

Coordination of lingual and mandibular gestures for different manners of articulation

**Christine Mooshammer[†], Anja Geumann⁺, Phil Hoole[‡],
Peter Alfonso^{*}, Pascal van Lieshout[°] and Susanne
Fuchs¹**

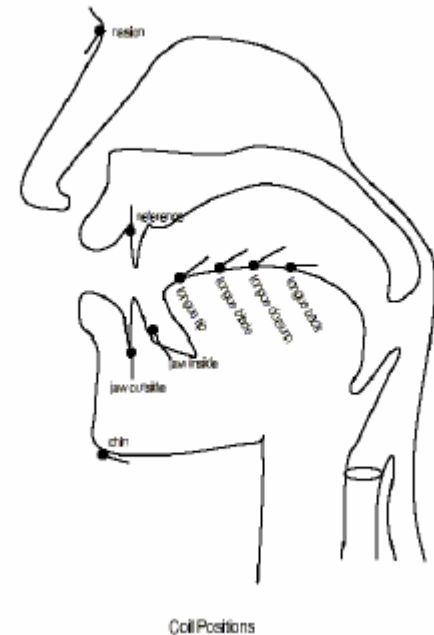
[†] IPDS, Christian-Albrechts Universität, Kiel, Germany; ⁺ Department of Computer Science, UCD, Ireland; [‡] Institut für Phonetik und Sprachliche Kommunikation, LMU, München, Germany; ^{*} University of North Dakota, Grand Forks, USA; [°] Graduate Department of Speech-Language Pathology, University of Toronto, Canada; ¹ ZAS, Berlin, Germany

Background

- Coronal consonants in AP:
Tract variables: TTCL + TTCD
Model articulators: tongue body, tongue tip and jaw.
- Aim of this study:
Differential role of the jaw for the coronal consonants /s, ʃ, t, d, n, l/
by analysing the timing between tongue tip and jaw movements

Method

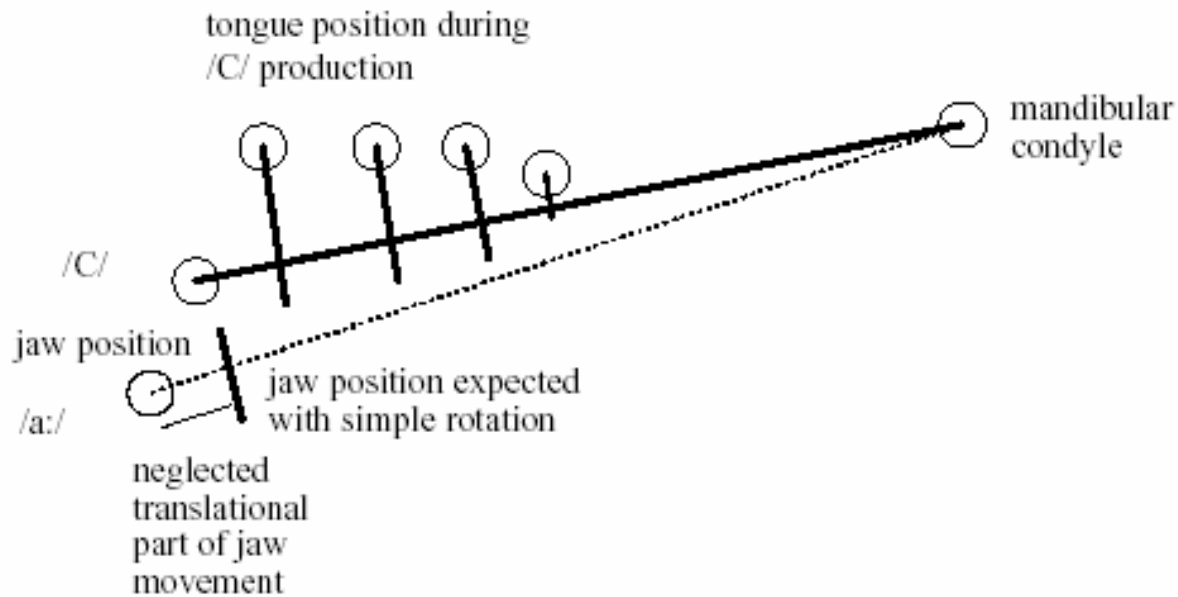
- Five speakers of German
- EMMA:
 - 4 sensors on the tongue
 - 3 for measuring jaw movements(inner and outer surface of the gums, angle of the chin)



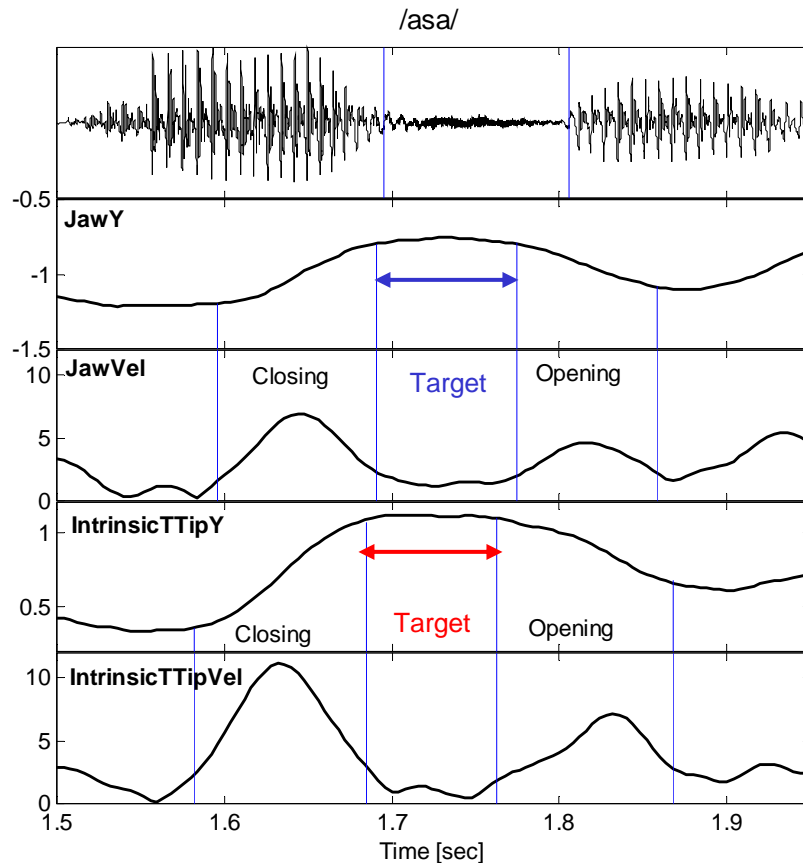
Speech Material

- Symmetrical VCV sequences with
V: /i:, e:, a: / and C: /s, ʃ, t, d, l, n/
Carrier phrase:
“Hab das Verb ____ mit dem Verb ____
verwechselt”
(I mixed up the verb ____ with the verb ____)
- 12 repetitions of each sequence in
randomized order

Intrinsic Tongue Tip



Labelling



Latencies for

- Onset of the closing movement
- Velocity peaks
- Target achievement
- Target offset

RESULTS: Spatial Differences

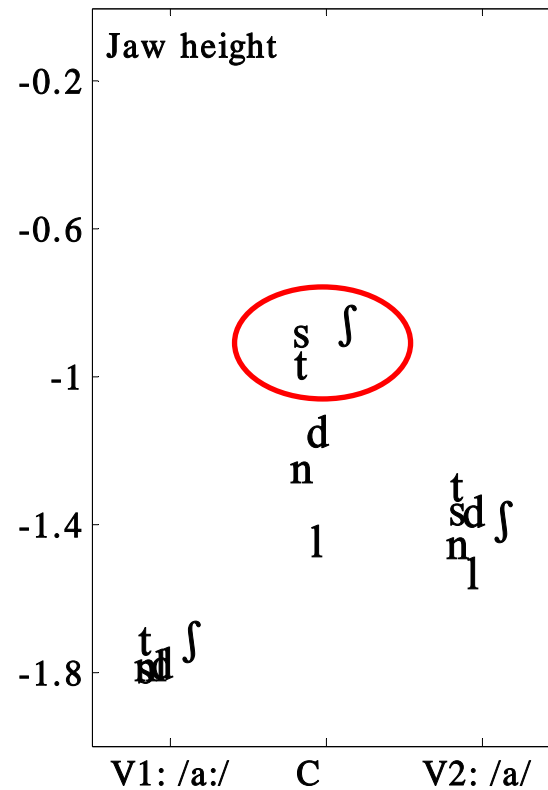
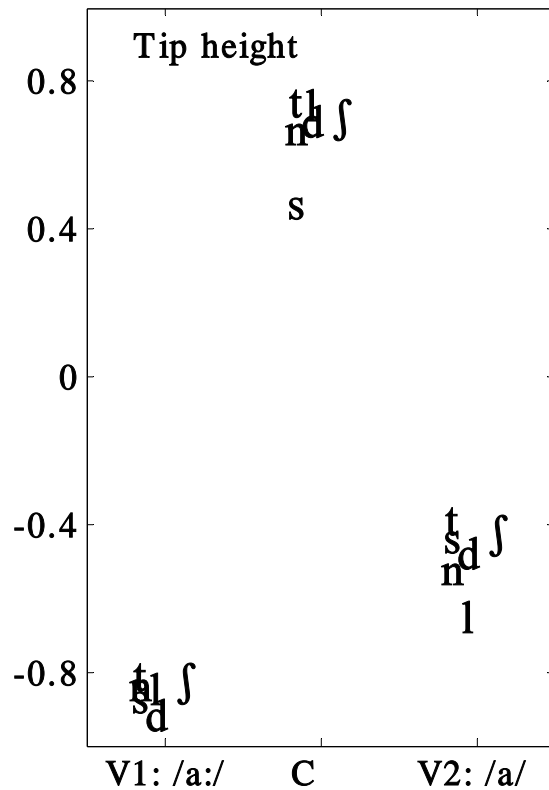
Assumption:

Task of the jaw:

lifting the tongue tip towards the constriction location

→ The order of the consonants should be the same for
tongue tip height and jaw

RESULTS: Spatial Differences



RESULTS: Spatial Differences

- Order for tongue tip:
/ʃ, t, d, n, l/ > /s/
- Order for jaw height:
/s, ʃ/ ≥ /t/ > /d/ > /n/ > /l/

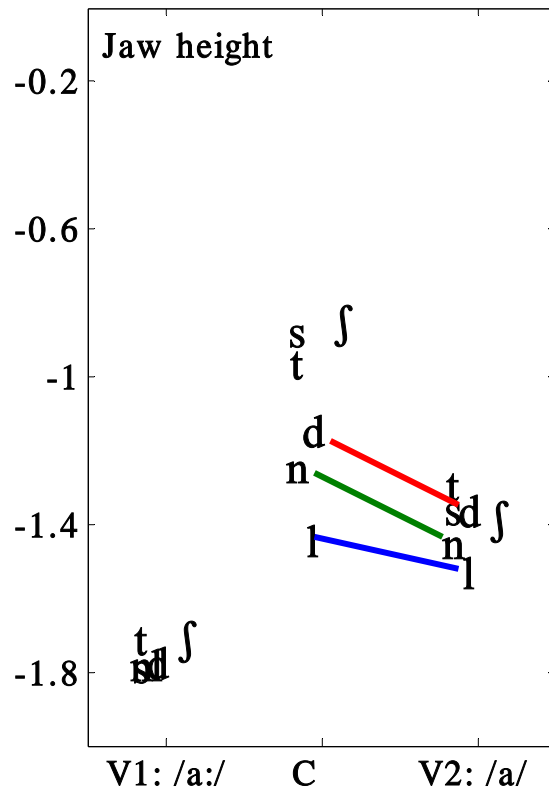
➔ Differential role of the jaw

In agreement with:

Keating et al. (1994), Lee (1994), Kühnert et al. (1991)

RESULTS: Contextual Effects

Consonantal effect on vocalic jaw height



V1 = stressed /a:/

➔ no significant differences

V2 = unstressed /a/

➔ /l/ < /n/ < /t/

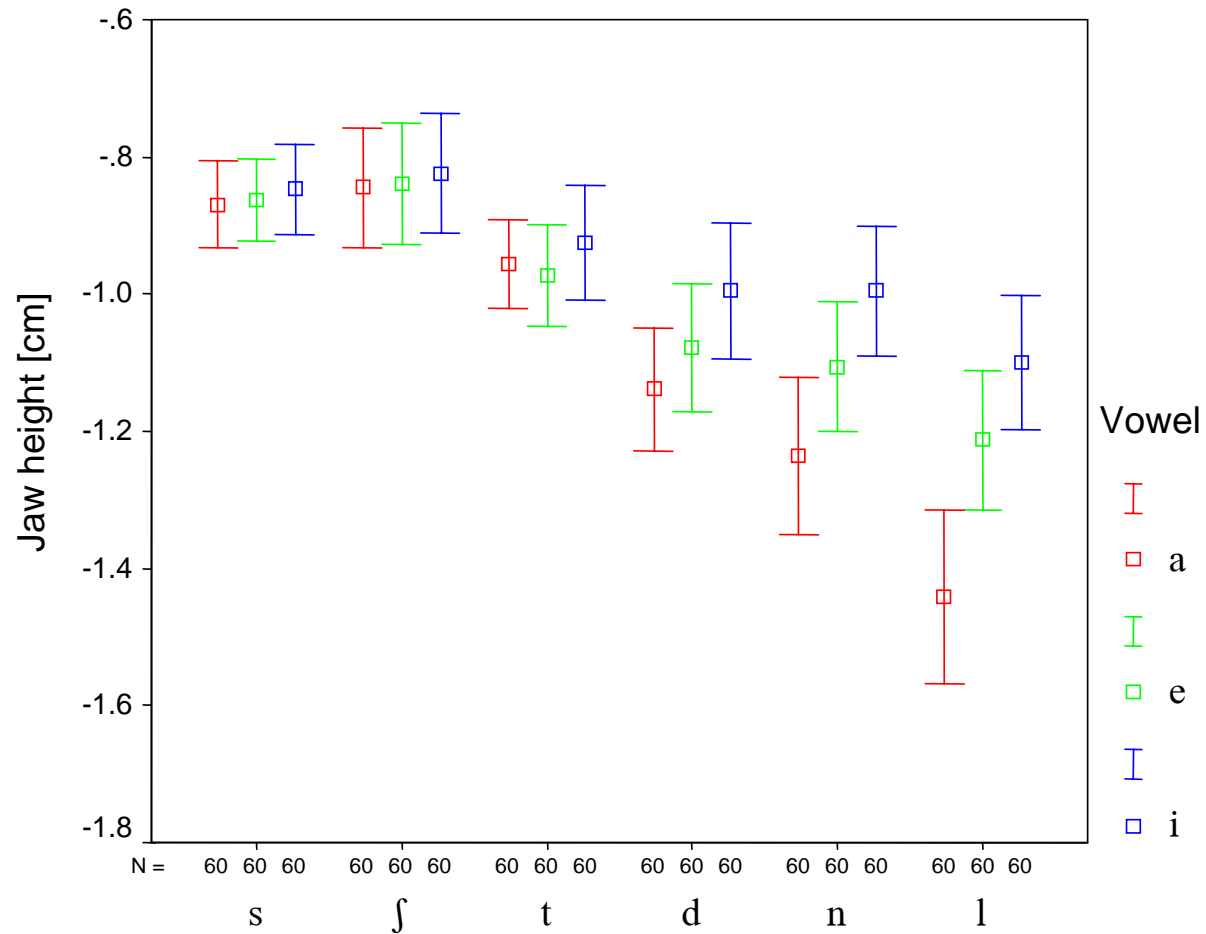
➔ No jaw opening for

19 % of /d/ items

12 % of /n/ items

27 % of /l/ items

RESULTS: Contextual Effects

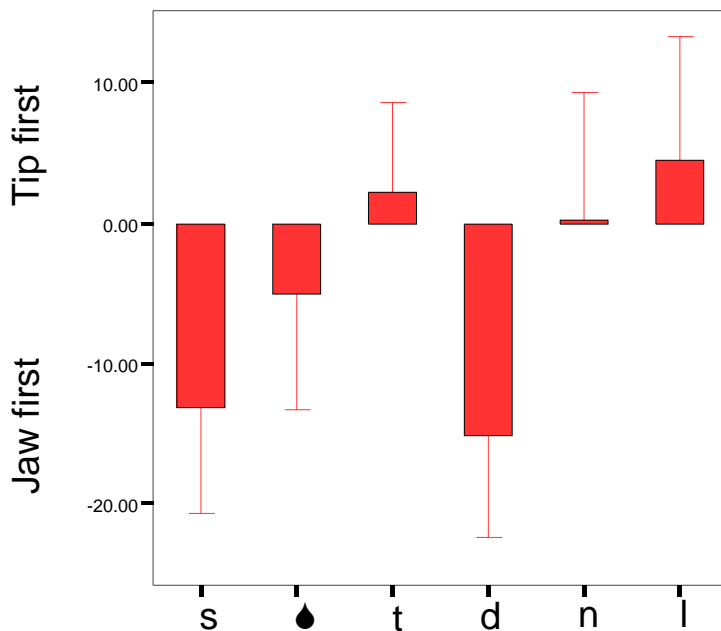


RESULTS: Latencies

Onset latency

Negative: jaw first

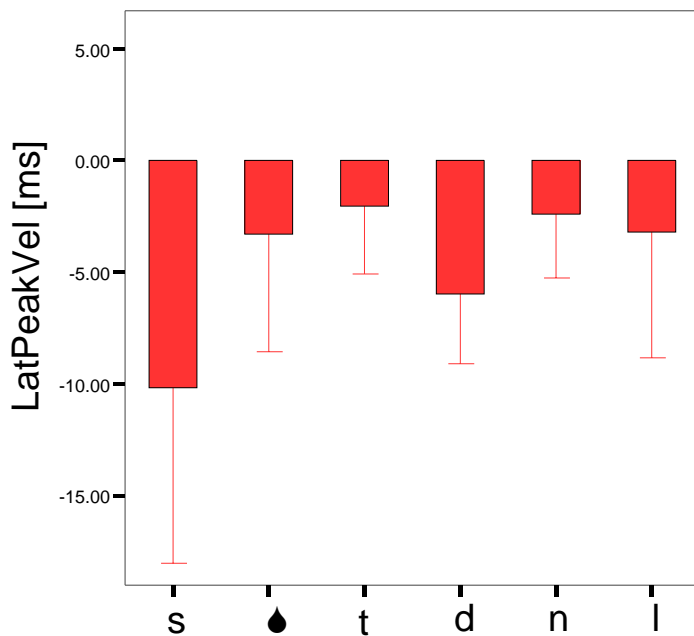
Positive: intrinsic tongue tip first



- Very variable
- Tendency for jaw advancement in /s/ and /d/ compared to /t/ and /l/
- BUT: no general pattern for all speakers

RESULTS: Latencies

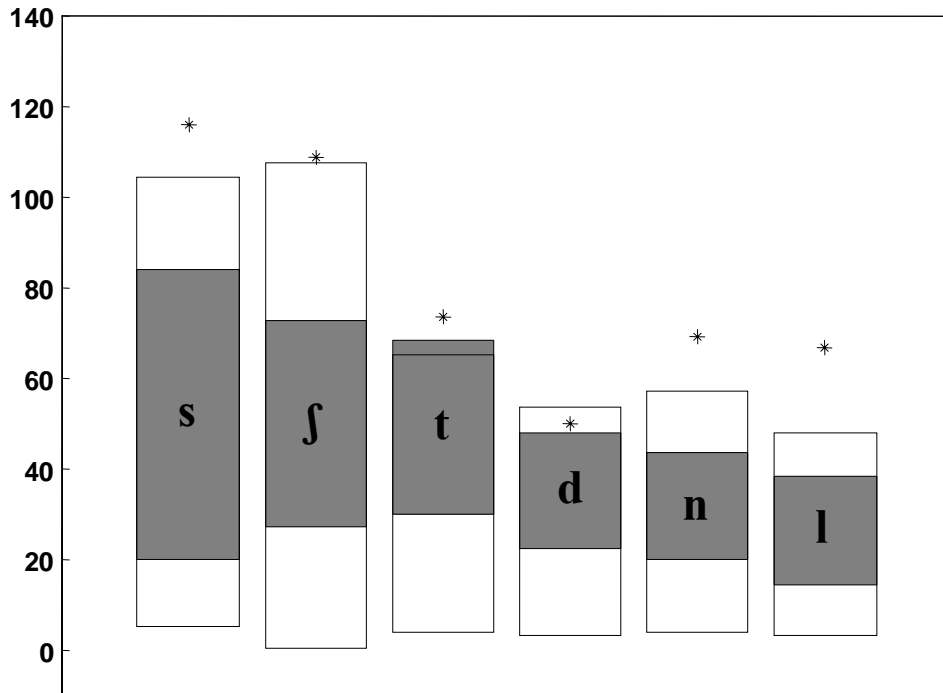
Peak velocity of the closing movement



- Less variable
- Tendency for a greater jaw advancement in /s/ compared to /t/
- BUT: no general pattern for all speakers

RESULTS: Target Latencies

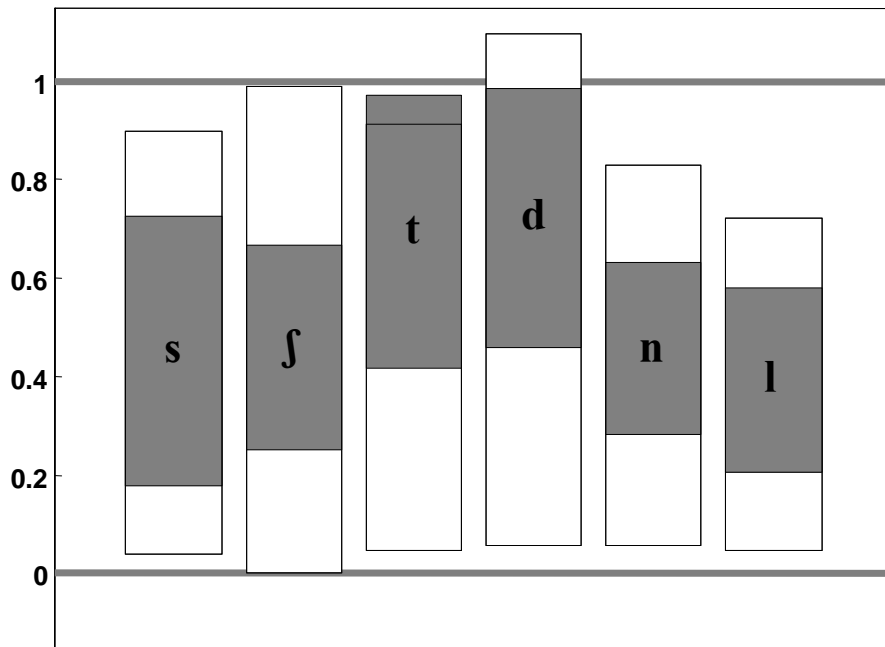
Latencies: Consonant



- Onset: /l, s/ < /t, ʃ/
- Jaw hold duration: /s/ > /ʃ, t/ > /d, n, l/
- Offset: /t, d/ > /n, l/ > /s/ > /ʃ/

RESULTS: Jaw Target Achievement

Normalized jaw timing



- Onset: /t,d/ > /ʃ, n, l, s/
- Offset:
/t, d/ > /s, ʃ, n, l/
- Symmetrical pattern for
/s, ʃ, n, l/
- Asymmetrical pattern for
/t, d/
- Jaw hold duration:
/s, t, d/ > /ʃ, n, l/

SUMMARY: Sibilants

- High and invariant jaw position
 - Longer jaw hold duration for /s/ than for /ʃ/
- ➔ Two tasks for the sibilants
1. obstacle noise source
 2. stabilization of the tongue
- ➔ Second task reduced for /ʃ/

SUMMARY: Stops

- Jaw target offset is coordinated with the burst
- Lower and more variable jaw position for /d/

➔ Task of the jaw for /t/:
Provision of a close constriction for
producing a prominent burst

SUMMARY: Sonorants

- /n/: lower and variable jaw height
→ Jaw task: supporting tongue tip
- /l/: low jaw position necessary
→ Jaw task:
space for the more apical articulation
+ avoiding lateral contact

DISCUSSION:

Modelling within Task Dynamics and AP

Sibilants: high weights for the jaw

BUT: Icelandic alveolar fricatives

/s/: closed jaw

/θ/ teeth apart

➔ Revitalisation of the

LOWER TEETH HEIGHT tract variable

(Saltzman & Munhall 1989)

DISCUSSION:

Modelling within Task Dynamics and AP

Stops:

- Toda, Malayalam???
- Differential timing between tongue tip and jaw???