

Is longer also stronger? The relationship between temporal and spatial expansion in domain-initial prosodic strengthening of vowels

The fact that prosodic structure impacts the realization of articulatory gestures has been well established over the past decade (Edwards et al., 1991; Fougeron & Keating, 1997; Byrd & Saltzman, 2003; Cho, 2002, 2004, 2005; among many others). One important question for models of articulatory control is the relation between duration and spatial expansion of articulatory gestures in different prosodic environments (cf. Byrd & Saltzman, 2003; Byrd et al. 2005; Beckman et al., 1992; Fougeron & Keating, 1997). The results of some studies suggest that lengthening entails strengthening of the lengthened articulatory gestures (Byrd & Saltzman, 2003; Byrd et al. 2005). Others suggest that lengthening and strengthening are controlled independently of each other (e.g. Beckman et al., 1992; Fougeron & Keating, 1997). The studies reporting a mismatch between temporal and spatial expansion investigated strengthening at prosodic boundaries. The current study contributes to this body of research by investigating the relation between temporal and spatial expansion in domain-initial unaccented syllables in three prosodic domains (**IP**, **AP**, **Wd**), with particular attention to the position of the vowel relative to the prosodic boundary, as a first or second segment (VC vs CVC syllables) in a specified domain.

Data from eight native speakers of American English was collected for this study. Each participant read six repetitions of the 12 target sentences in random order. Tongue movements during the production of the target sentences were scanned using an Antares Sonoline ultrasound machine, and the sentences were recorded. Participants' heads were stabilized during data collection (cf. Davidson & Decker, 2005). Ultrasound images for each target vowel were extracted, and the frame with the most advanced position of the tongue body was determined as the target frame (cf. Benus & Gafos, 2007). The edge of the tongue in the target frame was traced using EdgeTrak (Li et al., 2005). The tracings of the six repetitions for each vowel in each syllable and prosodic environment were averaged and compared using the spline-smoothing ANOVA procedure described in Davidson (2006). Furthermore, the duration of all vowels was measured in the acoustic data using PRAAT, and then statistically analyzed along the same comparison parameters as the ultrasound data.

The analysis revealed that there was only a correlation between duration and articulatory magnitude of the vowel gesture when comparing the position of the vowel with respect to the location of the IP boundary: Vowels in absolute initial position (VC) were articulated stronger in 94% of the tested cases and were also significantly longer ($p < .05$) than the vowels in domain initial (CVC) syllables. Comparisons that target domain-initial strengthening rather than proximity to boundary, show different pattern. Comparing vowels in **IP** initial VC syllables to those in **Word** initial VC syllables yielded an articulatory difference in 88% of all investigated cases, but the durations of those vowels were not different ($p = .2$). These results suggest that temporal and spatial expansion are not correlated in domain-initial strengthening of unaccented domain-initial VC syllables and that duration and articulatory magnitude of vowel gestures are controlled independently.

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