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C-to-V coarticulation induced formant dynamics variability in L1/L2/HL Spanish vowels

Introduction and Background. In English, vowel quality is significantly affected by syllable stress, showing reduction and centralization in unstressed conditions [1]. That is, vowels in stress positions will be more peripheral than unstressed vowels. Likewise, in English, the voicing of coda consonants can alter not only the duration of the vowel [2], but also its quality in certain contexts, e.g. *mad* vs. *mat* [1] or *ride* vs. *write* [3, 4]. However, in Spanish, those effects of vowel quality change are not present, and stress has not been found to alter formant properties of vowels significantly, at least when observing the vowel's midpoint [5]. Notably, most studies have focused solely on first language (L1) production, overlooking second (L2) or heritage (HL) language production. Furthermore, new statistical methods that allow for time-series analyses have emerged, providing the opportunity to conduct a more fine-grained description of formant trajectories.

Research Questions & Hypotheses. (RQ1) Will there be voicing-induced effects in vowel formant trajectories in Spanish? (H1) As vowels are usually longer in duration in pre-voiced consonant contexts, and longer durations are negatively correlated with vowel centralization, we expect vowels in pre-voiced contexts to exhibit more peripheral values. (RQ2) Will HL/L2 speakers show parallel patterns to L1 Spanish speakers? (H2) If HL/L2 Spanish speakers can adjust their English coarticulatory settings, they should show symmetrical patterns to those by L1 speakers; however, if they do not adjust them, vowel fronting/raising should appear in /a/ [1].

Methods. 55 participants took part in this experiment, 12 Spanish native speakers of Spanish (L1Sp), 21 second-generation heritage speakers of Spanish (HSS) from the Chicagoland area, and 22 L2 American learners of Spanish (L1En) from the Chicagoland area. They participated in a read-aloud task in Spanish producing CV_1C_2V (near-)minimal pairs (where V_1= /a, i/ and C_2= [t-ð, k-ɣ, s-z]). Each participant produced 48 target tokens. From each vocalic segment, 20 time-normalized points were obtained, thus resulting in 52,800 data points for the statistical analysis. The data were fit into a Generalized Additive Mixed Model (GAMM) in *R* where F1 and F2 contours were observed across time. For each variable, the predictors of interest were CONSPAIR ([t-ð; k-ɣ; s-z]), SEX (female; male), and a three-way interaction between GROUP (L1Sp; HSS; L1En) x VOICING (Voiced; Voiceless) x VOWEL (a; i). Smooth terms over TIME were included for the factors and the three-way interaction, as well as a factor smooth over TIME for SPEAKER by the three-way interaction, and a random intercept for WORD.

Results. All groups showed parallel tendencies. In terms of /a/, they lowered F1 as the segment progressed in pre-voiced environments (contrary to the duration-centralization hypothesis.) Quality-wise, HSS showed significantly lower values (i.e., higher tongue position) than the other groups, which could have happened due to cross-linguistic effects. Regarding F2, significant effects were found for L1Sp and HSS and each voicing condition, as they showed higher values (i.e., more anterior tongue position) for pre-voiceless contexts. Concerning /i/, all groups showed similar tendencies by having lower F1 values in pre-voiced contexts (in agreement with the duration-centralization hypothesis.) No significant differences were found in F2 (see Figures.)

Conclusion. The voicing condition of the upcoming consonant shows significant effects with varying results on Spanish vowels. This can be explained by the Quantal Theory's prediction about point vowels showing less perturbations (and /i/ being more peripheral than /a/ in Spanish.) Across groups, similar patterns were found, where vowel quality mainly changed regarding tongue height (F1) but not tongue anteriority (F2.) This study demonstrated that HL/L2 speakers of Spanish can adjust their coarticulatory settings between their L1/HL and L2, as their results resemble L1 Spanish speakers', and do not show the allophonic features that are found in their English variety.

References

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Figures