

## Syllable position in secondary dorsal contrasts: an ultrasound study of Irish

Ryan Bennett<sup>1</sup>, Jaye Padgett<sup>1</sup>, Máire Ní Chiosáin<sup>2</sup>, Grant McGuire<sup>1</sup>, Jennifer Bellik<sup>1</sup>

<sup>1</sup>University of California, Santa Cruz (USA), <sup>2</sup>University College Dublin (Ireland)  
padgett@ucsc.edu, rbennett@ucsc.edu, maire.nichiosain@ucd.ie, gmcguire1@ucsc.edu, jbellik@ucsc.edu

This study examines the articulatory robustness of secondary dorsal /C<sup>j</sup> C<sup>v</sup>/ contrasts in Irish, across different word/syllable positions, using ultrasound imaging. We find that /C<sup>j</sup> C<sup>v</sup>/ contrasts are more articulatorily distinct in onset position than in coda position, and speculate that syllable-based differences in the articulation of /C<sup>j</sup> C<sup>v</sup>/ may help explain why /C<sup>j</sup> C<sup>v</sup>/ contrasts are preferentially realized in onset position across languages.

Every consonant in Irish is either contrastively palatalized /C<sup>j</sup>/ or contrastively velarized /C<sup>v</sup>/. These /C<sup>j</sup> C<sup>v</sup>/ contrasts occur both word-initially and word-finally (1). Word-final /C<sup>j</sup> C<sup>v</sup>/ contrasts can also mark morphosyntactic distinctions, such as plural vs. singular inflection (2).

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| (1) /b <sup>j</sup> ɔ:n <sup>v</sup> / ‘peak’              | /b <sup>v</sup> ɔ:n <sup>v</sup> / ‘white’                             |
| /p <sup>j</sup> ɔ:n <sup>v</sup> / ‘pen’                   | /p <sup>v</sup> ɔ:n <sup>v</sup> / ‘pawnshop’                          |
| /b <sup>v</sup> r <sup>v</sup> ɔ:di/ ‘neck’                | /b <sup>v</sup> r <sup>v</sup> ɔ:d <sup>v</sup> / ‘drizzle’            |
| /s <sup>v</sup> k <sup>v</sup> ɔ:l <sup>v</sup> / ‘shadow’ | /s <sup>v</sup> k <sup>v</sup> ɔ:l <sup>v</sup> / ‘supernatural being’ |
| (2) /k <sup>v</sup> at <sup>i</sup> / ‘cats’               | /k <sup>v</sup> at <sup>v</sup> / ‘cat’                                |
| /b <sup>v</sup> ɔ:di/ ‘boats’                              | /b <sup>v</sup> ɔ:d <sup>v</sup> / ‘boat’                              |

Work on the typology of /C<sup>j</sup> C<sup>(v)</sup>/ contrasts has shown that such contrasts are more susceptible to loss in word/syllable-final position [1, 2], particularly for labials. Word-final /C<sup>j</sup> C<sup>(v)</sup>/ contrasts seem to be less perceptible than word-initial /C<sup>j</sup> C<sup>(v)</sup>/ contrasts in both Russian and Irish [3-6], possibly due to differences in the availability and robustness of acoustic cues in each of these contexts [7]. However, there is relatively little work examining possible articulatory bases for these perceptual asymmetries, and none on Irish. Kochetov [2, 8] found that the palatalization gesture of [p<sup>j</sup>] is reduced and differently timed in onset position compared to coda position. These articulatory differences may contribute to the perceptual and typological asymmetries noted above regarding /C<sup>j</sup> C<sup>(v)</sup>/ contrasts across word/syllable contexts.

Our study considers comparable contrasts in Irish. We test the hypothesis that sound changes affecting /C<sup>j</sup> C<sup>(v)</sup>/ contrasts, and the resulting typology, stem from patterns of articulatory reduction and coordination, likely working in tandem with perceptual asymmetries across syllabic contexts. Specifically, we expect that dorsal positions reflecting /C<sup>j</sup> C<sup>v</sup>/ contrasts will show less articulatory separation in coda (word-final) compared to onset (initial) contexts.

We’ve collected ultrasound data from 7 Irish speakers, representing all major dialects (Ulster, Connacht, Munster). We present data from 4 speakers here, and will analyze data from the remaining 3 speakers prior to the conference. Speakers uttered 5 repetitions of a list of C-initial and C-final Irish words. Target consonants were all stops (labial, coronal, velar), paired for secondary articulation (/C<sup>j</sup>/ vs. /C<sup>v</sup>/), syllabic position (onset vs. coda), and vowel context (adjacent to [i:], [u:], or [ɔ:]). All target consonants were in word-initial stressed syllables; target onsets were always word-initial, and target codas always word-final. In each pass through the list, words were presented in random order, embedded in the carrier phrase [ˈdʲu:rtʲ ˈi:fə \_\_\_ əˈnʲu:vɾə] ‘Aoife said \_\_\_ last year’. Ultrasound data was collected using a Terason T3000 ultrasound system with a model 8MC3 probe, mounted in an Articulate Instruments Ultrasound Stabilization Headset [9], at 60 frames/second. The tongue surface in these images was traced with EdgeTrak [10] (Fig. 1).

We assess dorsal position in target consonants in three ways: using loess-smoothed curves; comparing the position of the highest point of the tongue dorsum; and computing Root Mean Sum of Squared Distances between two curves [11] (Fig. 2).

All three measures find that /C<sup>i</sup> C<sup>v</sup>/ contrasts are more widely separated in word-initial (onset) position than in word-final (coda position). This is especially true for labials and dorsals. Consonants show more coarticulation with neighboring vowels when in coda position; this is again especially true for labials. These observations hold whether we compare onsets vs. codas at C release, or instead compare onsets at CV transition with codas at VC transition. We conclude that typological asymmetries in the distribution of /C<sup>i</sup> C<sup>v</sup>/ contrasts are reflected in articulatory asymmetries in the production of these contrasts in the synchronic phonetics of Irish.

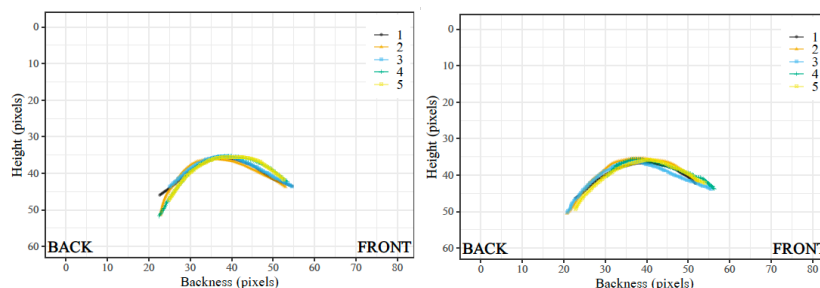


Fig. 1: tracings for [b] in word-initial (left) vs. final (right) position adjacent to [u:], C offset.

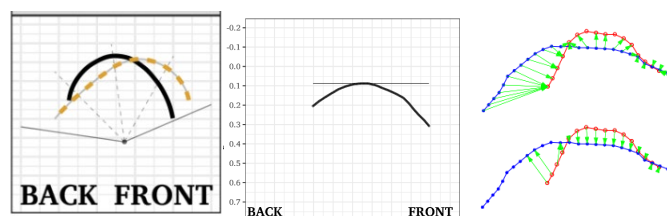


Fig. 2: loess-smoothed comparisons; peak dorsal position; RMSSD measures (Csapó et al. 2017)

## References

- [1] Takatori, Y., 1997. *A study of constraint interaction in Slavic phonology*. Yale University PhD.
- [2] Kochetov, A., 2002. *Production, perception, and emergent phonotactic patterns*. Routledge.
- [3] Kochetov, A., 2004. Perception of place and secondary articulation contrasts in different syllable positions: language-particular and language-independent asymmetries. *Language and speech* 47.4.
- [4] Kochetov, A., 2006a. Testing licensing by cue. *Phonetica* 63.
- [5] Ní Chiosáin, M. & J. Padgett, 2012. An acoustic and perceptual study of Connemara Irish palatalization. *Journal of the International Phonetic Association* 42.2.
- [6] Padgett, J. & M. Ní Chiosáin, 2018. The perception of a secondary palatalization contrast: a preliminary comparison of Russian and Irish. In R. Bennett et al. (eds.), *Hana-bana: a festschrift for Junko Ito and Armin Mester*.
- [7] R. Wright, 2004. A review of perceptual cues and cue robustness. In B. Hayes et al. (eds.), *Phonetically based phonology*. Cambridge University Press.
- [8] Kochetov, A., 2006b. Syllable position effects and gestural organization: Evidence from Russian. In: L. Goldstein et al. (eds.), *Papers in Laboratory Phonology VIII*. Mouton de Gruyter.
- [9] Wrench, A., 2008. *Articulate Assistant user guide, version 1.17*.
- [10] Li, M. et al., 2005. Automatic contour tracking in ultrasound images. *Clinical linguistics and phonetics* 19.6-7.
- [11] Csapó, T. et al., 2017. Comparison of distance measures in tongue contour traces of ultrasound images. Poster presented at Ultrafest 2017.