

Phonetic content and prosodic structure affect pre-boundary lengthening in German

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Background: One of the major correlates of prosodic phrasing is the lengthening of material immediately preceding the phrase boundary. This effect, referred to as pre-boundary lengthening (PBL), has been attested for German as a stable correlate of boundary production (*e.g.*, Petrone *et al.* 2017). However, it is hardly understood what stretch of speech, or domain, preceding the boundary undergoes lengthening. The present study investigates the PBL domain in German, testing two hypotheses: the Word Rime hypothesis, which posits that PBL is initiated on the nuclear vowel of the last main stress syllable and thus defines the domain based on phonological structure (*e.g.*, Kohler 1983), and the Overlap hypothesis, which posits that a lengthening gesture of fixed duration overlaps with the final word and thus refers to phonetic content (*e.g.*, Byrd & Saltzman 2003). The latter entails that the onset of PBL varies depending on the number of given segments. Our study reveals an intricate interplay of both aspects.

Experiment: We conducted a production study that controls for the position of word stress (penultimate *vs.* antepenultimate), the number of segments (CV.CV.CV *vs.* CV.CV.CVC), and the presence of a following prosodic boundary. We employed three types of target words (1), which were all trisyllabic proper names. Two types had penultimate stress and differed only as to the presence of a final coda consonant (*e.g.*, *RaMOⁿa* *vs.* *RaMOⁿas*). The third type had antepenultimate stress (*e.g.*, *KA^rolin*). The realization of a prosodic boundary after the target word was elicited by means of structurally ambiguous lists of the type [A or B and C], which can be interpreted as comprising a left-branching structure or a right-branching. This ambiguity is resolved by means of a prosodic boundary after B in the left-branching case and after A in the right-branching case. The target words were in position B. An example item is given in (2). We recorded 12 items of this sort with 24 subjects. The data for each type of target word were analyzed separately. We measured the duration of each segment. Linear mixed effects models accounting for DURATION as a function of BOUNDARY were fitted to the data of each segment. The models were tested against reduced models by means of likelihood ratio tests (LRTs).

Results and discussion: Figs. 1 and 2 present the results for the duration differences of the target words with penultimate stress and Fig. 3 presents the results for the duration differences of the target words with antepenultimate stress across subjects. In all significant cases, the segment is longer in phrase-final position (yellow boxes) than in phrase-medial position (green boxes). As indicated in Fig. 1, the LRTs applied to the data of the CV.CV.CV target words (*e.g.*, *RaMOⁿa*) yielded a significant effect for the onset consonant of the penultimate/stressed syllable (C2) and all following segments (V2, C3, V3). In contrast, as indicated in Fig. 2, the CV.CV.CVC target words (*e.g.*, *RaMOⁿas*) showed a significant effect for the vowel of the penultimate/stressed syllable (V2) and all following segments (C3, V3, C4). This finding supports the Overlap hypothesis, as PBL is initiated later if a word has an additional segment. As for the target words with antepenultimate stress (*e.g.*, *KA^rolin*), we found a significant effect for all vowels (V1, V2, V3), but not for the initial onset consonant (C1). This supports the Word Rime hypothesis, as PBL is initiated on the rime of the main stress syllable. We assume that the rime of the main stress syllable serves as an anchor for PBL initiation, but the domain expands to the left if the amount of following material is limited. Our findings are compatible with the pi-gesture model (Byrd & Saltzman 2003) and support the account on gesture coordination in Katsika *et al.* (2014). Our account is also in line with the observation that PBL can occur on segments preceding the main stress syllable (see, *e.g.*, Cho *et al.* 2013 for American English). Finally, Fig. 4 illustrates that PBL is most salient in the final rime independent of the rime-internal structure.

- (1) a. [penultimate stress, CV.CV.CV] e.g., *RaMOna*
 b. [penultimate stress, CV.CV.CVC] e.g., *RaMOnas*
 c. [antepenultimate stress] e.g., *KArolin*
- (2) a. Ich werde **Karolin** oder **Ramona und Peter** einladen. [(1a), medial]
 Ich werde **Karolin** oder **Ramona und Peter** einladen. [(1a), final]
 ‘I will invite Karolin or Ramona and Peter.’
- b. Ich werde **Karolins** oder **Ramonas und Peters Freunde** einladen. [(1b), medial]
 Ich werde **Karolins** oder **Ramonas und Peters Freunde** einladen. [(1b), final]
 ‘I will invite Karolin’s or Ramona’s and Peter’s friends.’
- c. Ich werde **Ramona** oder **Karolin und Peter** einladen. [(1c), medial]
 Ich werde **Ramona** oder **Karolin und Peter** einladen. [(1c), final]
 ‘I will invite Ramona or Karolin and Peter.’

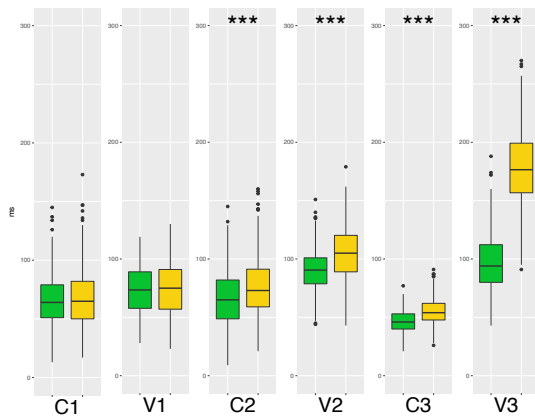


Fig. 1 Duration plots (ms) for the segments of the target words with penultimate stress and CV.CV.CV structure, e.g. *RaMOna* (n=288)

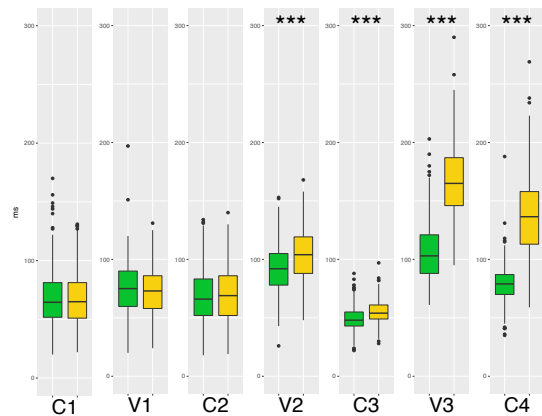


Fig. 2 Duration plots (ms) for the segments of the target words with penultimate stress and CV.CV.CVC structure, e.g. *RaMOnas* (n=288)

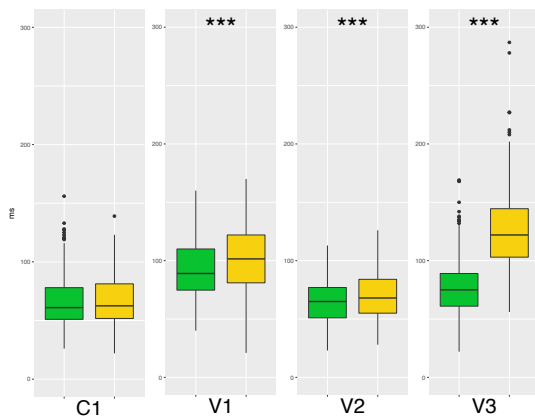


Fig. 3 Duration plots (ms) for the vowels and the initial onset consonant of the target words with antepenultimate stress, e.g. *KArolin* (n=288)

■ medial ■ final

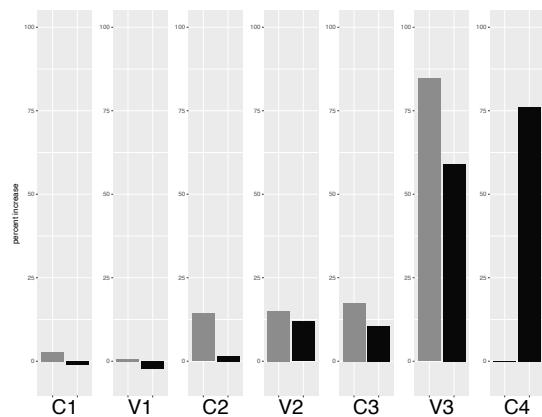


Fig. 4 Percent increase of the mean duration of the segments in the target words with penultimate stress, e.g. *Ramona* and *Ramonas* (n=288)

■ CV.CV.CV ■ CV.CV.CVC

References: ◆Byrd, D. & E. Saltzman. 2003. The elastic phrase: Modeling the dynamics of boundary-adjacent lengthening. *J. Phon* 31, 149–180. ◆Cho, T., J. Kim & S. Kim. 2013. Preboundary lengthening and preaccental shortening across syllables in a trisyllabic word in English. *J. Acoust. Soc. Am.* 133(5), EL384-90. ◆Katsika, A., J. Krivokapić, C. Mooshammer, M. Tiede & L. Goldstein. 2014. The coordination of boundary tones and its interaction with prominence. *J. Phon.* 44, 62-82. ◆Kohler, K. 1983. Prosodic boundary signals in German. *Phonetica* 40, 89–134. ◆Petrone, C., H. Truckenbrodt, C. Wellmann, J. Holzgrefe-Lang, I. Wartenburger & B. Höhle. 2017. Prosodic boundary cues in German: Evidence from the production and perception of bracketed lists. *J. Phon.* 61, 71-92.