Predicting difficulty in L2 speech: Moving towards a comprehensive model of L2 perception and production

Matthew Patience
University of Toronto

Theories of L2 acquisition of sounds are based on the perception/categorization of sounds (e.g., [1, 2]) or markedness (e.g., [3, 4]). These theories cannot adequately predict or explain difficulty arising from complex articulatory movements. In order to incorporate articulatory difficulty (AD) into a theory of L2 acquisition, it is necessary to understand what is articulatorily complex for L2 speakers, and to what extent AD plays a role in L2 production. The present study aimed to determine the extent to which AD was a factor in the L2 Spanish of L1 English speakers, and how the role of AD varied with increased proficiency. Previous work has found that AD is a factor in the acquisition of certain sounds [5, 6, 7, 8], thus AD was expected to be a significant predictor of accuracy. Moreover, while AD was expected to play less of a role in advanced L2 speakers, it was predicted to still be a factor, based on the findings from previous work indicating that advanced speakers continue to have difficulty with articulatorily complex segments [7, 8].

In order to determine whether AD was a factor in L2 productions, it was necessary to first quantify the AD of Spanish segments. 20 L1 Spanish and 25 L1 English-L2 Spanish speakers residing in Madrid performed a complex articulation task. They repeated nonce VCV sequences as rapidly as possible for seven seconds. Five Spanish segments absent from English [β̞ ɣ̞ 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 ([9]). Productions were extracted and analyzed in Praat [10]. The type of segment produced for each repetition was determined according to a visual, acoustic, and auditory analysis of the spectrogram and waveforms. Speed (productions per second) and accuracy rates were calculated. To account for speed-accuracy tradeoffs, a relative ease of articulation (REA) score was calculated (speed divided by accuracy; [11]). A linear mixed-effects model was run on both the L1 and L2 data, revealing that the REA scores differed across segments ($p < .001$) and that the L2 group experienced more difficulty overall ($p < .001$). Tukey corrected post-hoc pairwise comparisons revealed the following hierarchies, from least to most difficult: L1 [m β̞] < [t] < [ɣ̞ ɲ r χ]; L2 [m] < [t β̞] < [ɣ̞ ɲ] < [r χ]. We argue that difficulty arises in segments involving the tongue dorsum ([ɣ̞ ɲ r χ]) and / or with complex aerodynamic requirements [r χ].

In order to determine whether AD was a significant factor in L2 speech, the same speakers from the previous experiment completed a picture description task. The task elicited the production of the five Spanish segments [β̞ ɣ̞ ɲ χ r]. The recordings were extracted and analyzed in Praat [10]. Each segment was marked as either target or non-target according to a perceptual, acoustic, and visual analysis of spectrogram and waveforms. A mixed-effects binomial logistic regression was run, with accuracy (target – non-target) as the outcome variable. Two predictors were also entered in the model: the AD ranking of the target segments (value of 1-3, indicating the level of AD: 1- β̞; 2-ɲ, ɣ̞; 3-χ, r), and the oral proficiency of the speakers (determined according to foreign accentedness ratings, on a scale of 1-5; as in [6, 7]). Results revealed that AD was a significant predictor of accuracy ($p < .001$). Moreover, there was an interaction between AD and oral proficiency ($p = .012$). Contrary to the prediction, only the least proficient speakers differed from controls, and only for the most articulatorily difficult segments. No other differences were found across groups. The significance of the results are discussed in regards to a model of L2 speech, highlighting what we still need to learn to be able to elaborate a comprehensive L2 speech model capable of predicting perception and production difficulty.

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