Prosodic modulation and the role of the segmental gestural molecule

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Introduction. Under prosodic modulation at a phrase boundary or prominence (e.g., stress, focus, contrast) [1,2], intra- and intergestural timing exhibits variability [3,4,5]. Such articulatory timing variation has almost exclusively been studied for individual constriction gestures across segments, and often examined separately for boundaries and prominence. However, recent studies suggest that *within-segment* [6] intergestural overlap (e.g., onset-to-onset lag) may exhibit a more stable pattern—i.e., one less affected by individual gestural duration—and that relative timing could also be sensitive to gestural magnitude [7]. We assess *within-segment* intergestural timing (phasing) stability by examining its resistance to prosodic modulation. We deploy state-of-the-art dynamic vocal tract imaging to probe the relative timing between oral and velum gestures in nasal segments, investigating whether variations in a single gesture influence oral-velum temporal coordination in Korean nasals, as well as the role prosodic modulations may play. Implications for an inherently dynamic phonological representation of the segment are weighed.

Method. Midsagittal vocal tract speech production data was acquired from five Korean speakers using real-time Magnetic Resonance Imaging (rtMRI). Target items were /n#p/, /n#t/, /n#n/ sequences across four prosodic conditions (Wd, AP, AP+focus, & IP; 7/8 reps each) [syllable onset data was also recorded but is not reported here]. Gestural onset and target timepoints for the velum gesture were computed from the velum image centroids using thresholded *xy* tangential velocity (Fig 1). TT gestural magnitude was determined by image region-of-interest analysis; VEL lowering magnitude was calculated from vertical centroids. TT and VEL durations were defined as onset-to-target interval duration. Velum to tongue tip intergestural lag is indexed as the delay between the two gestures' onset points—positive onset lag indicating that velum lowering precedes oral constriction. Results for gestural lag, duration, and magnitude were analyzed using linear mixed effects models.

Results & discussion. For both TT and VEL gestures, longer duration is correlated with larger magnitude, as seen in the positive relations between TT closure duration and magnitude (Fig 2a) and between VEL lowering duration and lowering degree (Fig 2d). Onset lags are not influenced by either TT duration nor TT magnitude (Fig 2b-c) but are correlated with VEL duration and VEL magnitude (Fig 2e-f). That is, the oral TT component is delayed as the nasal VEL component lengthens or increases in magnitude. This is consistent with a scenario in which relative timing within the segment is influenced by the earlier nasal component gesture but is unaffected by the gestural evolution of the (later) oral component. Lastly, effects of a large boundary (IP) and of prominence (AP+focus) are seen, as both TT and VEL duration and magnitude increase compared to at smaller boundaries (Wd & AP) (Fig 3a-d). In contrast, onset lags *remain stable* across all boundary conditions as well as under focal prominence (Fig 3e)—i.e., no boundary effects are shown on temporal lags. This suggests that a boundary's π-gesture and a focus μ-gesture may not be impacting a sub-segmental gestural timing level, while they nevertheless lengthen and strengthen all component gestures within its domain. This finding on the segment-internal lag stability under prosodic modulations crucially differ from prior findings across segments. These results will be situated within an Articulatory Phonology framework in which prosodic modulation gestures may interact with the coupling within gestural molecules characterized dynamically at the granularity of the segment.

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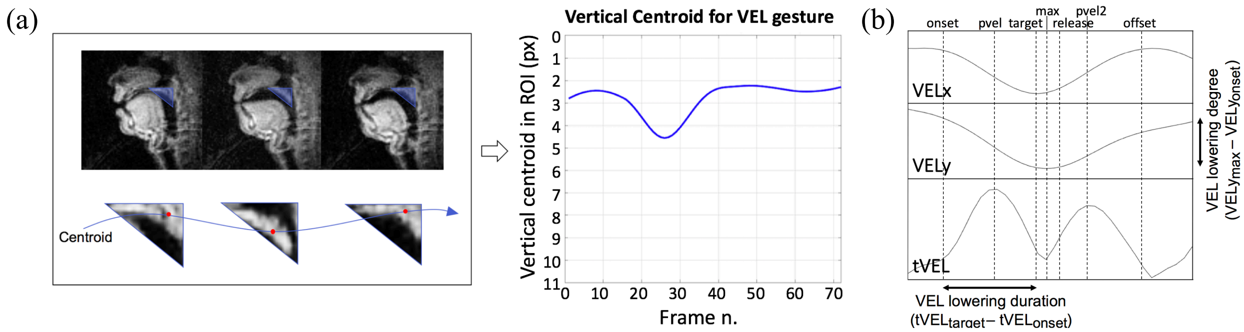

Fig 1. *(a) Velum centroid tracking in real-time MRI image*
(b) Velum xy trajectories & calculated tangential velocity and its temporal landmarks

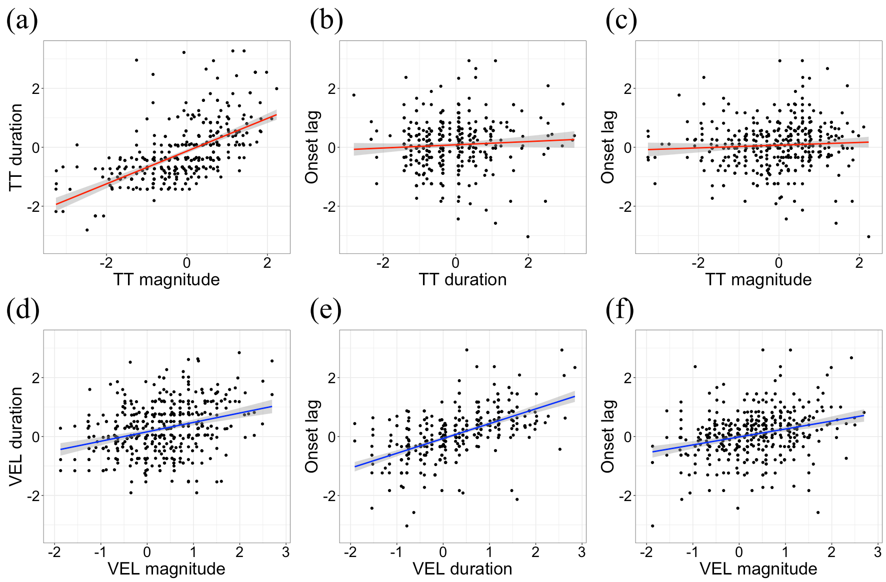

Fig 2. *Correlation graphs (z-scored within speaker): (a) TT duration & magnitude (b) onset lag & TT duration (c) onset lag & TT magnitude (d) VEL duration & magnitude (e) onset lag & VEL duration (f) onset lag & VEL magnitude*

(Note. VEL magnitude refers to velum lowering degree, and positive values indicate greater velum lowering)

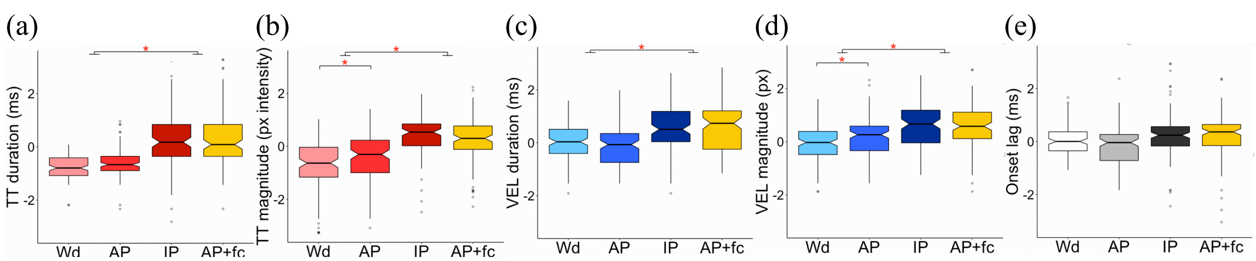

Fig 3. *(a) TT constriction duration, (b) TT magnitude, (c) VEL lowering duration, (d) VEL magnitude, and (e) onset lags across boundaries (Wd, AP, IP) and under prominence (AP+focus)*

References

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