The effect of pitch accent on V-to-V coarticulation induced variability of vowels

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Coarticulation is one of the main sources of segmental variability. Since the seminal work of [1] it is recognized that not only adjacent speech sounds but also transconsonantal vowels have an effect on each other, and the vowels in V_1CV_2 sequences are claimed to be produced with one single underlying diphthongal gesture to which the consonant's gesture is superimposed. The extent a segment is susceptible to coarticulation, i.e., the contextual variability it exhibits, is referred to as coarticulatory resistance (CR; greater resistance = less variance) [2]. CR in V-to-V coarticulation may be influenced by several factors. In an acoustic study [3] showed that Vs show smaller variability, if they are in a (lexically) **stress**ed syllable (vs. unstressed) (5 speakers). [4] confirmed that the above effect also exists for higher level (sentential) **accent** taking the edge and the first quarter of the V as points of measurement, but he tested it only in the articulatory domain (6 speakers). Although inconclusively and in smaller samples, it was also shown that certain **V-qualities** show greater resistance than others: in German, /i/ was found to be more resistant than /a/ (3 speakers) [5], in Italian, /i/ was more resistant than /a/, and /a/ than /u/ (1 speaker) [6], while in Thai, the high Vs /i/ and /u/ were similarly resistant (6 speakers) [7]. Lastly, [8] demonstrated that **intervening Cs** which exert a smaller degree of tongue dorsum contact with the palate allow for more V-to-V coarticulation (5 speakers). In an attempt (1) to further explore if prominence provokes CR in V-to-V coarticulation, (2) to uncover the language-specificity of the effect of prominence, and (3) to clarify the effect of V-quality, in the present study we analysed V-to-V carryover coarticulatory effects in the acoustic domain, in real words, in minimally constrained C-context (to maximize V-to-V effects), in the presence/absence of sentence level accent (+ word stress co-varying with accent) in Hungarian, and in a larger dataset (i.e., in more speakers) than previous studies.

We recorded 10 Hungarian adult female speakers producing /uh**u**/C_{alv}/u/, /ih**u**/C_{alv}/u/, /ih**i**/C_{alv}/i/, and /uh**i**/C_{alv}/i/ in words embedded in meaningful sentences, in two accent conditions: ˈV*h***V**C_{alv}V and V#ˈ*h***V**C_{alv}V. We used the glottal fricative /h/, as it is underspecified for oral configuration, and thus interferes the least with the single diphtongual gesture of the V segments. We measured F_1 and F_2 of V_2 at the left edge (median of first 10%; F_{2onset}) and in the temporal midpoint (median of mid 10%; F_{2mid}). Building on the locus equation approach, to gauge the **degree of coarticulation,** we fitted linear models on F_{2mid} and F_{2onset}, as a function of the tested variables [2]. **V-variability** was quantified by i) the magnitude of V target dispersion expressed in Euclidean distances of V_2 data points from the midpoint of the V ellipses in the $F_{1mid} \times F_{2mid}$ plane (separately for /i/ and /u/ × accent cond. × context), and ii) the difference of F_{2onset}s of coarticulated and non-coarticulated instances. The latter two measures were tested with linear mixed effects models.

Steep slopes for /i/ and slopes of approx. 0 for /u/ in both conditions reflect that /i/s were produced more stationary in time than /u/s, irrespective of the presence of accent (Fig 1). The analysis of Euclidean distances revealed that tokens were more variable in /i/ than in /u/ [$F(1, 10) = 10.55$, $p < 0.01$)], and in symmetrical (vs. asymmetrical) contexts [$F(1, 14) = 10.33$, $p < 0.01$)] irrespective of the presence of accent (Fig 2). This finding along with the regression fits suggests that the more dynamic realization of /u/ tokens resulted in higher accuracy in reaching V-target in /u/. Finally, F_{2onset} differences showed that there is generally little difference between coarticulated and non-coarticulated Vs, but in unaccented condition, /i/ varied more due to coarticulation (V × condition interaction: [$F(1, 30) = 16.04$, $p < 0.01$)]).

These results contradict some of the previous findings on V-quality, as we found that /u/ showed less variation than /i/. Moreover, results partly also contradict [3, 4] with respect to the effect of pitch accent, as we found that the lack of accent decreased CR only in /i/. The striking divergence of results may stem from the numerous methodological differences of the cited studies and the present paper (i.e., maximised V-to-V effect, use of real words, different quantification of variance), and the larger sample size used in this study, but may also point to language specific patterns in the interaction of prosody and V-to-V induced variation.

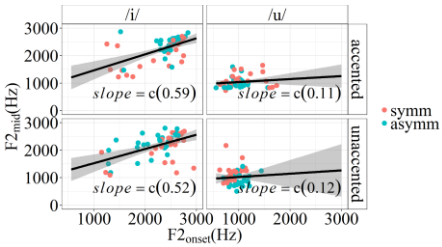

Figure 1. "Locus equations" for the target V_2 in coarticulating (asymm) and non-coarticulating (symm) contexts, as a function of prominence

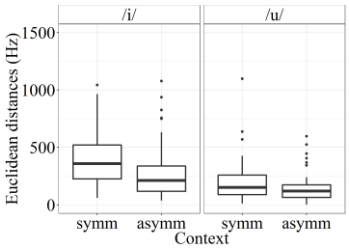

Figure 2. Acoustic dispersion of /i/ and /u/ on the basis of V_{2mid} spectral values

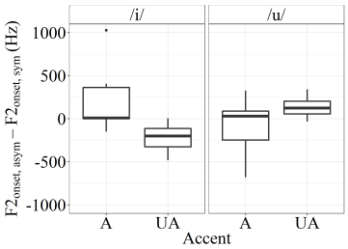

Figure 3. Differences of F_{2onset}s of coarticulated (asym) and non-coarticulated (symm) vowels

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While conducting the study, the first author was supported by the *Hungarian Ministry of Human Capacities (Emberi Erőforrások Minisztériuma), Hungarian Talent Program (Nemzeti Tehetség Program) NTP-NFTÖ-18.*