulty with HC than CH (word-medially)
  - Heijna & Klimper (2018): British English listeners use preaspiration (HC) as cue to fortis-lenis contrast in stops, suggesting it is salient enough to be useful
- Cross-linguistic preference for postaspiration > preaspiration and directionality of HC → CH metathesis is not just perceptual
- Preaspiration may be rare because it is rarely innovated
- Preaspiration often strengthened by adding oral stricture (Silverman 2003)
- Metathesis may favor CH sequences because their gestural timing is more stable than HC sequences (Parrell 2011), or because laryngeal articulation prefers to ‘bind’ to stop release (Kingston 1990)
- Subtle perceptual factors not captured here (e.g., poor listening conditions affect HC more than CH)

- Outstanding questions on [h] in HC sequences
  - How do other cues interact in HC sequences to affect perception?
  - [h] in HC sequences is highly variable in production; variability absent from my data
  - Breathy transition (Ni Chasaide 1985), preceding vowel duration, stop closure duration
  - Preaspiration often strengthened by adding oral stricture (Silverman 2003)
  - Metathesis may favor CH sequences because their gestural timing is more stable than HC sequences (Parrell 2011), or because laryngeal articulation prefers to ‘bind’ to stop release (Kingston 1990)
  - How does the status of [h] in HC sequences affect perception?
  - Status of preaspiration differs cross-linguistically: variable/optional (e.g., Italian) vs. obligatory (e.g., Faroese (Helgason 2002))
  - In metathesis, [h] is adjacent to the stop, but does not featurally belong to it