Articulatory patterns of monomorphemic and dimorphemic homophonous words

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Hypotheses and Methods
Hypothesis

- Given findings that phonetic signals (acoustic and articulatory) vary depending on the morphological structure (cf. Cho, 2011; Lee-Kim, 2013; Plag et al. 2017, etc.) we hypothesize that articulations of stem vowels in monosyllabic words will differ depending on whether the final coda will be morphemic or not (/aI#d/, vs. /aId/).
Methods

- 18 Speakers
- Number of [aId] words
  - 16 monomorphemic
  - 12 diphormpheric
- Categories
  - Dimorphemic (i.e. [aI#d])
    - pried (past)
  - Monomorphemic (i.e. [aId])
    - a) pride (noun)
    - b) pride (verb)
- Number of
  - Triplets = 3 (e.g. I pride, the pride, he's pried)
  - Doublets = 5 (e.g. I guide, the guide)
  - Single = 15 (the bride)
Presentation of stimuli

• Carrier sentence included „morphological marker“
  – Say „He's pried“ again (Vpast, dimorph)
  – Say „I pride“ again (Vpres, monomorph)
  – Say „the pride“ again (Nsng, monomorph)

• Experimental set up (Condition)
  – Blocked sessions (9 speakers)
    • First half of experiment: All dimorph words
    • Second half of experiment: All monomorph words
  – Mixed sessions (9 speakers)
    • Monomorph & dimorph words totally randomized across experiment
Phonetic effects: Overlay articulation (onset of [ai])

- Carrier sentence included „morphological marker“
  - Say „He's pried“ again (Vpast, dimorph)
  - Say „I pride“ again (Vpres, monomorph)
  - Say „the pride“ again (Nsng, monomorph)
Phonetic hypothesis: Carryover articulation (onset of [ai])

- Possible effects of carryover coarticulation from previous word
  - Say „He's pried“ again (Vpast, dimorph) → [hi:] + [ai]
  - Say „I pride“ again (Vpres, monomorph) → [aI] + [ai]
  - Say „the pride“ again (Nsng, monomorph) → [T@] + [ai]

- Hypothesis:
  Tongue height at [ai] onset after
  - [@] < [aI] < [i:]
  due to carry-over coarticulation
Additional hypotheses

- Given that morphemic boundaries are a locus of higher phonotactic variability, it is possible that a morphemic coda is less well learned than a non-morphemic coda, therefore we should find less anticipatory coarticulation between the vowel and the coda.

- Given known frequency effects, it is possible that “categories” with a higher average frequency of occurrence will show stronger reduced articulations.

Log Google counts for phrases:

<table>
<thead>
<tr>
<th>Phrase</th>
<th>Beta</th>
<th>SE</th>
<th>T</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vpast (Intercept)</td>
<td>9.3</td>
<td>0.56</td>
<td>16.4</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Morp Vpres</td>
<td>4.0</td>
<td>0.89</td>
<td>4.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Morph Nsng</td>
<td>7.0</td>
<td>0.84</td>
<td>8.3</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

**Mean tongue body positions**

- Vowels investigated
- Inflectional exponent

vertical axis

horizontal axis

- i
- I
- d
- s
- A
Analysis

- Tongue height of tongue body in [aI] across time.
- Smooths and tensors in Generalized Additive Mixed-Effect Model
- Individual models in each condition (Blocked, Randomized)
- Predictor structure
  - Controls
    - Time * Segment duration
    - Time * Frequency → not significant
  - Effect of interest
    - Time * Morphology (Vpast, Vpres, Nsing)
    - Time * Median tongue height in the last 20% of the previous word (to control for overlay coarticulation: HPrev. Values are ranked)
  - Random effects
    - Random factor smooths by participant
    - Random factor smooth by phrase (He's/I/the + word)
Analysis and Results
Analysis of vowel duration

- Vowel duration of [aI] analyzed in a linear mixed-effect model (predictors: frequency & word category, random intercepts for participants and words)
  - no significant differences between the dimorphemic Vpast and the monomorphemic Vpres and Nsng words were found
  - no effect of frequency of occurrence (google phrase counts, e.g. “he's pried”) was found

Fixed effects:

<table>
<thead>
<tr>
<th></th>
<th>Beta</th>
<th>SE</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>-1.57</td>
<td>0.064</td>
<td>-24.7</td>
</tr>
<tr>
<td>Frequency</td>
<td>-0.001</td>
<td>0.002</td>
<td>-0.768</td>
</tr>
<tr>
<td>Morphology: Vpres</td>
<td>-0.005</td>
<td>0.05</td>
<td>-0.093</td>
</tr>
<tr>
<td>Morphology: Nsng</td>
<td>0.04</td>
<td>0.06</td>
<td>0.690</td>
</tr>
</tbody>
</table>
Tongue height in [aɪ] – Randomized condition

- Tongue height in [aɪ]….
  - a) … is proportional in the entire vowel to tongue height in the last 20% of the previous word (HPrev).
  - b) … across time interacts with HPrev across time insofar as with HPrev values onset tongue positions in [aɪ] are lowered and offset positions are raised; the effect is reversed with high HPrev values.
  - c) Main effect in Vpast: tongue body describes a raising movement pattern across time
  - d) Partial effect (difference) to [aɪ] in Vpres: No significant difference to Vpast
  - e) Partial effect to [aɪ] in Nsing: No significant difference to Vpast

![Graphs and charts illustrating tongue height and movement patterns](chart1.png)

- “He's pried”
- “I pride”
- “The pride”
Tongue height in [aI] – Blocked condition

- a) … is proportional in the entire vowel to tongue height in the last 20% of the previous word (HPrev).
- b) … across time interacts with HPrev across time insofar as with HPrev values onset tongue positions in [aI] are decreased and offset positions are increased; the effect is reversed with high HPrev values.
- c) Main effect in Vpast: tongue body describes a u-shaped movement pattern across time
- d) Partial effect of [aI] in Vpres (i.e. difference to [aI] in Vpast): onset positions are lowered, offset positions are raised in contrast to Vpast
- e) Partial effect in Nsing: onset positions are lowered, offset positions are raised in contrast to Vpast

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a) Partial effect of HPrev
b) Partial Effect Interaction with HPrev
c) Effect of Time Vpast
d) Partial Effect Vpres
e) Partial Effect Nsing
```

“He's pried”
“I pride”
“The pride”
Absolute velocity across time

- Absolute movement velocity in [al] …
  - a & b) … is not affected by HPrev in the blocked but in the randomized condition. In both conditions Hprev interacts with time.
  - c) … is high at the onset in both conditions. In the blocked condition, it decreases towards ~ time point 0.6 and then increases towards the offset. In the randomized condition, it steadily decreases towards the offset.
  - d&e) is decreased at the onset and increased at the offset of the vowel in both conditions
Summary for [aId] words

- Effect of overlay coarticulation on onset
  - Hypothesis: [aI] following [T@] < [aI] < [hi:]
  - Results in blocked condition:
    [aI] following [aI, T@] < [hi:]
  - Results in randomized condition:
    [aI] following [aI] = [T@] = [hi:]

- Effects of morphological category onto entire trajectory in blocked condition
  - Larger tongue movement amplitude
    in monomorphemic than in dimorphemic words in spite of control for carryover coarticulation!

- Possible explanation for effect of condition:
  - uncertainty about morphology was lower in blocked condition than in randomized condition, where no expectation could be built up due to randomization
  - this possibly allowed speakers to come up with a strategy for articulation
Replication

Testing the model from [-aId] words in [-aUd] words

- **Material:**
  - monomorphemic (3 “I” words, 5 “The” words)
  - dimorphemic (4 “he's” words)

- **Analysis**
  - The same model like for [-aId] words

- **Peak on results:**
  - no effects at all (!!!) in the vertical axis, not even across time!
  - only an effect in the horizontal axis
Horizontal tongue body position in [-aU]+[d]

- Horizontal tongue body positions in [aU]...
  - a) … are proportional to frontness in previous word in both conditions
  - b) … are constantly retracted across time, but only so in blocked condition
  - c&amp;d) … show shallower retraction in the monomorphemic words in the blocked condition
Conclusion

- Effect of condition from [-aId] words replicated for [-aUd] words.
- Direction of effect is reversed insofar that articulations become smaller in the monomorphemic words.
Thanks for listening