

## Hierarchy of articulatory difficulty of Spanish sounds for L1 and L2 Spanish speakers

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Explanations of relative difficulty in L2 speech normally do not explicitly include a role for complex articulatory movements and focus on markedness (Eckman, 2008) or the perceptual categorization of sounds (Flege, 1995; Best & Tyler, 2007). An explanatorily and predictively adequate L2 speech theory must include a model of production difficulty, yet our understanding of what is articulatorily easy/difficult is limited. While research on phonetic constraints has revealed that articulations involving frication (Recasens et al., 1997), trilling (Recasens & Pallarès, 1999; Ohala & Solé, 2010), and posterior places of articulation (Boersma, 1998) are complex, the combinations of complex articulatory gestures that result in the greatest difficulty for L2 learners is understudied. The goal here is to adapt a method used in the speech sciences to establish empirically a hierarchy of difficulty of sounds for L2 speakers.

10 L1 Spanish and 10 advanced L1 English-L2 Spanish speakers residing in Madrid repeated nonce VCV sequences as rapidly as possible for seven seconds. Five Spanish segments absent from English ([β, γ, χ, ɲ, r]) were produced in two contexts ([eCa], [aCe]). [m, t] (present in both languages) were also included as a baseline, as stops were predicted to be the least difficult (Lindblom & Maddieson, 1988). In contrast, [r, χ] were expected to be the most difficult, given the precise aerodynamic conditions required for their production. Productions were analyzed acoustically (place and manner of articulation, voicing), and speed and accuracy rates (correct vs. incorrect) were calculated; segments with slower and lower accuracy rates were analyzed as the most difficult.

The following hierarchies were observed (Figure 1): L1 [m, t, β] > [γ, ɲ, r, χ]; L2 [m] > [t, β] > [γ, ɲ] > [r] > [χ]. Results, consistent with findings on coarticulatory resistance (Recasens et al., 1997; Recasens & Pallarès, 1999) and phonetic constraints (Lindblom & Maddieson, 1988; Boersma, 1998; Ohala & Solé, 2010) indicate that segments with complex aerodynamic requirements or involving the tongue body were the most difficult. Hierarchies were similar across language groups; however, the L2 speakers experienced more difficulty overall, especially with the segments that involved trilling and frication.

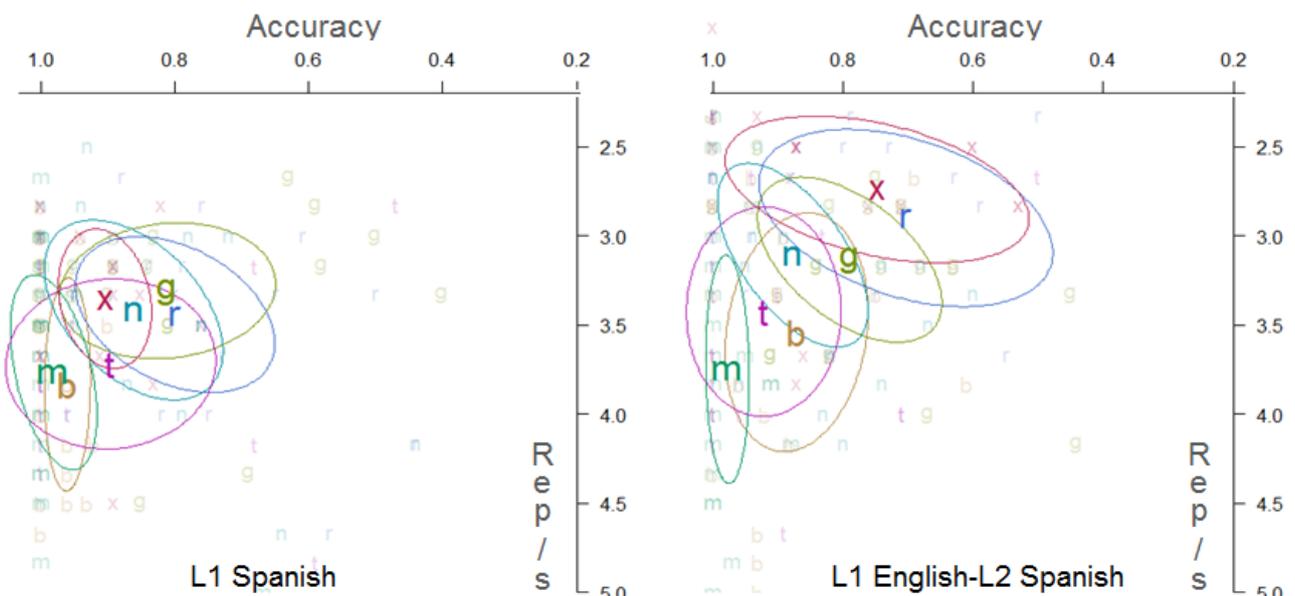


Figure 1. Two dimensional graph displaying % target accuracy (x-axis) and speed in repetitions/second (y-axis), by language group (L1 vs. L2 speakers). Bolded segments represent mean values; circles represent values within one SD. m=[m]; b=[β]; g=[γ]; n=[ɲ]; x=[χ]; r=[r].

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