Contributions of the vocal tract shape to the C-center effect

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Introduction: The C-center effect

- Onset consonants are timed in-phase with the vowel
- Stable interval: C-center to anchor
Introduction: Influence of coarticulation

Example from our earlier study:

- C-center effect is influenced by coarticulatory surroundings
- C-center effect is found when the tongue needs to move more to reach the vowel following a singleton than following a cluster

C-center effect

/kve-ve/ → shift towards the vowel

"negative C-center effect"

/glai-laI/ → shift away from the vowel
Introduction: Vocal tract shapes

Male-female differences in vocal tract shape and articulatory variability

- Fant (1966)
- Honda et al. (1996)
- Simpson (2001)
- Fuchs et al. (2008)
- Winkler et al. (2011)
Hypothesis

Observation I: the C-center effect depends on coarticulation
- larger articulatory distance from C to V in CV than in CCV → C-center effect
- larger articulatory distance from C to V in CCV than in CV → no C-center effect

Observation II: Articulatory variability depends on a speaker’s vocal tract
- longer pharyngeal cavity → more variability perpendicular to the palate
- longer oral cavity → more variability along the palate

→ The C-center effect depends on a speaker’s vocal tract shape.
Hypothesis: more concrete

- Vocal tract shape
- "female" vs. "male"
- Pattern of variability
- Along the palate vs. perpendicular to the palate
- Vertical coarticulation
- Little vs. much
- Gestural timing differences
- C-center effect vs. no C-center effect

**Test condition:** /gl/ cluster -> effect expected

**Control condition:** /pl/ cluster -> no effect expected
Methods

**EMA-experiment**
- 8 German native speakers (4m, 4f)
- NDI WAVE system
- TT sensor during /l/ analysed

**Speech material**
- /gl/-/l/: in initial and medial position, e.g. *gleiten-leiten*
- /pl/-/l/: in initial and medial position, e.g. *plagen-lagen*
- 24 items in a carrier phrase
- 16 repetitions
Methods: C-center analysis

- **vowel**: plateau offset of prevocalic consonant to plateau onset of anchor vowel
- **vowel compression**: $vowel_{cv} - vowel_{ccv}$

![Graph showing C-center analysis](image-url)
Methods: variability patterns (tongue tip)

Variability patterns:
- Along the palatal outline: triangle
- Perpendicular to the palatal outline: quadrilateral
Methods: variability patterns (tongue tip)

- all data rotated to a horizontal palatal contour
- z-normalization to account for size differences

- vertical dimension separated into 10 bins of equal size
- IQR of x-values for each bin
- slope of linear approximation
- correlation between slope and vowel compression
Results: two examples

/gl/: vocal tract shape has an influence on the C-center effect

/pl/: vocal tract shape has no influence on the C-center effect
Results

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<thead>
<tr>
<th>CCV word</th>
<th>rho</th>
<th>p</th>
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</thead>
<tbody>
<tr>
<td>gleiten</td>
<td>.868</td>
<td>.000</td>
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<td>.629</td>
<td>.008</td>
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<td>glänzen</td>
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<td>.013</td>
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<td>begleiten</td>
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<thead>
<tr>
<th>CCV word</th>
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<th>p</th>
</tr>
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<tbody>
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</table>

/gl/: vocal tract shape has an influence on the C-center effect

/pl/: vocal tract shape has no influence on the C-center effect
Summary

The occurrence of the C-center effect, actually an effect linked to syllable structure, is influenced by a speaker’s vocal tract shape.

In the low vowel context investigated here, there are speakers prone to produce a C-center effect (speakers who vary their tongue position along the palatal outline). And there are speakers without a C-center effect (with variation perpendicular to the palatal outline).

Present analysis: based on a simple relationship, the one between movement amplitude and duration

"Quadrilateral" speakers move more in the CCV than in the CV item, "triangular" speakers do not move more.
"The syllable is an abstract phonological constituent without clear phonetic correlates (Ladefoged and Maddieson 1996)." (Zec, 2007)

At least: Measuring this (phonological) effect on phonetic data is difficult.

interspeaker differences and coarticulation are reasons for the contradictory findings in the C-center literature.
Acknowledgments

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