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# 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 diphorphemic
- 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 expriment

# 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)

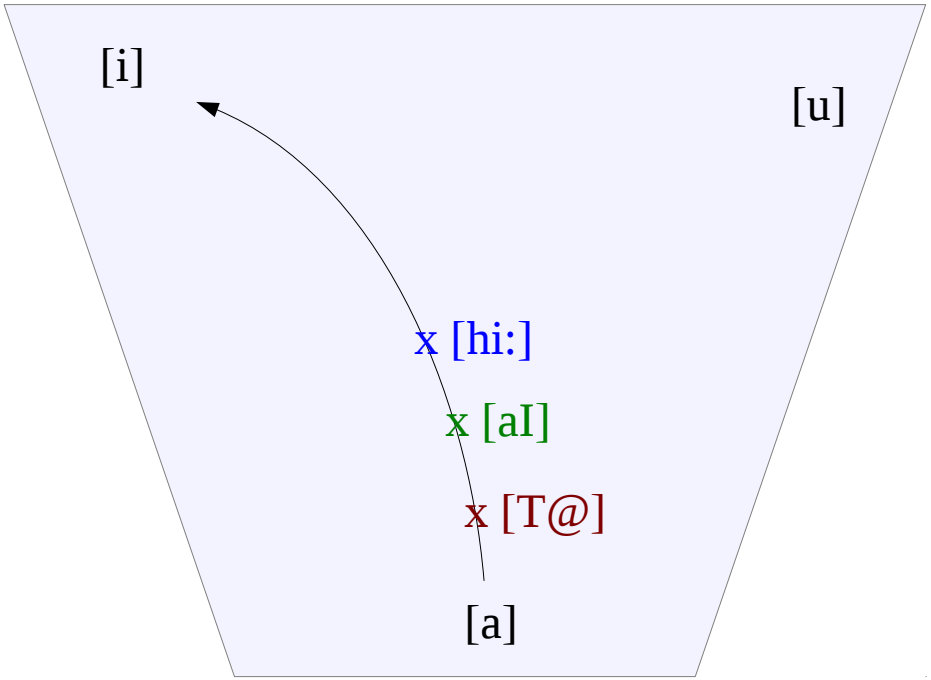
# Phonetic hypothesis: Carryover articulation (onset of [ai])

- 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

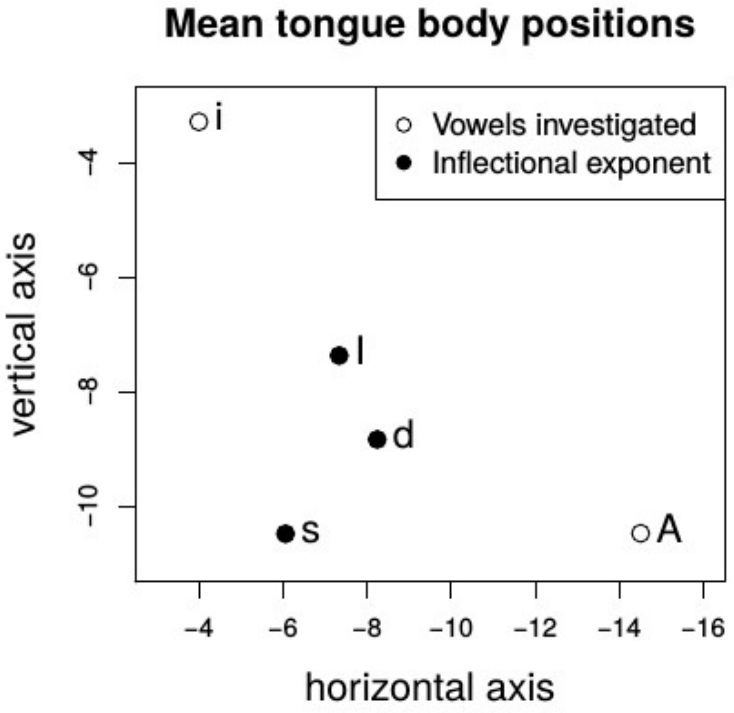
    coarticulation



# 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

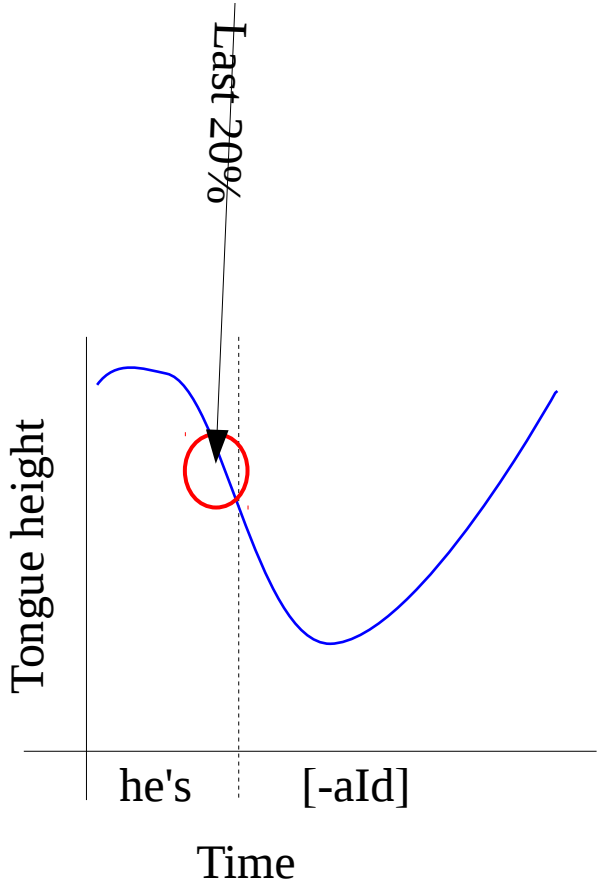



Log Google counts for phrases:

| | | Beta | SE | T | P |
|---|---|---|---|---|---|
| Vpast (Intercept) | | 9.3 | 0.56 | 16.4 | <0.001 |
| Morp | Vpres | 4.0 | 0.89 | 4.5 | <0.001 |
| Morph | Nsng | 7.0 | 0.84 | 8.3 | <0.001 |

# 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

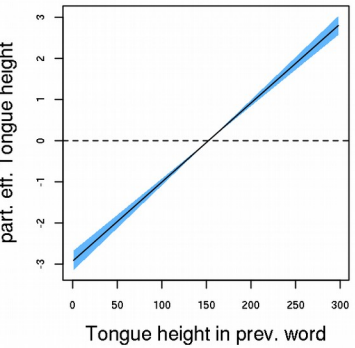
Fixed effects:

| | Beta | SE | T |
|---|---|---|---|
| (Intercept) | -1.57 | 0.064 | -24.7 |
| Frequency | -0.001 | 0.002 | -0.768 |
| Morphology: Vpres | -0.005 | 0.05 | -0.093 |
| Morphology: Nsng | 0.04 | 0.06 | 0.690 |

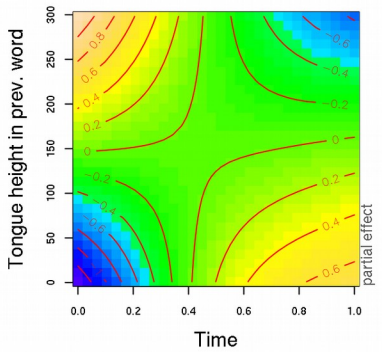
# Tongue height in [aI] – Randomized condition

- Tongue height in [aI]….
  - 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 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 [aI] in Vpres: No significant difference to Vpast
  - e) Partial effect to [aI] in Nsing: No significant difference to Vpast

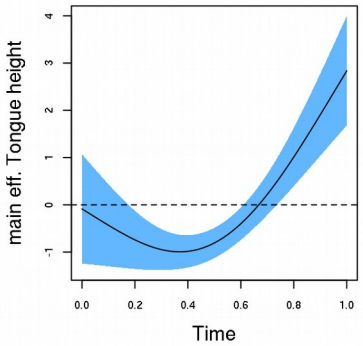
a) Partial effect of HPrev




b) Partial Effect Interaction with HPrev

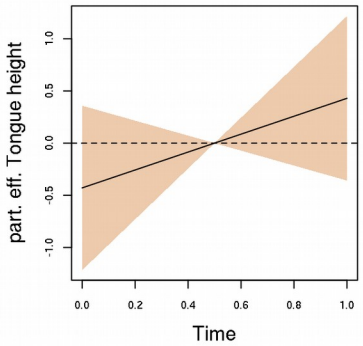



c ) Effect Time Vpast



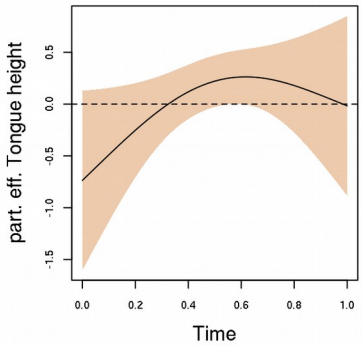

“He's pried”

d) Partial Effect Vpres




“I pride”

e) Partial Effect Nsing

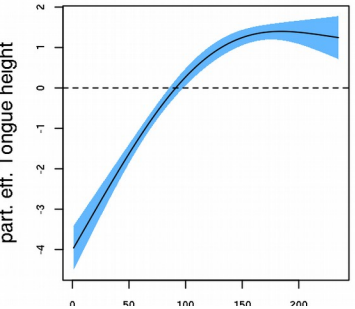



“The pride”

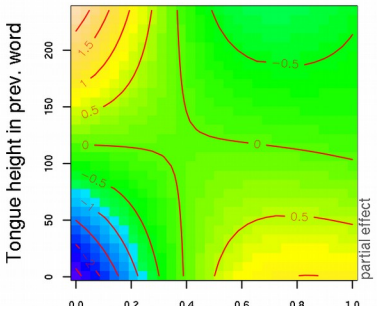
# Tongue height in [aI] – Blocked condition

- Tongue height in [aI]….
  - 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

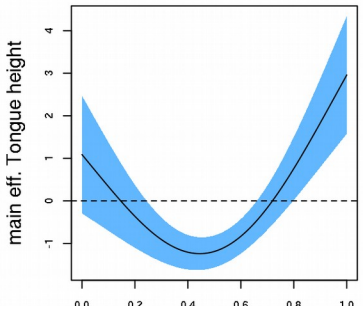
a) Partial effect of HPrev




b) Partial Effect Interaction with HPrev

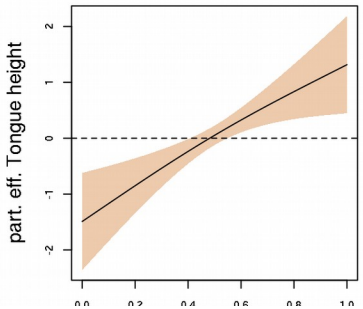



c ) Effect of Time Vpast



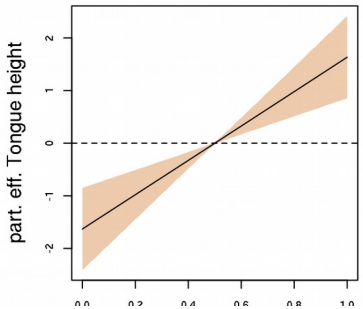

“He's pried”

d) Partial Effect Vpres




“I pride”

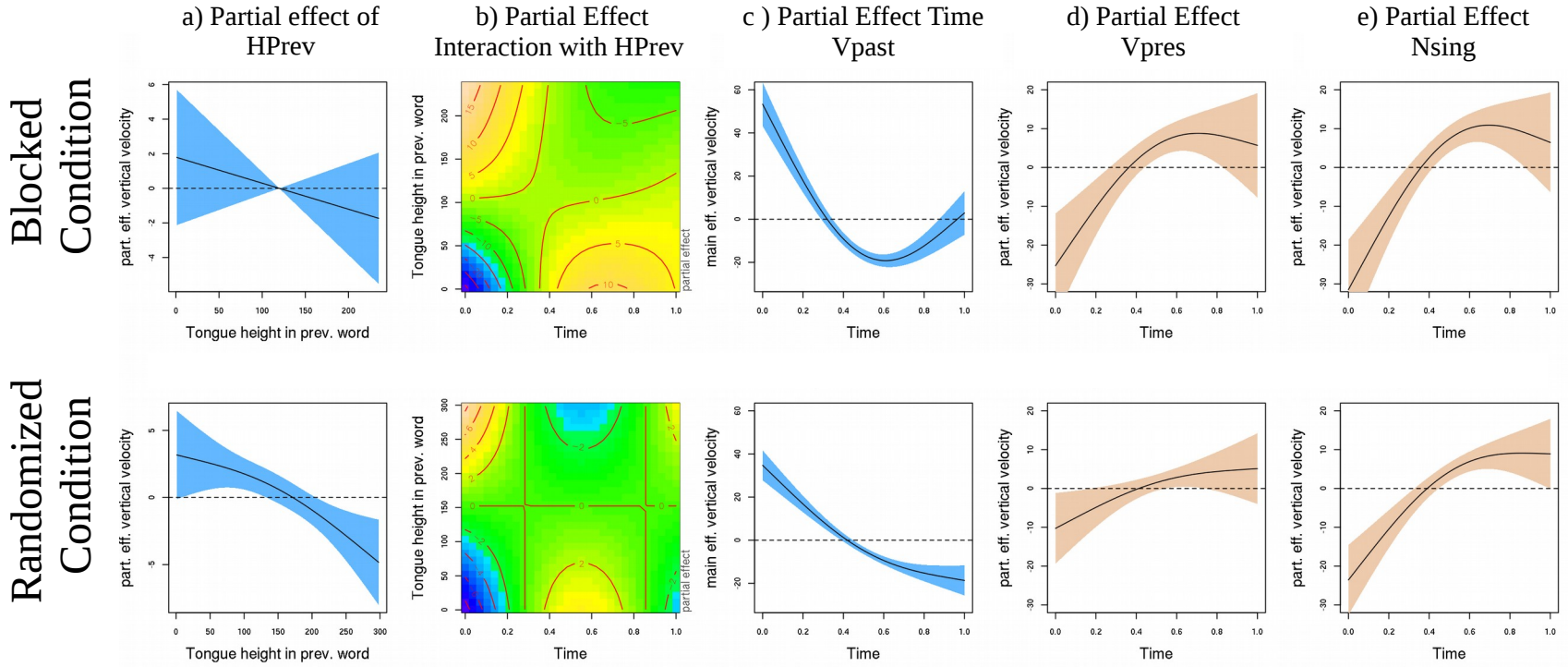
e) Partial Effect Nsing




“The pride”

# Absolute **velocity** across time

- Absolute movement velocity in [aI] …
  - 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

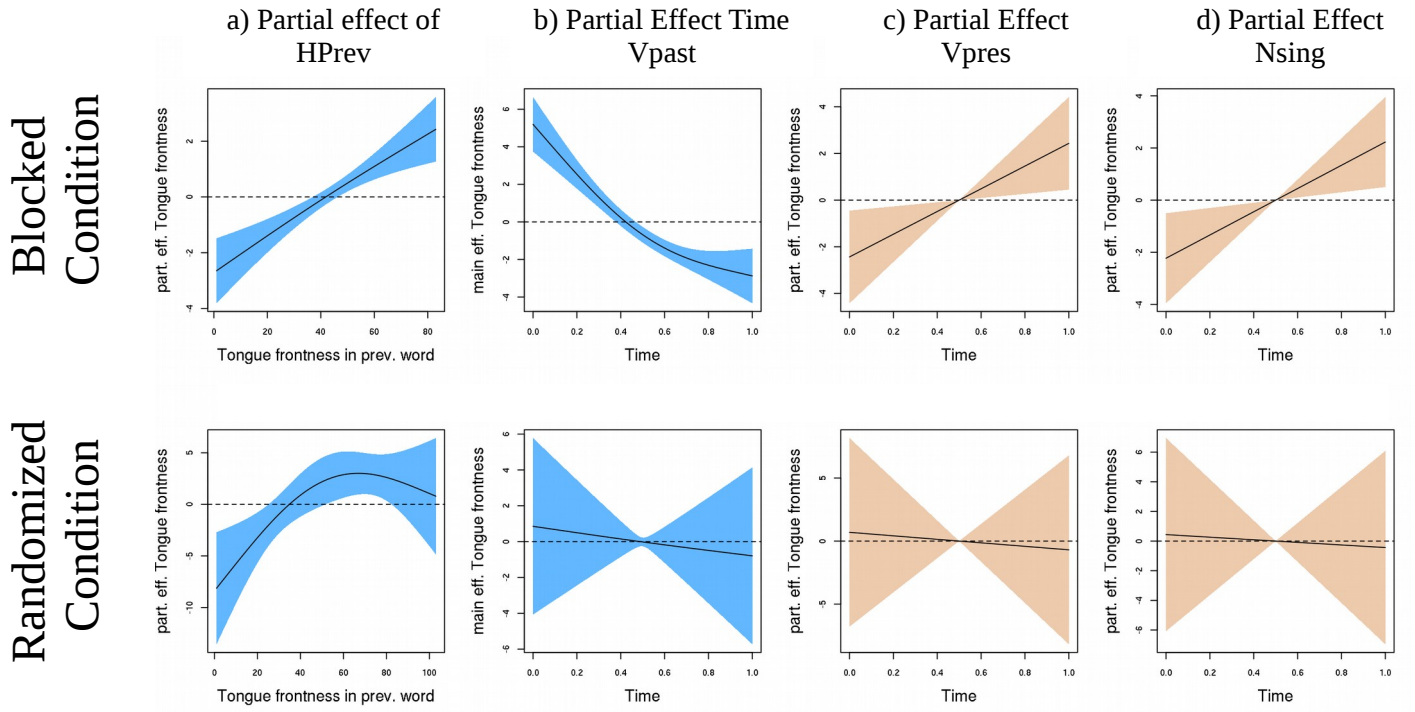
# Replication

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&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