Spanish Spirantization is not phonetic weakening: a modular view

Purnomo, G.[1], Mellesmoen, G.[1], Gick, Bryan[1,2]
[1] Dept. of Linguistics, University of British Columbia, Vancouver, British Columbia, Canada
[2] Haskins Laboratories, New Haven, Connecticut, USA

All speech sounds are produced through specific, coordinated body movements. However, models of speech have seldom drawn on current theories of biomechanics or neuromuscular organization. The Interdisciplinary Speech Research Lab has developed a model of speech movement built on modular control (e.g., Gick & Stavness 2013, Gick et al. 2019). The resulting framework is incompatible with widely held views of speech in many ways. For example, phonological descriptions often describe sounds as being "weakened", often with reference to a reduction in articulatory effort, which causes them to "become" different sounds. One of the most widely cited cases of this is that of Spanish spirantization, in which oral closure movements are said to be produced in a "weakened" form. Previous work suggests that the voiced alveolar (/d/) and bilabial (/b/) plosives surface as the weaker interdental (/ð/) and labiodental (/v/) fricatives, respectively (González 2006, Piñeros 2002, Piñeros 2003, Kaplan 2010). This description is incompatible with a modular model because simply changing the degree of muscle activation will never allow a failed /b/ to become a /v/. This is because the movements associated with the sounds /b/ and /v/ are produced with distinct sets of muscles rather than a single set of muscles scaled to different activation levels. This implication – that different speech sounds correspond to different neuromuscular organizations – is highly controversial for models of speech. The question thus arises as to whether the spirantized variant may reasonably be viewed as a failed attempt at reaching a closure target or as a different target altogether. The present study asks whether Spanish speakers employ distinct sets of muscles when they produce spirantized forms. Videos of naturalistic speech from varying Spanish (both European and Latin American) regions were selected from the video-sharing platform Youtube. All frame instances of labial and coronal consonants were extracted by hand and coded by trained phoneticians for stress pattern, place in word, and preceding and following environment. The area of visible tongue for alveolar in each video frame was measured and recorded using ImageJ. Differences in visible physiology suggests in different active musculature since the mechanism needed for tongue protrusion in an interdental sound differ to mechanisms for simply making contact with the alveolar ridge. Area measurements were normalized for statistical analysis. ANOVAs were performed on the scipy package Python on the area measurements, and chi-squared analyses were performed on the counts of voiced, voiceless and nasal targets. Results to date indicate that spirantized versions of the canonical voiced targets are not simply the result of decreases in the degree of muscle activation, but rather employ a distinct set of muscles. These contrast to the voiceless and nasal targets, which do not show any variation. Implications will be discussed for theories of phonetics-phonology and sound change.

References

Gick, B., Schellenberg, M., Stavness, I. and Taylor, R. (2019). Articulatory Phonetics. In W. F. Katz & P. Assmann (eds.). *The Routledge Handbook of Phonetics*. Ch 5. New York: Taylor & Francis.

Gick, B., Stavness, I., Chiu, C., & Fels, S. (2011). Categorical variation in lip posture is determined by quantal biomechanical-articulatory relations. *Canadian Acoustic*s, 39(3), 178-179.

Gonzaléz, C. (2006). The phonetics and phonology of spirantization in North-Central Peninsular Spanish. *ASJU Journal of Basque Linguistics and Philology*, XL,409-436.

Kaplan, A. (2010). *Phonology shaped by phonetics: The case of intervocalic lenition*. (University of California, Santa Cruz dissertation).

Ortega-Llebaria, M. (2004). Interplay between phonetic and inventory constraints in the degree of spirantization of voiced stops: Comparing intervocalic /b/ and intervocalic /g/. Spanish and English. In Timothy L. Face (ed.), *Laboratory approaches to Spanish phonology*, 237-253.

Piñeros, C.-E. (2002). Markedness and laziness in Spanish obstruents. *Lingua*, 112, 379-413.

Piñeros, C.-E. (2003). Accounting for the instability of Palenquero voiced stops. *Lingua*, 113(12), 1185-1222.