**Final lengthening in German**

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Prosodic variation not only affects tonal aspects, but also the temporal properties of individual segments (see e.g. Byrd and Saltzman 1998). This interplay between segmental and suprasegmental layers is not uniform, i.e. different segments and segment classes are influenced in different ways. For example, there are indications that at boundaries consonants show different amounts of lengthening (cf. Cho 2015). For vowels in German, Hoole and Mooshammer (2002) and Mooshammer and Fuchs (2002) found that tense but not lax vowels stretch in stressed syllables and compress for fast speech rate. In this study we investigate the effects of phrasal boundaries on the temporal characteristics of the preceding syllable in acoustics and articulation. Previous studies found that vowel gestures tend to be longer at strong prosodic boundaries (e.g. Byrd 2000). However, up to now the interaction of tenseness and final lengthening has not been investigated. The π-gesture model of Byrd and Saltzman (2003) predicts a local slowing of the clock at prosodic boundaries, leading to a gradually increasing lengthening effect towards the boundary independent of the segmental content. As a consequence, both tense and lax vowels should show an effect of lengthening.

Acoustic and tongue movement data of six subjects aged 23–28 years have been recorded in a sound proof cabin by means of EMA (AG 501, Carstens Electronics). Six minimal pairs differing in vowel tenseness were presented on a monitor, with 5 repetitions. The target word is embedded in two boundary strength contexts: phrase-medial (1) and phrase-final (2).

(1) 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.’

(2) Ich fuhr mit der Bahn. Am Donnerstag wurde noch gestreikt.
   ‘I took the train. On Thursday, there was still a strike.’

Only the word pairs Bahn – Bann ‘train – ban’ and Beet – Bett ‘bed (bot.) – bed’ are considered here. The data (N = 351) are labeled for the closing gesture duration towards consonants in the target word using mview (Mark Tiede, Haskins Laboratories) and for acoustic vowel duration using Praat (Boersma 2001). Closing duration is defined as the time span of closing movement onset and plateau onset for the word-final consonant by using a 20% threshold criterion. Pause duration after the target word was also labeled. We ran two linear mixed effects models, with the articulatory closing duration and acoustic vowel duration as dependent variables, respectively.

For the articulatory analysis the model takes phrasal condition (medial vs. final), Euclidean distance (movement amplitude during closing of the consonantal articulator), tenseness (lax vs. tense) and manner of articulation of the following consonant (nasal vs. plosive) as fixed effects and speech rate (in syllables per second without pauses) as covariate including all interactions. Subjects are included as random effects. To obtain normally distributed residuals, a Box-Cox-Transformation suggested the logarithmized closing duration. A backward stepwise model selection using AICs (Akaike 1974) results in a model (intercept = 3.6, se = .05) with no significant main effects for tenseness and phrasal condition. Closing durations of tense vowels are longer for fast speech rates whereas lax vowels show shorter closing durations in faster speech (β = .04, se = .01, p < .001, cf. Fig. 1, panel 4). This can be attributed to the following consonant: While there is no significant interaction of tenseness and phrasal condition, the interaction of manner of articulation of the following consonant and phrasal condition affects the closing duration (β = .07, se = .03, p < .03, cf. Fig. 1, panel 3).

For the acoustic analysis the model takes phrasal condition and tenseness as fixed effects and speech rate and pause duration as covariates including all interactions. Subjects are included as random effects. A backward stepwise model selection using AICs results in a model (β = 78.7, se = 6.5) with a significant interaction of phrasal condition and tenseness (β = 21.6, se = 3.4, p < .001, cf. Fig. 1, panel 1) and a significant interaction of phrasal condition and tenseness, speech rate (β = −15.7, se = 4.1,
p < .001, cf. Fig. 1, panel 2). The difference of phrase-medial and phrase-final position is significantly larger for tense vowels than for lax vowels. The three-way interaction comes about because lax vowel durations are relatively stable for speech rate variation (confirming earlier studies by Hoole & Mooshammer 2002), whereas tense vowels are shortened when speaking faster, even more so when they are followed by a stop.

In summary, despite the tendencies found in previous work for lax vowels to not be affected by prosodic structure, the current study finds that acoustic vowel durations of lax vowels are lengthened in phrase-final position, although less than tense vowels. For faster speech rates, however, lax vowels tend to be incompressible, confirming previous findings.

References


