LabPhon 2016

Final lengthening in German

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Research question: To what extent do **final lengthening** and **vowel tenseness** interact?

Final lengthening

- Segments often lengthen at or near a prosodic boundary (cf. Beckman et al. 1992; Cambier-Langeveld 1997; Byrd & Saltzman 1998; Byrd et al. 2006; Cho & McQueen 2005; Turk & Shattuck-Hufnagel 2007; inter alia)
- At boundaries, the task-dynamic model predicts a lengthening of the closing gesture, and smaller peak velocities, but no change in articulator displacement (Beckman et al. 1992).
- The π-gesture model predicts that a local slowing of the clock at prosodic boundaries leads to a gradually increase in lengthening close to the boundary (Byrd & Saltzman 2003).

Segments

- The π-gesture model predicts that all gestures lengthen in a similar fashion.
  - Vowels tend to be longer (Byrd 2000).
  - Consonant gestures tend to be longer (Berkovits 1994).
- In German, **tense** but not **lax vowels** stretch in stressed syllables and compress for fast speech rate (Hoole & Mooshammer 2002; Mooshammer & Fuchs 2002).

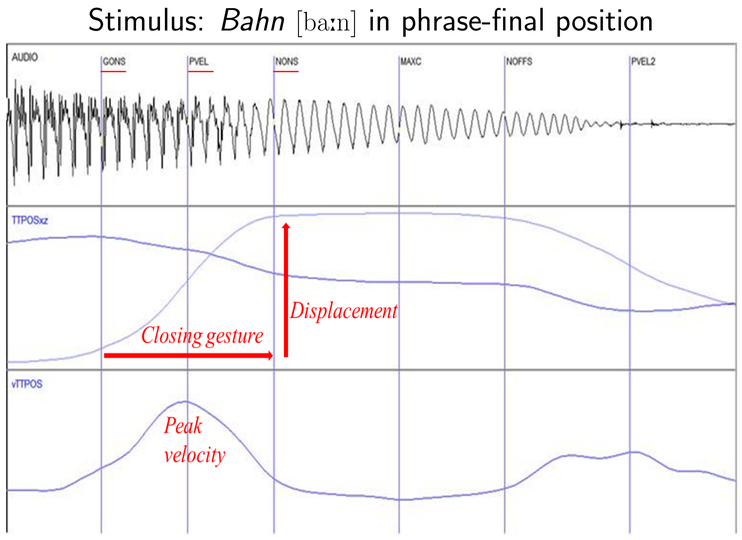
Questions

1. For German, the acoustic **vowel duration** in the phrase-final condition is expected to lengthen for tense vowels. Are lax vowels affected differently compared to tense vowels?
2. Is **closing gesture duration** towards the consonants longer in duration in phrase-final position?
3. Which kinematic parameters of the closing gesture are affected by final lengthening?
   - Duration; Articulator displacement; peak velocity.

Method & Data

- Tongue movement data via EMA (AG 501, Carstens Electronics) along with acoustic data
- 8 German subjects read 4 target words embedded in carrier sentences (repeated 5 times)
- Boundary strength contexts: phrase-medial and phrase-final
- Labeling of closing gesture duration towards consonants in the target word using the custom made MATLAB tool *mview* (Mark Tiede, Haskins Laboratories)
- Acoustic labeling with Praat (Boersma 2001)
- Speech rate calculated in syllables per sec. (excl. pauses).

Stimulus: *Bahn* [baːn] in phrase-final position



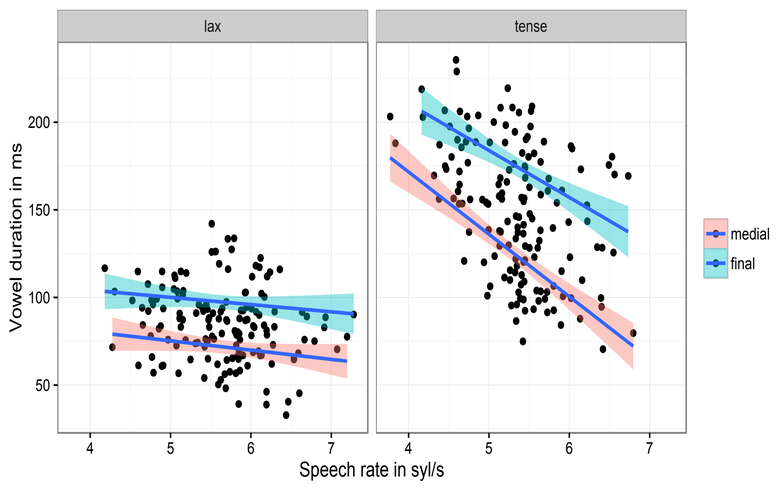
Stimuli

Target words: Bahn [baːn] – Bann [ban] 'train – ban';
Beet [beːt] – Bett [bɛt] 'bed (bot.) – bed'

Phrase-medial:
Ich fuhr mit der Bahn am Donnerstag. Am Mittwoch wurde noch gestreikt.
'I took the train on Thursday. On Wednesday, there was still a strike'

Phrase-final:
Ich fuhr mit der Bahn. Am Donnerstag wurde noch gestreikt.
'I took the train. On Thursday, there was still a strike.'

Effect on vowel duration

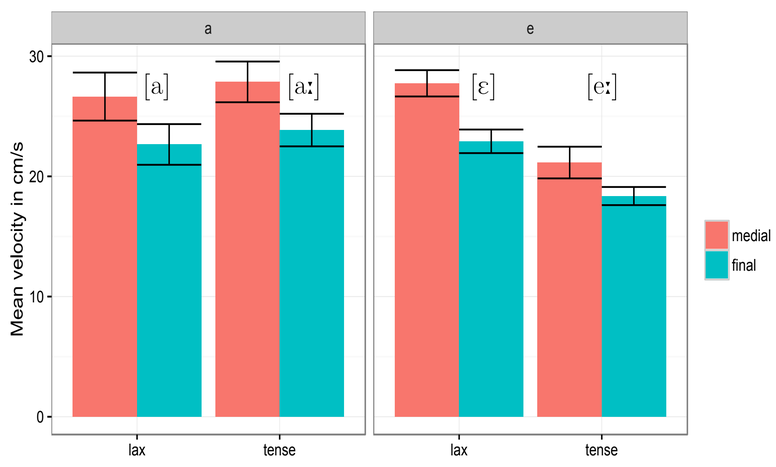


Lax vowels are 31% longer in phrase-final positions. Tense vowels are lengthened by 45%, respectively. Lax vowels are nearly unaffected by increasing speech rate.

	Effect on vowel duration
(Intercept)	71.81 (3.87)***
condfinal	25.74 (3.12)***
tensenesstense	47.32 (3.40)***
rate.z	0.53 (2.55)
condfinal:tensenesstense	25.52 (4.40)***
tensenesstense:rate.z	−17.88 (2.53)***
AIC	2658.37
Num. obs.	304

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Effect on velocity



Smaller peak velocities for phrase-final positions; interaction of position and tenseness for *Beet/Bett*.

	Bann/Bahn	*Bett/Beet*
(Intercept)	1.27 (0.23)***	0.28 (0.14)
condfinal	−0.54 (0.07)***	−0.38 (0.06)***
tensenesstense	−0.03 (0.10)	−0.50 (0.06)***
rate.z	0.21 (0.10)*	0.29 (0.07)***
tensenesstense:rate.z	−0.16 (0.07)*	−0.01 (0.06)
condfinal:tensenesstense		0.15 (0.09)
condfinal:rate.z		−0.26 (0.05)***
AIC	204.35	89.50
Num. obs.	152	149

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

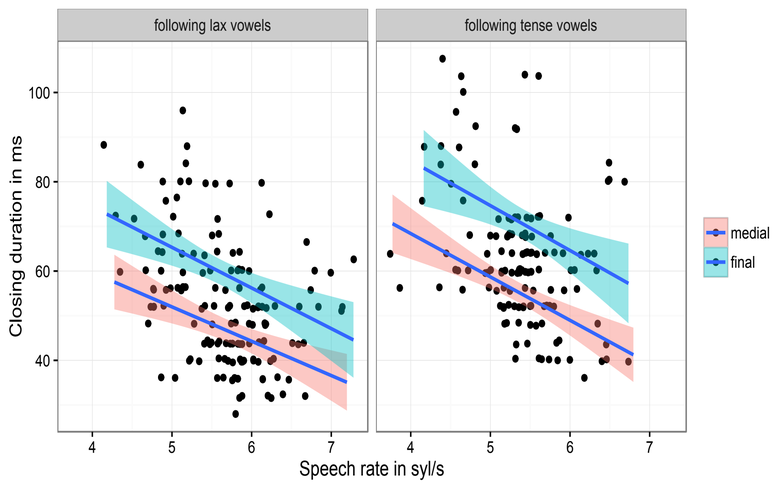
Summary

1. Tense and lax vowels can be lengthened in phrase-final position. The effect is significantly smaller for lax vowels.
   - Lax vowels seem to be incompressible for faster speech rates, confirming previous findings.
2. Closing gesture duration is longer in phrase-final position.
3. Displacement is not significantly affected by phrase-final position; peak velocity is significantly smaller for phrase-final position. *Bahn/Bann* and *Beet/Bett* are affected differently by tenseness.

Conclusion

- The results of this study support the assumption of the π-gesture model and the task-dynamic model, showing a lengthening effect at strong prosodic boundaries for vowels in acoustics and for consonants in articulation.
- Lax vowels can be lengthened in final positions, contrary to findings for speech rate and stress.
- Lengthening of lax vowels seems to be limited by the quantity contrast.

Effect on closing gesture duration

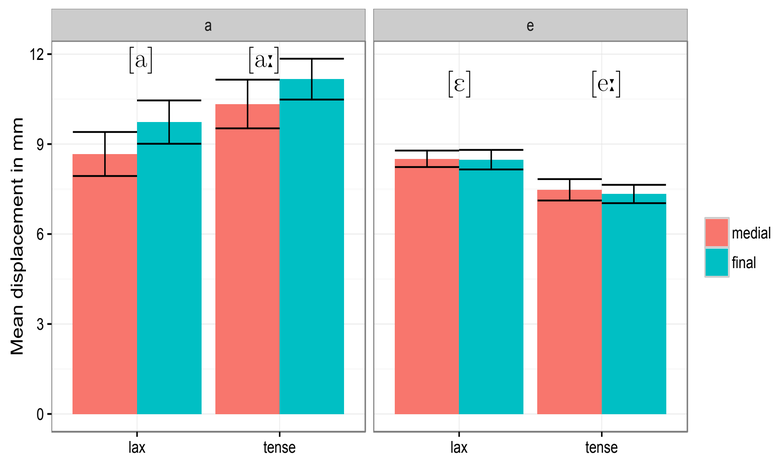


Closing duration decreases with faster speech rate, and closing takes longer for tense vowels.

	Effect on closing duration
(Intercept)	3.83 (0.05)***
condfinal	0.22 (0.02)***
tensenesstense	0.18 (0.03)***
rate.z	−0.04 (0.03)
AIC	-75.17
Num. obs.	297

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Effect on amplitude



Tenseness but not position affects articulator displacement.

	Bann/Bahn	*Bett/Beet*
(Intercept)	14.86 (1.38)***	8.45 (0.48)***
condfinal	0.40 (0.42)	
tensenesstense	1.90 (0.60)**	−0.83 (0.18)***
rate.z	−0.30 (0.45)	
condfinal:tensenesstense	−1.11 (0.59)	
AIC	647.71	434.29
Num. obs.	152	137

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

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