

Global effects of constriction degree in heterorganic stop sequences in Spanish

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In standard Articulatory Phonology theory (Browman & Goldstein, 1989, 1992) gestures are defined on the basis of a set of simple tract variables. Of these, constriction degree (CD) and constriction location (CL) are usually identified as correlates of the more traditional phonological notions 'manner of articulation' and 'place of articulation', respectively. The relationship between these two basic gestural attributes and whether they can be activated independently of each other remains a point of contention in the theory. Browman & Goldstein (1989) distinguish between 'input' and 'output' features; while the 'input' features refer to more strictly articulatory, production aspects at the individual gestural/articulator level, 'output' features have to do with more 'global' consequences at the vocal tract level which take into consideration aspects not only of articulation per se, but also aerodynamics and acoustics. This distinction between input and output features is particularly relevant for CD, given that the overall aerodynamic and acoustic nature of a given utterance will depend to a great extent on the different constriction degrees that are activated at any given point in time during the production of a sound or sequence of sounds. Browman & Goldstein (1989)'s tube geometry proposal is an attempt to formalize the composite output effects of CD at different points in the vocal tract; the idea is that the effect of different CDs for different gestures percolates up the geometry hierarchy to produce an overall vocal tract CD.

The study reported on here aims to test the predictions regarding global CD effects mentioned above by looking at heterorganic stop sequences in Spanish. It is well known that Spanish voiced stops /b, d, g/ lenite (spirantize) in all positions except in absolute initial position, after nasals and, for /d/, after /l/. Given that Spanish also systematically assimilates nasals to the point of articulation of following consonants, the nonleniting contexts for /b, d, g/ (other than absolute initial position) always involve homorganic sequences: /mb/, /nd/, /ld/, /ŋg/. If we understand spirantization as essentially the result of articulator undershoot (Honorof, 1999; Parrell, 2014), the homorganicity of nasal+stop sequences can be seen as largely responsible for the lack of lenition in the stops. (Romero, 1995) shows that the nasal+stop sequences are in fact produced with one single articulatory gesture. Since the nasal requires full occlusion, the gesture is realized as a complete closure, which prevents undershoot in the stop. This accounts for the different outcome in homorganic /ld/, with no lenition, compared to heterorganic /lb/ or /lg/, which show lenition.

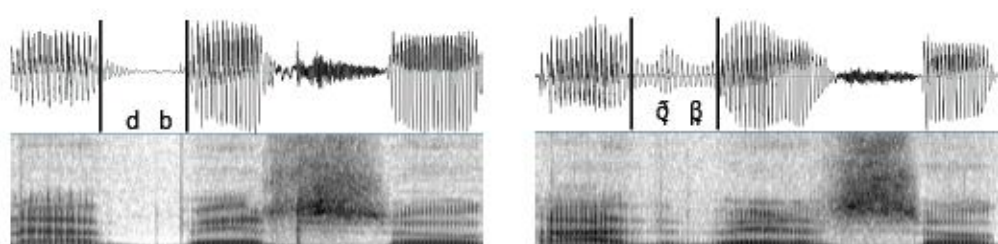
While most work on Spanish stop lenition has focused on the contexts outlined above, there are other possible sequences in the language which challenge the idea that lack of lenition—understood as a reduction in CD—is necessarily linked to homorganicity—an agreement in CL. Sequences of two stops in words such as *adquirir*, *abdicar*, *adverso*, *subcampeón*, or stop+nasal as in *abnegar*, *admirar*, *asignar*, present interesting study cases because they are all heterorganic and therefore the presence or absence of lenition cannot be accounted for in the same terms as with the more common homorganic sequences. It remains to be seen, therefore, to what extent the CD specifications for each member of the stop+stop or stop+nasal sequences influence each other in these heterorganic clusters. The predictions within Articulatory Phonology's tube geometry proposal would indicate that if there is a complete occlusion within the tongue tube for C2, then the closed CD would percolate all the way to the vocal tract level, which would in turn condition C1 to appear as fully constricted as well. If, on the other hand, C2 is lenited and therefore the vocal tract tube allows for a certain degree of laminal airflow, we would expect C1 to show signs of lenition as well. Thus, in a word like *abdicar*, if /d/ is fully occluded then we would expect /b/ to be fully occluded as well. If, on the other hand, /d/ is lenited, we would expect /b/ to show signs of lenition too.

In order to test this hypothesis an acoustic study was carried out with a set of words that included the following stop+stop sequences: *abdicar*, *adverso*, *rugby*, *adquirir*, *subclase*, and the following stop+nasal sequences: *abnegar*, *admirar*, *asignar*. Because of the limited number of lexical items in Spanish that include these sequences, it was not possible to control for all possible combinations of

place of articulation or voicing. The set used here, however, is made up of words that are by no means unusual or unfamiliar to any educated speaker of Spanish. Six native speakers of peninsular Spanish from the Madrid area (three male and three female) read the words in carrier sentences at two different speaking rates, a slightly faster rate and a slightly slower rate than normal, as established by an automatic computer presentation of the stimuli. The two rates were included in order to encourage the production of more lenited tokens (at the faster rate) and more occluded tokens (at the slower rate), following Soler & Romero (1999). Measurements of consonant duration and relative amplitude were obtained for both C1 and C2. Segmentation of lenited tokens was facilitated by the use of an automatic event identification procedure based on first derivative traces of signal intensity.

Preliminary quantitative results for two of the subjects (one male and one female) show some of the expected patterns, in addition to other interesting configurations. Figure 1 below shows, on the left, an example of the word *adverso* in which both consonants (/d/ and /b/) show complete occlusion and, on the right, another example of the same word in which both consonants are clearly lenited.

Figure 1: Examples of fully occluded (left) and lenited (right) stops in two instances of the word *adverso*.



A high percentage of the words analyzed for these two subjects show the fully occluded pattern seen on the left image in Figure 1. In those cases, both stops are consistently fully occluded. The pattern on the right image of Figure 1 is less common, especially at slower rates, but when it does occur, it shows equally consistently both consonants as lenited. Other patterns include high degrees of lenition in stop+nasal sequences in which also the nasal is lenited (see Honorof, 2003), as well as examples in which a fully occluded C1 is released into an epenthetic vowel which, in turn, causes lenition of C2, as in some instance of the word *rugby*. It remains to be seen exactly in what way consonant duration, as induced by the differences in rate, interacts with the observed patterns of lenition or lack thereof. But at least from the qualitative data analysis performed so far, it seems that there is indeed a hierarchy of constriction degree, as hypothesized in Articulatory Phonology's tube geometry, which determines the extent of lenition in stop clusters even when these are not homorganic.

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