Effects of phonological contrast on phonetic variation in Hindi and English stops

Introduction

- **Question:** How do different systems of phonological contrast affect patterns of phonetic variation?
- **Potential hypothesis:** Systems with more phonological contrasts should exhibit less within-category variation than systems with fewer contrasts (Lindblom, 1986).
- **Hypothesis:** Variation predicted by number of phonemes in an inventory.

But phonological contrasts are not unidimensional in phonetic space

- Issues with quantifying within-category variation: What are the relevant phonetic dimensions? What counts as a "system"?
- **Proposal:** We only expect less variation along the particular phonetic dimensions that realize additional contrasts.

Case study: Hindi and English stop consonants

- Hindi has four contrasting stops at each place of articulation; English has two.
  - Hindi velar stops: /g/ /g̥/ /k/ /k̥/
  - English velar stops: /g/ /k/

  - If variation is predicted by number of phonemes in an inventory, we might expect Hindi speakers to constrain variation on all dimensions, including lag time.
  - Hindi /k̥/ should vary less than English /k/ in voiceless lag time.

- If variation is predicted by additional contrast along a single dimension, Hindi speakers will only exhibit less variation along phonetic dimensions which distinguish additional contrasts relative to English.
  - Hindi /k/ and /g/ should vary less than English /g/ /k/ in voicing.

Phonetic dimensions in Hindi and English stops

<table>
<thead>
<tr>
<th></th>
<th>Hindi</th>
<th>English</th>
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<tbody>
<tr>
<td>Voicing</td>
<td>unaspirated</td>
<td>unaspirated</td>
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<tr>
<td></td>
<td>/k/</td>
<td>/g/</td>
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<td>[pre]voiced</td>
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<tr>
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- No difference expected in voiceless lag time (positive VOT) because the space of contrasts is the same in both languages.
- Difference expected in prevoicing because Hindi has additional voicing contrasts relative to English (Kagaya et al., 1975).

The Experiment

- Production task: Native speakers of each language read CVC words where first consonant was a stop followed by [a] or [u].
- 14 Hindi speakers and 9 English speakers recorded; 7 of each analyzed after exclusions.
- Carrier phrases: Say X again; Dobara X doharao.

Results: No difference in lag time variation

- All graphing and analysis done in R (R Core Team, 2013; Wickham, 2009).

Results: Prevoicing variation differs

Voicing in Hindi voiced stops

- All Hindi voiced stops
- Speaker with less voicing
- Speaker with most voicing

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Discussion and conclusion

- **Main result:** Patterns of variation are language-specific and relative differences can be predicted by how phonological contrasts are implemented.

- The mathematically intuitive "larger inventory = less variation" hypothesis is not trivially true. We have to acknowledge how contrasts are realized in phonetic space.
- Non-contrastive structure emerges when the contrastive structure allows variability.
- Future work: Comparing non-contrastive to contrastive phonetic dimensions in the same language. Statistical difficulty of comparing across dimensions/units.

Results: Prevoicing variation differs

- No difference in lag time variation

- Why are Hindi speakers just as variable as English speakers?
  - Levene’s Test for homogeneity of variance not significant.
  - Additional evidence for understanding prevoicing and lag as separate dimensions (Mikutel & Reetz, 2007)

Even non-contrastive variation is systematic

- The phonological system of English allows more prevoicing variation without threatening the maintenance of contrast.
  - Even though the variation is not contrastive, it is still structured by context.
  - Previous studies have reported more prevoicing before high vowels, citing an articulatory explanation (Smith, 1975).
  - This pattern emerges in English, but not Hindi.

- Hindi phonologically voiceless stops:
  - Hindi stops before [a]
  - Hindi stops before [i]
  - Hindi stops before [u]

- Hindi phonologically voiceless stops:
  - Hindi stops before [a]
  - Hindi stops before [i]
  - Hindi stops before [u]

- English phonologically voiceless stops:
  - English stops before [a]
  - English stops before [i]
  - English stops before [u]

- Hindi phonologically voiced stops:
  - Hindi stops before [a]
  - Hindi stops before [i]
  - Hindi stops before [u]

- English phonologically voiced stops:
  - English stops before [a]
  - English stops before [i]
  - English stops before [u]

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