The role of phonetic and phonological information in featural representation: 
Cue restructuring in English u-fronting

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**Overview**
- u-fronting (in the Northeast US) causes
  - /o/ and /u/ overlap in F2 (traditional cue of backness)
  - /o/ and /u/ to be distinguished by F1 (non-traditional cue of backness)
- Questions of the paper
  - What cues do listeners use to distinguish /o/ and /u/?
  - Do they carry over for the /o-/e/- contrast (not changing)?
- Bigger issues
  - Featural status of the front–back distinction in English
  - Role of phonetics and phonology in featural representations
  - Assessing support for distinctive features

**Theoretical Background**
- Observed class behavior when the distinction is both
  - phonetically natural (used similarly)
  - phonologically active (used in phonological patterns)
- E.g. English speakers extend phonotactic patterns on [+/-voice] to untrained segments (Cristiá & Peperkamp, 2012)
- But [+/-back] is phonologically inactive
- Theories of distinctive features (e.g. Jakobson et al., 1951; Chomsky & Halle, 1968; Hall, 2001) predict a feature for backness too

**Backness in English**
- Low level of phonological activity—few patterns use [+/-back]
  - UCLA PL learners did not learn any salient constraints
- Used to be phonetically natural, u-fronting might change that
  - Nationwide Speech Corpus (Clopper & Pisoni, 2006): F2 clearly distinguishes front vs. back vowels (top)
  - Lang and Davidson (2016): no F2 boundary can be drawn (bottom)

**Methods**
- Four-alternative forced-choice identification of synthesized stimuli
  Participants:
  - monolingual native speakers from the Northeast US
  - data from 27 participants
  Stimuli:
  - 256 unique tokens
  - vowels synthesized along 4 measurements (F1, F2, F3, and duration)
  - each measurement could be prototypical or in-between (2^3=16 combinations—conditions)
  - each condition was synthesized for all 4 vowels (16*4=64)
  - high pair: /o/ and /u/; mid pair: /i/ and /e/
  - 4 unique tokens for each vowel+condition combination (64*4 = 256)
  Task:
  - participants heard 1 sound/trial, had to identify which word it came from
  - blocked design: a mid and a high vowel block (randomized)
  - 4 alternatives for each (only underlined words were ideal responses)
    - high tokens: LICK, LEAK, LOOK, LUKE
    - mid tokens: HICK, SAKE, SOKK, SOAK
  Measurements—partial credit system:

<table>
<thead>
<tr>
<th>Ideal response: LACK</th>
<th>Backness: accurate</th>
<th>Backness: inaccurate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laxness: accurate</td>
<td>LICK</td>
<td>LOOK</td>
</tr>
<tr>
<td>Laxness: inaccurate</td>
<td>LEAK</td>
<td>LUKE</td>
</tr>
</tbody>
</table>

Accurate and inaccurate responses for a tick token

**Results: Backness**
- F1 is a good cue for high vowels (H: β = 0.63, p < 0.0001; M: p = 0.9967)
  - Unless /i/ is much lower than /u/ (prototypical F1), participants made a lot of front-back mistakes
- F2 is a good cue for mid vowels (H: p=0.81; M: β = -0.51, p<0.0001)
  - More mistakes in backness identification for mid vowels if F2 was in-between /o/ and /e/

**Results: Laxness**
- Duration is a good cue both pairs (β = -0.26, p < 0.0001)
  - More laxness mis-identification with in-between durational cues
- F1 (p = 0.004 > 0.0016), F2 (p > 0.05), and F3 (p > 0.05) are not useful
- Participants performed better in the first block (β = 0.22, p<0.0001)
- More mistakes on laxness in the second block

**Conclusions**
- /u o i/ clearly different perceptually
- Laxness is consistently cued across vowel heights (by duration)
- The cuing of backness is inconsistent—on a contrast-by-contrast basis
  - F1 for high vowels, F2 for mid ones
- This does not support a [back] feature in English; two possible reasons:
  - magnitude of the cue (F1 difference too small between /o/ and /e/)
  - type of the cue (speakers are not sensitive to F1 for mid vowels)
- Found evidence for a category-level representation of cues, but not for a class-level one
- Areas of further research:
  - other types of experiments on phonologically inactive distinctions
  - similar experiments on phonetically unnatural, but phonologically active distinctions