Temporal and spatial adjustments to conflicting demands for consonantal targets

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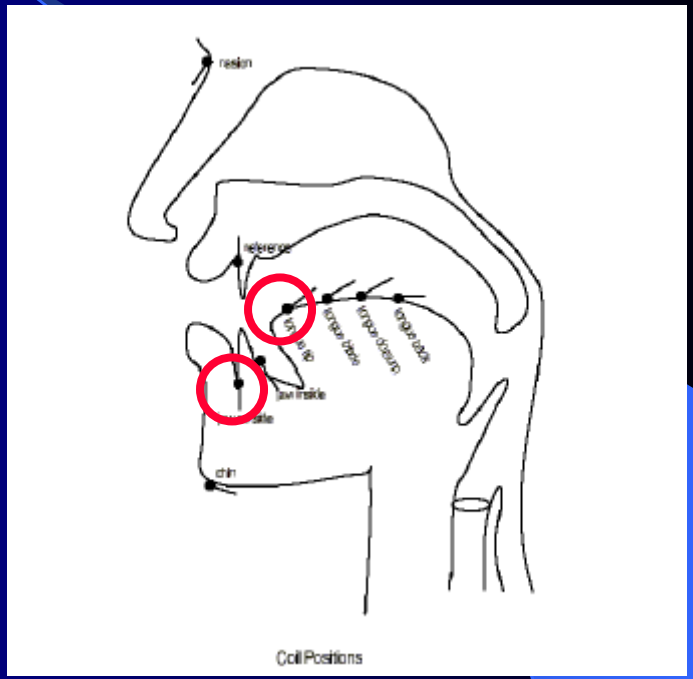
Introduction

- Role of the jaw for the coronal consonants /s, ʃ, t, d, n, l/
- Active articulator: tongue tip/tongue blade
- Assumption: jaw has a helping function
- Aim:
  further investigating the role of the jaw in the spatial and temporal domain

Method

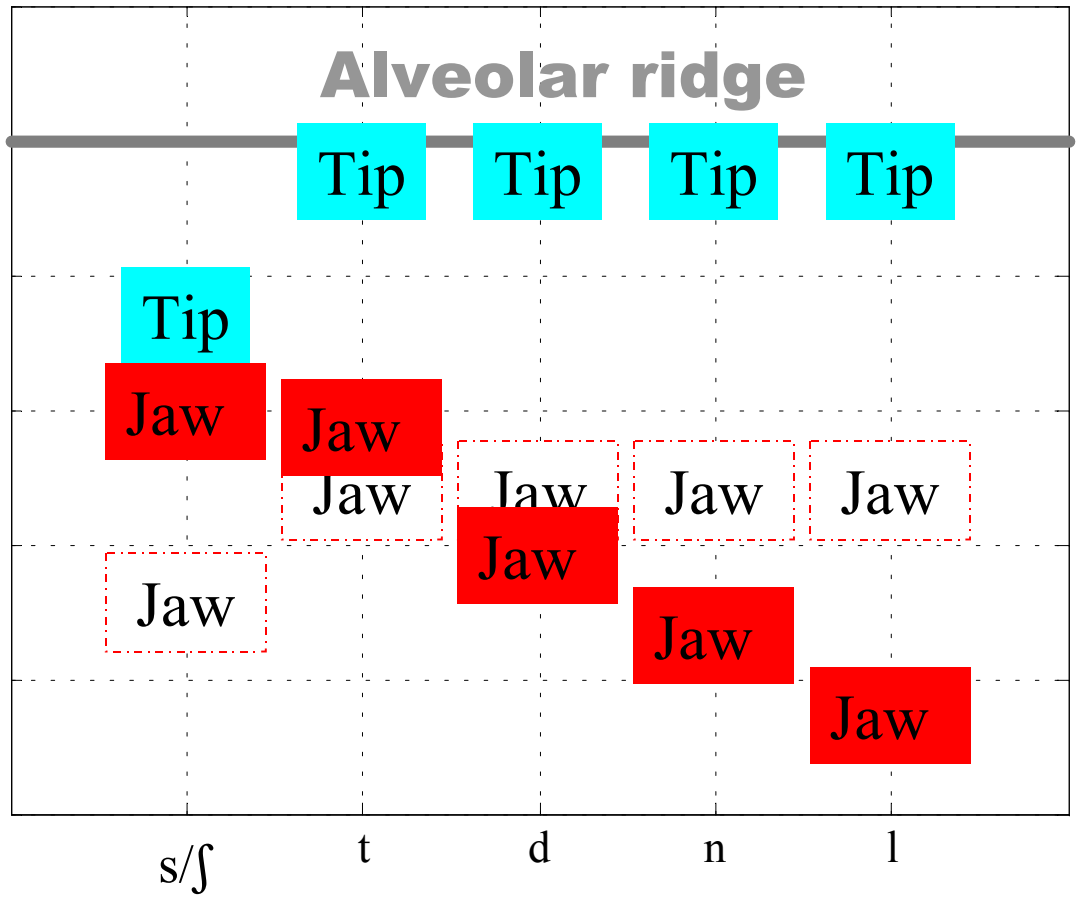
- Five speakers of German
- EMMA:
  4 sensors on the tongue
  3 for measuring jaw movements
  (inner and outer surface of the gums, angle of the chin)



Speech Material

- Symmetrical VCV sequences with
  V: /iː, eː, aː / 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 ___)
- Two loudness conditions:
  - Comfortable = N
  - Loud = L
- 12 repetitions of each sequence in randomized order

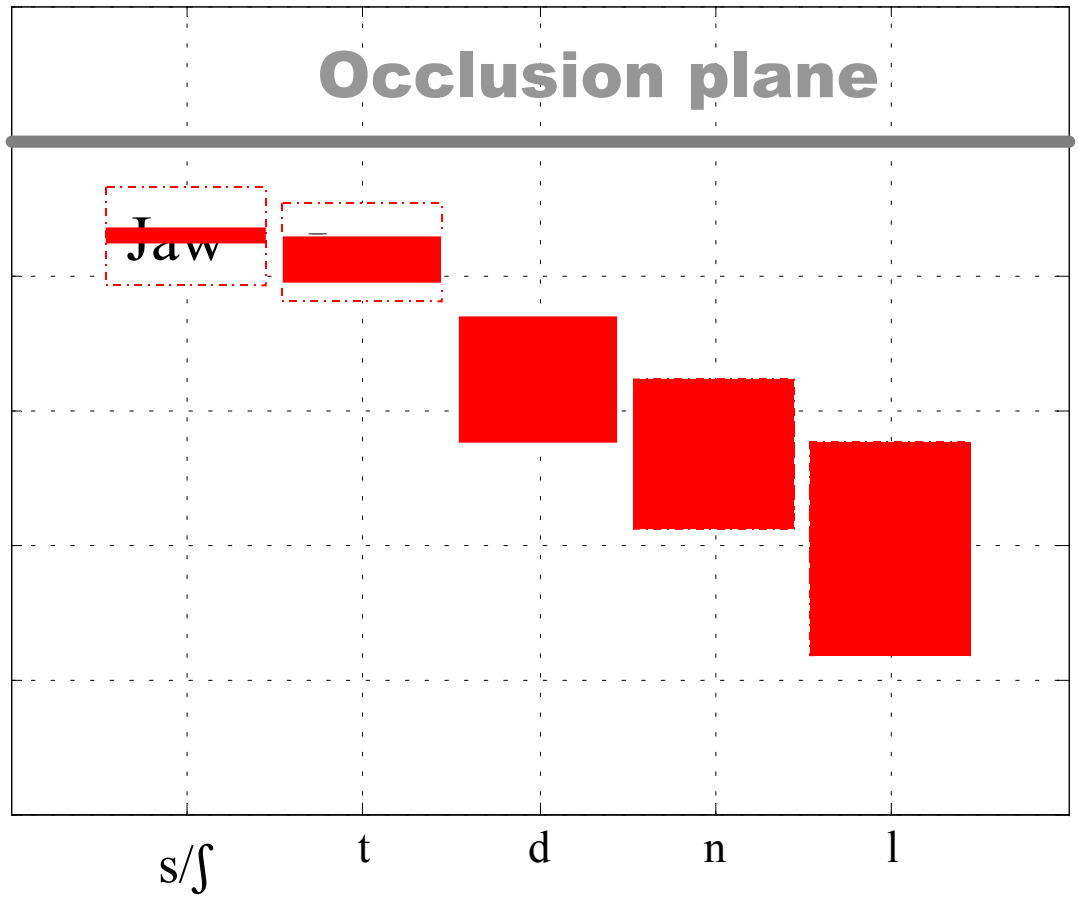
Targets for coronals



jaw target predicted

Jaw target measured

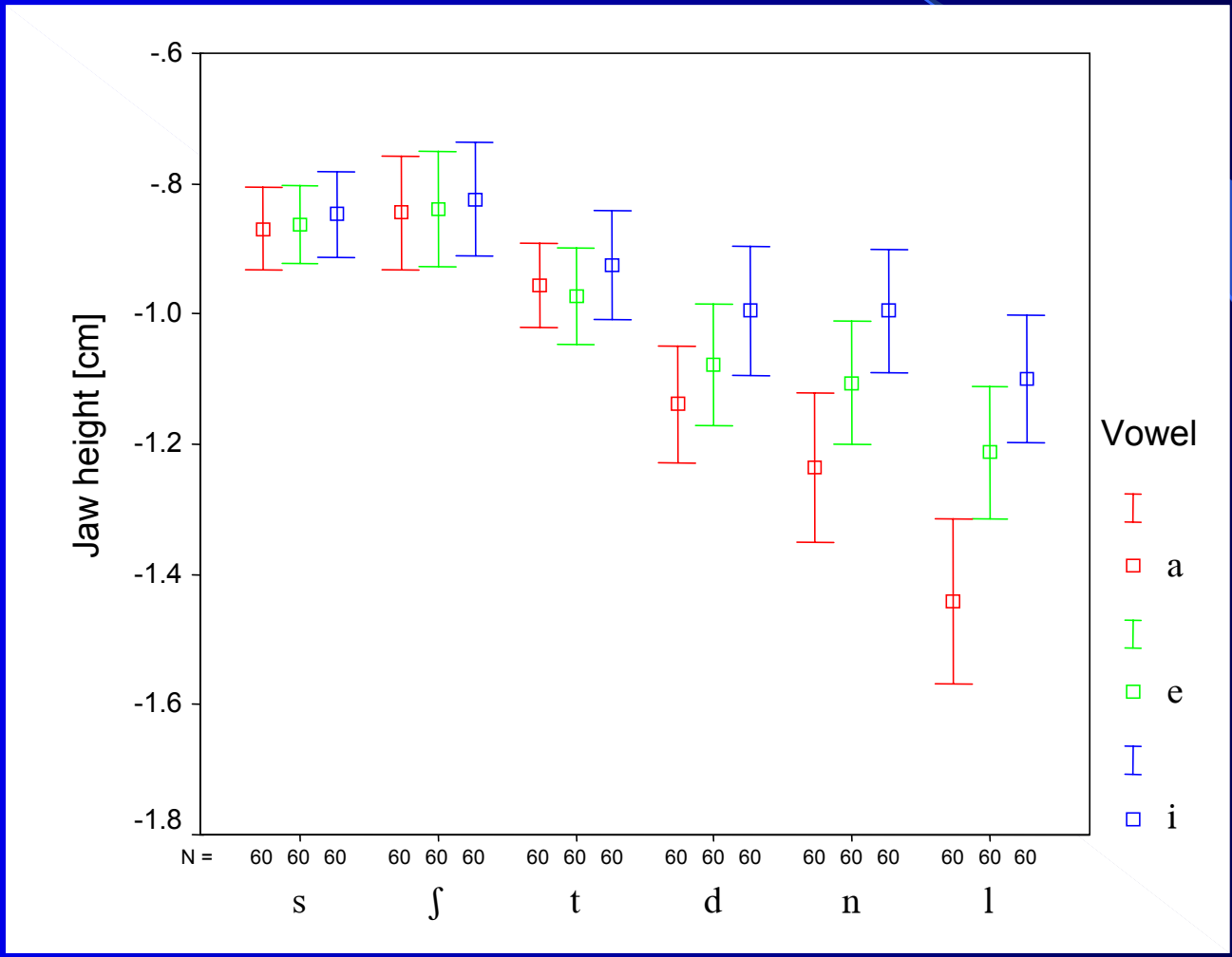
Variability of jaw targets due to vocalic context



Variability predicted

Variability measured

Variability: Contextual Effects



RESULTS: Spatial Differences

- Order for jaw height and precision:
  /s, ʃ/ ≥ /t/ > /d/ > /n/ > /l/
- ➔ Differential role of the jaw

Jaw Tasks:

- Sibilants: provision of the second noise source, the front teeth
  ➔ small and precise interdental distance
- /t/: tight closure for producing a salient burst
- /l/: low position for providing space for the apical articulation
- /d, n/: „carrier“ for the tongue tip to a different degree

In agreement with: Keating et al. (1994), Lee (1994), Kühnert et al. (1991), Hoole et al. (in press) etc.

Role of the jaw in the production of „prominence“

- Prominence here: all different kinds of emphasis (lexical word stress, focus, sentence accent, global vocal effort, contrastive accent, emphatic stress...)

Lower jaw positions for higher levels of prominence

WHY???

➔greater mouth opening

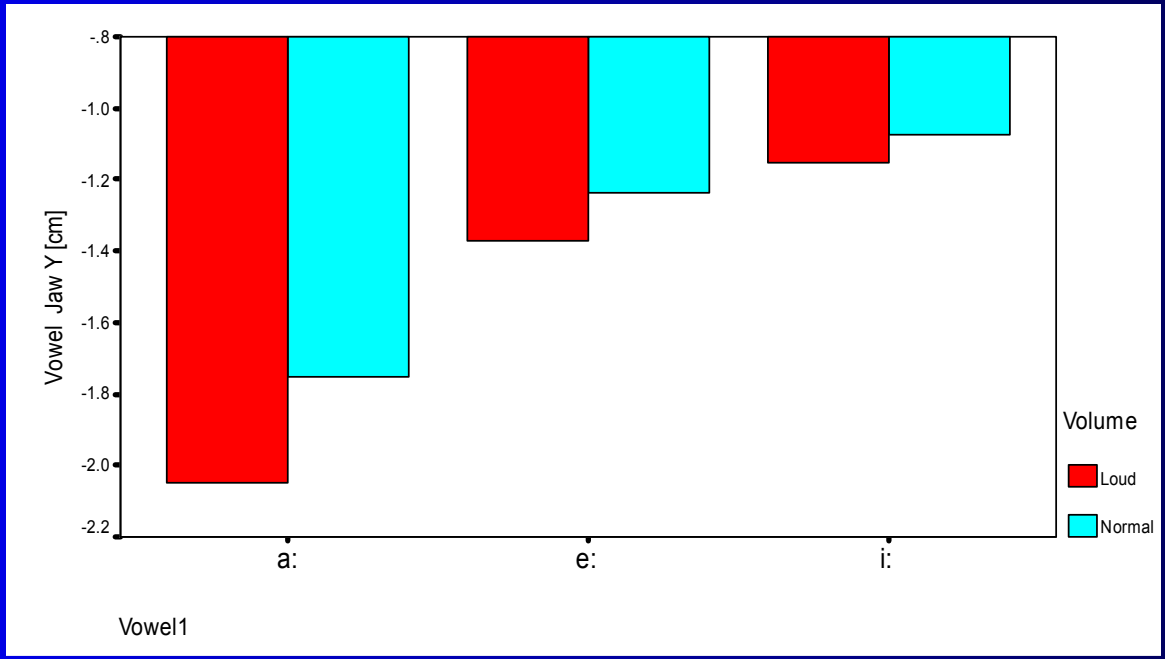
➔larger amplitudes in the acoustical speech signal

Jaw and prominence

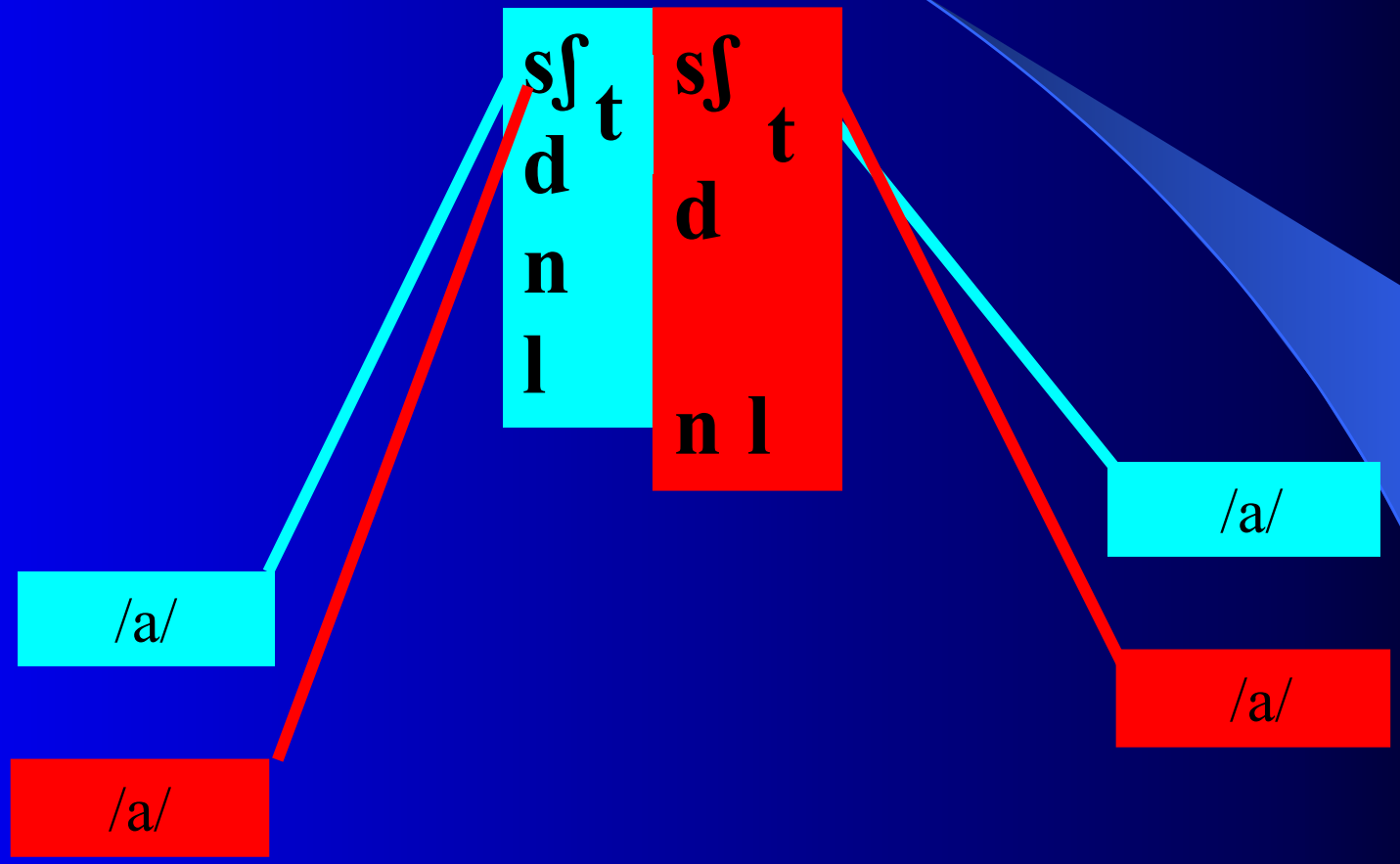
SEGMENTS	CONSEQUENCE OF JAW LOWERING	JAW
Vowels	louder	↓= for [+high] ↓ for [-high]
Laterals	?louder?	???
Nasals	no change	???
Fricatives	approximants???	???
Stops	no change	↓↑= (speaker, position, place)

Jaw and loudness

- Vowels:
  - /i/: lower for all speakers
  - /e/: lower for all speakers
  - /a/: lower for all speakers



Jaw and loudness



normal loud

Only /a/ context is considered here

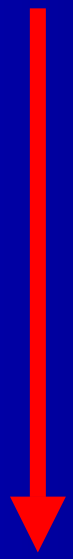
Jaw and loudness

- Consonants:
  - /s/: 1 speaker ↑, 4 speakers =
  - /ʃ/: no effect
  - /t/: 1 speaker ↓, 4 speakers =
  - /d/: 1 speaker ↓, 4 speakers =
  - /n/: 4 speakers ↓, 1 speaker =
  - /l/: 2 speakers ↓, 3 speakers =

➔ Changes for /n/ and maybe also /l/ are adjustments to the lower jaw positions during the lower vowels in loud speech

Spatial effects of loudness:

- Jaw lowering
  - /s, ʃ /
  - /t/
  - /d/
  - /n, l/
  - high vowels
  - low vowels



High and invariant jaw position

Low jaw position

- The jaw can only vary for prosodic demands if it is not recruited for a given sound.
- A given sound‘s jaw position is more likely to be affected by prominence the lower its „segment-specific“ jaw target.

Temporal adjustments to positional differences?

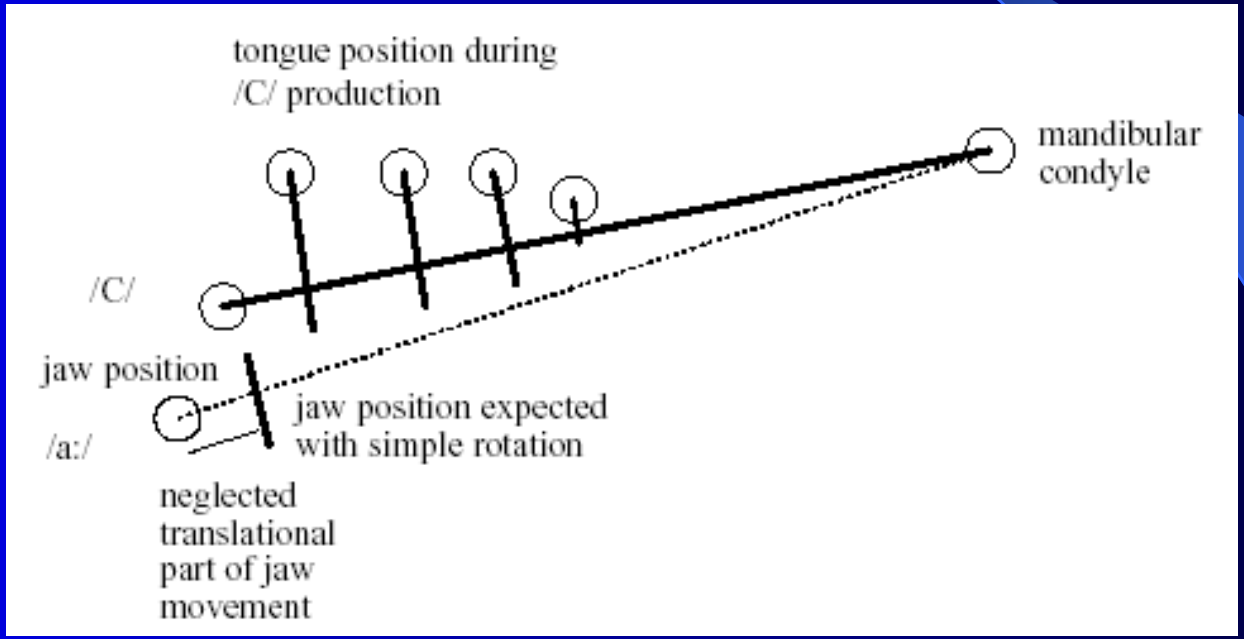
In general:

- Role of the jaw differs for varying manners of articulation
- Does the timing between jaw and tongue tip also change?

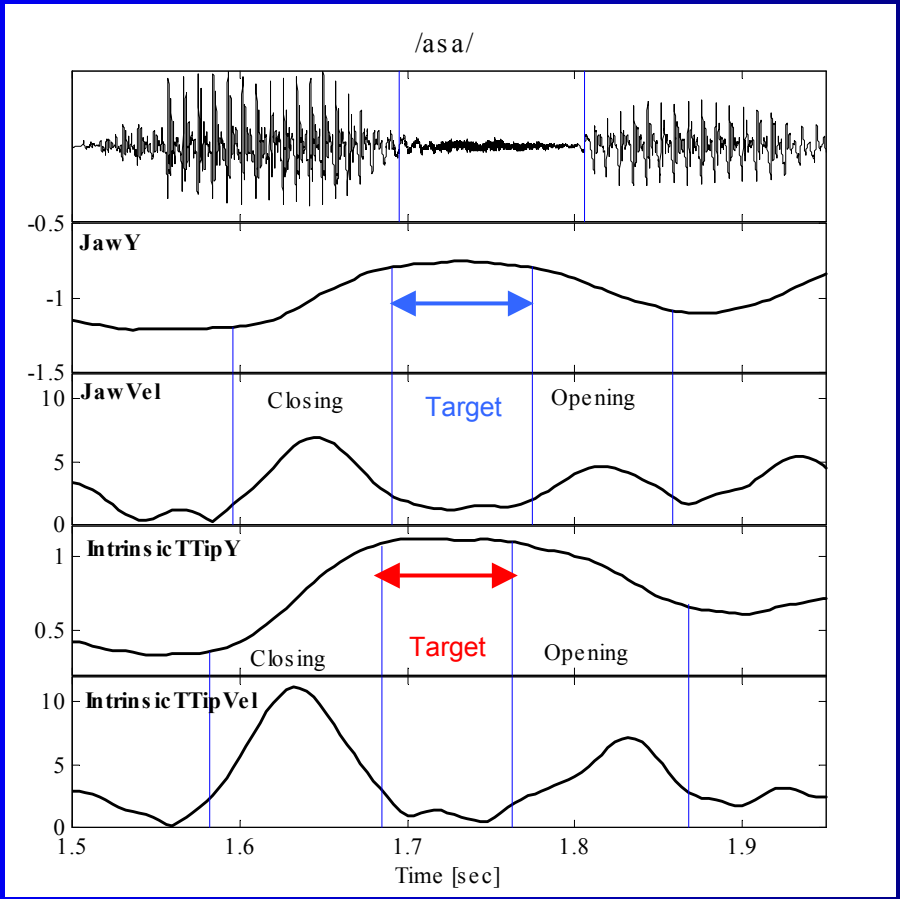
In particular:

- Is interarticulatory timing stable across different loudness conditions?

Intrinsic Tongue Tip



Labelling



Intervals:

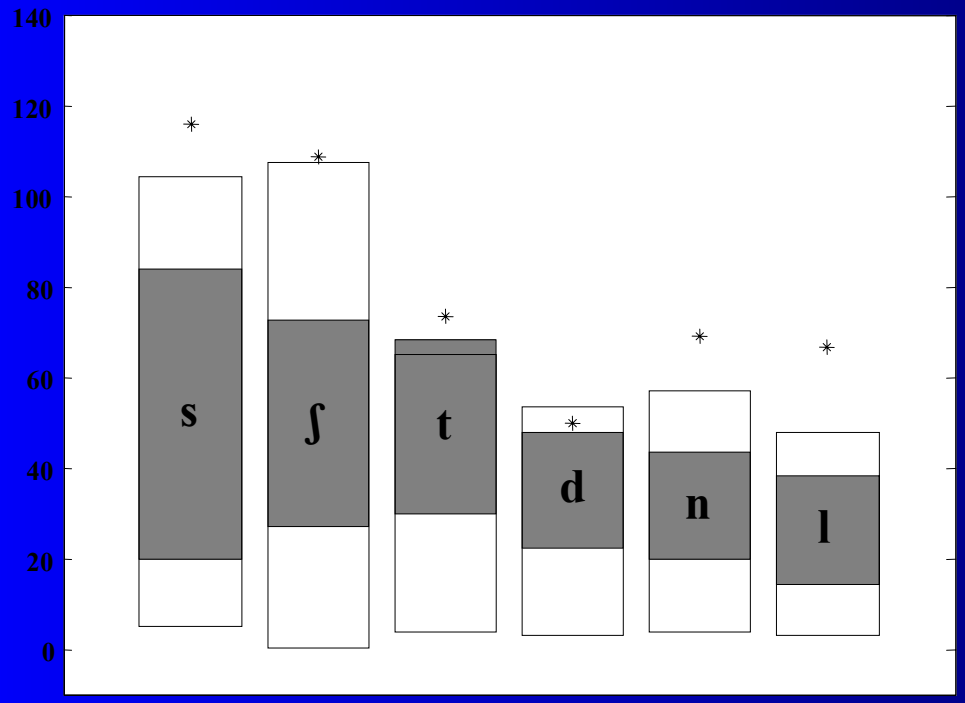
- Targets = stable phases (velocity below 20 per cent of maximum)
- Movements (velocity above 20%)

Latencies for

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

Temporal properties during the target

Assumption: the more important the jaw for a sound, the longer the jaw target duration

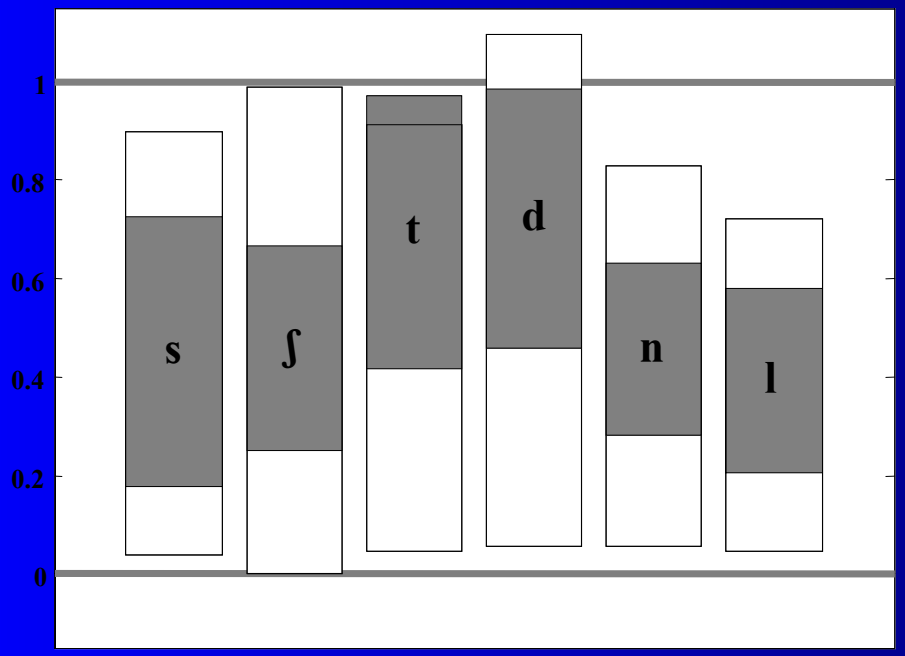


- Jaw target is always shorter than the tongue tip target
- Jaw hold duration: /s/>/ʃ,t/ > /d, n, l/

Dependency on intrinsic durations of the consonants?

Temporal properties during the target

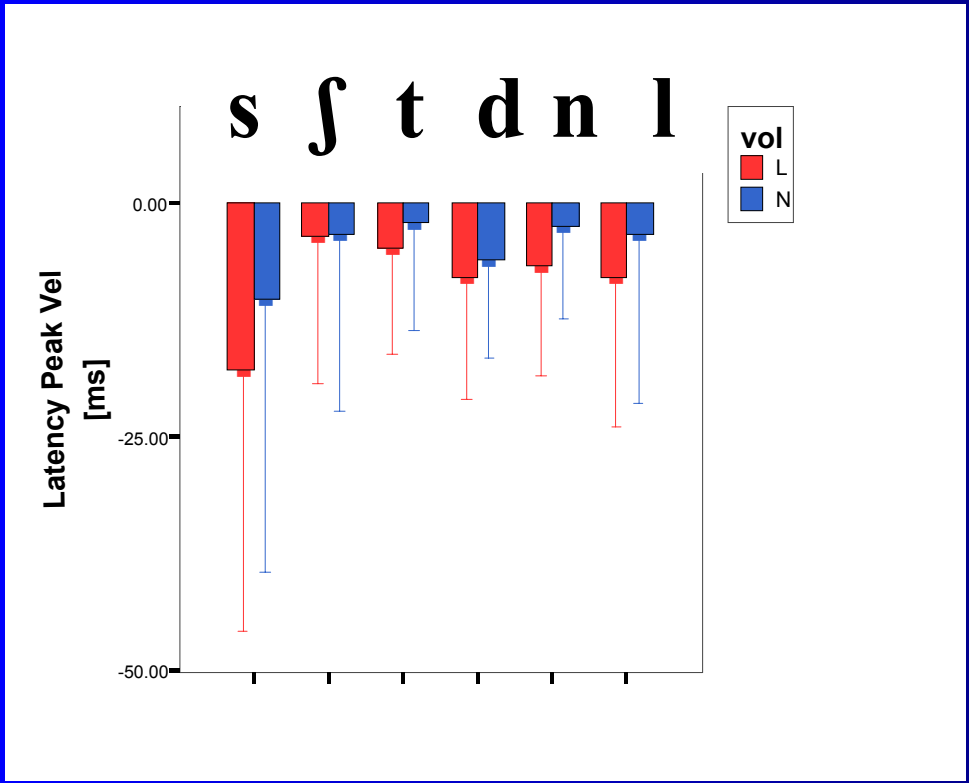
Normalized jaw timing



- 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/

Temporal adjustments to lower targets for the vowel

Lower jaw targets for vowels in loud speech➔



- No changes in target coordination for /s, S, t/
- Somewhat longer jaw targets for /d, n/ (only one speakers each)

➔Stable temporal patterns during the consonant

Latencies peak velocities

1. closing movement: jaw earlier for /s/ in loud speech (sig. for 3 speakers)
2. Opening movement: jaw later after /t/ in loud speech (sig. for 3 speakers)

Conclusion

- Temporal adjustments to lower jaw targets during **movement** and not **target** phases
- Loudness affects jaw positions
  1. of vowels very consistently
  2. of consonants dependent on the task and height of the jaw (reason: coarticulatory adjustment)

➔Segment identity is more important than general motor program for prosody

Future: linguistic prominence?

Conclusion

BUT:

inter- and intra-speaker variability

(e.g. latencies very variable during hold phases and less variable for peak velocities)

THEREFORE:

Models