The effects of place of articulation and voicing on bidirectional C-to-V coarticulation

Scarlet Wan Yee Li & Suzy Ahn
University of Ottawa

Background. Coarticulatory effects can operate bidirectionally, meaning that surrounding sounds may influence the realization of a preceding (i.e., anticipatory) or following (i.e., carryover) segment in the factors of places and manners of articulation, voicing, etc. In addition, both consonants and vowels can be influenced by coarticulatory effects lead to changes in place, manner and/or voicing of consonants and changes in vowel qualities. Extensive work investigating the effect of place of articulation (PoA) of consonants to the adjacent vowels has explored the anticipatory or carryover coarticulatory effects of consonants on F2 of adjacent vowels [6,8]. Another line of research has found that the voicing of consonants influences the adjacent vowel's f0 [1,3] and F1 [2,7]. Furthermore, the degree and direction of coarticulatory effects are affected by different linguistic aspects such as syllable and word boundaries [3,4]. Nonetheless, there remains a scarcity of studies investigating the bidirectional effects of PoA or consonant voicing with adjacent vowels, particularly when accounting for syllable and word boundaries.

Current study. The present study aims to examine (1) the effect of three PoA (alveolar, bilabial, and velar) and voicing (voiced, voiceless) of consonants on the quality of following and preceding vowels and (2) whether both anticipatory and carryover coarticulatory effects can extend within and across syllable and word boundaries.

Methods. Six speakers of Canadian English recorded producing words in /$C_1V_1.C_2V_2$/, /$C_1V_1\#C_2V_2$/ and /$C_1V_1C_2\#V_2$t/ sequences. F0, F1, and F2 frequencies were measured at the onset and offset of the target vowels (/i ɑ/) for comparing the coarticulatory effects brought by the adjacent consonants with different voicing and PoA (/p b t d k g/). Separate linear mixed-effect models were used to analyze the coarticulatory effects of consonants to vowel f0, F1, and F2. We have obtained preliminary results, and ongoing data collection is underway to confirm the robustness of these findings and ensure the clarity of the observed pattern.

Results. Preliminary results indicate that coarticulatory effects vary based on voicing and PoA of consonants. Voiceless consonants exhibited a greater effect on f0 bidirectionally compared to the voiced consonants (anticipatory: $\beta = 0.43$, $p = .02$, carryover: $\beta = 0.41$, $p = .04$), but smaller effects on F1 and F2 which are not statistically significant. Regarding PoA, results showed that the F2 frequencies in anticipatory context increased from bilabials to alveolars to velars. The findings also suggest that bidirectional coarticulatory effects are found across both syllable and word boundaries. Within and across these boundaries, larger anticipatory effects were found on f0 when compared to the carryover effects ($\beta = -0.65$, $p < .001$), while the carryover effect on F1 was more robust ($\beta = 0.18$, $p < .001$). Concerning F2, differences between coarticulatory effects were only evident in voiceless (anticipatory: $M = 0.08$, $SE = 0.27$, carryover: $M = -0.02$, $SE = 0.26$) and velar contexts (anticipatory: $M = 0.22$, $SE = 0.32$, carryover: $M = 0.07$, $SE = 0.32$). In sum, results suggest that voicing of the consonant had a greatest effect on f0 compared to F1 and F2, while PoA only influenced F2 in anticipatory contexts, and such coarticulatory effects can extend across syllable and word boundaries bidirectionally.

Significance. This study contributes to our understanding on how PoA and voicing of consonants influence the quality of following and preceding vowels. Additionally, it explores how such bidirectional effects can spread within and across word boundaries, aspects that have been rarely investigated in the existing literature.

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