Towards a Gestural Characterization of Liquids: Evidence from Spanish and Russian

Rhotics and laterals pattern together in a variety of ways in the phonology of many languages, yet it is not well understood what the basis of this grouping might be. A variety of features have been proposed to describe the phonological behavior of liquid consonants, including [lateral], [trill] and [liquid] (Chomsky & Halle 1968, Walsh-Dickey 1997), yet none of these primitives is capable of capturing the relevant set of consonants within or across languages (Proctor 2009). It is unclear what acoustic properties members of the class might share, if any (Lindau 1985, Ladefoged & Maddieson 1996). Articulatory studies have demonstrated that, despite their variant realizations, American English laterals and rhotics are all produced with both a coronal and a dorsal/pharyngeal gesture (Delattre & Freeman 1968; Sproat & Fujimura 1993; Browman & Goldstein 1995). In light of similar evidence for coronal and dorsal gestures in Salish and Mandarin liquid production (Gick et al. 2006), this suggests that the class of liquids might be potentially well characterized in the articulatory domain. However, it remains to be seen to what extent this characterization holds true in languages that employ a greater range of liquid contrasts. Two languages of particular interest are Spanish, which uses a clear lateral, and contrasts a tapped and a trilled rhotic, and Russian, which contrasts palatalized and non-palatalized liquids. The hypothesis being examined is that the class of coronal liquids consists of segments produced via the coordination of tongue-tip and tongue-body gestures.

An ultrasound experiment was conducted to compare the dynamic production of liquid and obstruent consonants in Spanish and Russian. Five speakers of American Spanish produced each of the coronal consonants /l-ɾ-r-d/ in three different intervocalic environments /i-a-u/. Four speakers of Contemporary Standard Russian produced consonants /l-lʲ-r-rʲ-d-dʲ/ in intervocalic environments /e-a-u/. Lingual motion was captured using high-speed optically-corrected ultrasound (Whalen et al. 2004). Tongue edges were extracted using semi-automatic tracking (Li et al. 2005). For each consonant, lingual posture was compared in intervocalic environments at three points in time: (i) the acoustic mid-point of the pre-consonantal vowel, (ii) the midpoint of consonantal production, and (iii) the acoustic mid-point of the post-consonantal vowel. Susceptibility to vocalic coarticulation was estimated by calculating dorsal displacement across consonantal tokens produced in antagonistic vocalic contexts.

Liquids in both languages were found to be united by a lower susceptibility to vocalic coarticulation than the coronal stops (Fig. 1), suggesting that articulation of the tongue dorsum is intrinsic to the liquid consonant. The tongue body gesture of the Spanish lateral resembles that of a mid-front vowel; dorsal articulation of the Spanish trill resembles that of a mid-back vowel. The tongue body gesture of the Russian non-palatalized lateral resembles that of a mid-back vowel; the Russian non-palatalized trill is produced with a dorsal gesture resembling that of a mid-central vowel.

These results are consistent with the hypothesis that coronal liquid consonants are segments corresponding to recurrent, stable constellations (Browman & Goldstein 1992) in which a consonant-like tongue-tip gesture is coordinated with a vowel-like tongue-body gesture (Gick et al. 2002). Such gestural configurations are inherently sonorous – due to the vocalic nature of the tongue body constriction and the incomplete or sporadic nature of the coronal closure – and therefore afford spontaneous voicing. Differences between clear and dark laterals are shown to result primarily from differences in dorsal target locations. Differences between rhotics are attributed to variation in the stiffness and degree of damping of tongue-tip and tongue body gestures – trills and retroflex rhotics being characterized by a more highly constrained dorsum, and taps by a more lightly damped tongue tip. Phonological processes involving interactions between liquids and nuclei – e.g. post-vocalic deletion, coloring and lengthening – are discussed as resulting from the blending of coproduced tongue body gestures.

Figures

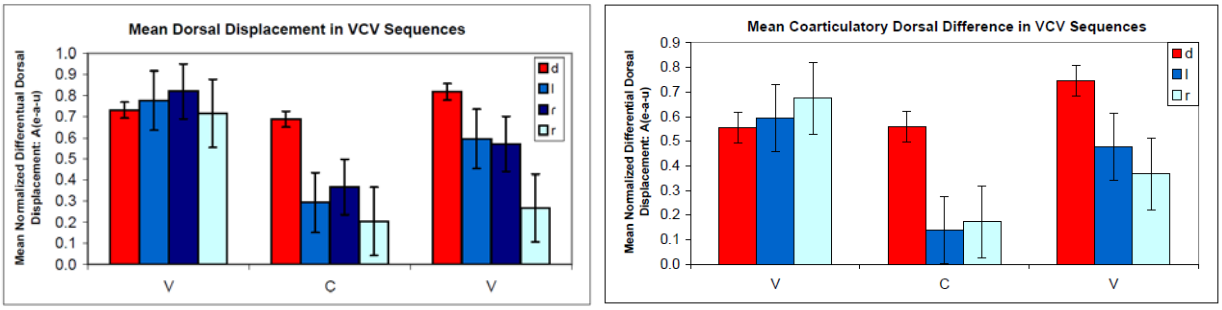

Fig. 1: Mean normalized differential dorsal displacement: coronal consonants, all subjects. Left: Spanish; Right: Russian

References

Browman, C.P. & L.M. Goldstein. 1992. *Articulatory phonology: an overview*. Phonetica 49: 155-180

Browman, Catherine P. & Louis M. Goldstein. 1995. *Gestural syllable position effects in American English*. In Fredericka Bell-Berti & Lawrence J. Raphael (eds.), Producing speech: contemporary issues (for Katherine Safford Harris), 19-34. New York: AIP Press

Chomsky, Noam & Morris Halle. 1968. The sound pattern of English. New York: Harper & Row

Delattre, Pierre & Donald C. Freeman. 1968. *A dialect study of American r's by x-ray motion picture*. Linguistics 44: 29-68

Gick, Bryan, A. Min Kang & Douglas H. Whalen. 2002. *MRI evidence for commonality in the post-oral articulations of English vowels and liquids*. Journal of Phonetics 30(3): 357-371

Gick, Bryan, Campbell, Fiona, Oh, Sunyoung and Tamburri-Watt, Linda, 2006, *Toward Universals in the Gestural Organization of Syllables: A Cross-Linguistic Study of Liquids*. JPhon. 34(1): 49-72

Ladefoged, Peter and Maddieson, Ian. 1996. The sounds of the world's languages. Oxford: Blackwell

Li, Min, Chandra Kambhamettu & Maureen Stone. 2005. *Automatic contour tracking in ultrasound images*. Clinical Linguistics & Phonetics 19(6-7): 545

Lindau, Mona. 1985. *The story of /r/*. In Victoria Fromkin (ed.), Phonetic linguistics: Essays in honor of Peter Ladefoged, 157–168. Orlando: Academic Press

Proctor, Michael. 2009. Gestural Characterization of a Phonological Class: the Liquids. PhD Dissertation, Yale University

Sproat, Richard & Osamu Fujimura. 1993. *Allophonic variation in English /l/ and its implications for phonetic implementation*. Journal of Phonetics 21(3): 291-311

Walsh-Dickey, Laura. 1997. The Phonology of Liquids. PhD Dissertation, UMass Amherst

Whalen, Doug. H., Khalil Iskarous, Mark K. Tiede, David J. Ostry, Heike Lehnert-LeHouillier, Eric Vatikiotis-Bateson & Donald S. Hailey. 2005. *The Haskins Optically Corrected Ultrasound System (HOCUS)*. Journal of Speech, Language, and Hearing Research 48(3): 543-553