

**Revisiting Incomplete Neutralization:
The Case of Coda Liquid Production in Puerto Rican Spanish**

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Recent advances in phonetic analysis have led researchers to re-examine sounds that were previously assumed to be contextually neutralized, or merged into a single pronunciation. By using fine-grained spectrographic analysis, linguists have discovered that in many cases where neutralization was assumed, sounds are actually incompletely neutralized. That is, there are small differences in the articulation of these sounds such that they are in fact not merged, even though impressionistic descriptions report them as such. These new findings on incomplete neutralization are the starting point of this investigation on coda /r/ in Puerto Rican Spanish (PRS), which the literature often refers to as 'lateralized' and supposedly neutralized with /l/, as shown in example (1) (Navarro Tomás 1948, López-Morales 1983, Ramos-Pellicia 2007, *inter alia*):

- (1) *mal* ('bad') [mal]
mar ('sea') [mal]

From Navarro Tomás's (1948) work up until recently, studies of this phenomenon described most occurrences of /r/ as neutralized to /l/, like in (1), but also noted a few productions of an 'intermediate' sound between /r/ and /l/. I take reports on this intermediate sound as an indication that /r/ and /l/ are in fact not always completely neutralized and I explore this hypothesis in the present study. Two recent studies, Simonet et al. (2008) and Luna (2010), present some preliminary acoustic data that seem to suggest that neutralization of coda liquids in PRS is in fact incomplete in some cases. These two studies inform the current project and methodology. In order to thoroughly understand the degree of neutralization, I utilize speech data from 24 speakers from San Juan to analyze the acoustic parameters of coda liquids in this variety of Spanish. Furthermore, I explore the role that several linguistic factors play in the degree of similarity between /r/ and /l/, including stress, word position (word medial vs. word final) and surrounding sounds. This is the first large-scale acoustic study on this phenomenon and also is the first study to consider the effects of stress, word position and surrounding sounds, which were not considered in previous studies. The research questions for this study are as follows: 1) What is the range of rhotic and lateral productions in PRS? 2) Are /r/ and /l/ in PRS incompletely neutralized in duration and formant structure? 3) How do the linguistic factors of stress, word position and surrounding sounds affect the degree of difference between realizations of /r/ and /l/?

To address my research questions, I extracted instances of orthographic coda /r/ and /l/ from about thirty minutes of each of the twenty-four sociolinguistic interviews that I conducted in San Juan in 2013. Using spectrographic information, I categorized each of the 2,701 instances of orthographic /r/ as approximants, taps, deletions, fricatives, vocalizations or trills. The 729 occurrences of orthographic /l/ were less variant and were categorized as approximants, deletions and fricatives. Then, all instances of approximant /r/ (N=1,984) and /l/ (N=703) were analyzed for duration and formant structure. I segmented the liquid segment together with its preceding vowel due to the difficulty of acoustically disentangling the vowel and liquid and the phonetic dependence of the rhotic and lateral sounds on the previous vowel (cf. Guirao et al 1991). Vowel+liquid sequences preceded by another vowel (like *que al*) were excluded from the analysis. Measurements of the first four formants were taken at seven time points during the vowel+liquid sequence in order to capture the dynamic trajectories of each formant throughout the duration of the sequence. Five mixed effects linear models, with duration, F1, F2, F3 and F4 as the dependent variable of each

model respectively were built in R. Speaker is considered as a random effect, and the fixed effects of word position, stress, previous sound and following sound were included as independent variables.

My results for the categorical analysis of /r/ and /l/ tokens show that approximant /r/ is the most frequent realization of orthographic /r/ (73.5%), followed by taps (10.7%), deletions (7.8%), fricatives (6.8%), vocalizations (0.009%) and trills (0.004%). Orthographic /l/ was far less variable with 96% approximants, 2% deletions and 2% fricatives. The formant analyses indicate that there are significant differences between /r/ and /l/ for F1, F3 and F4. My findings for F1 and F3 are not surprising given cross-linguistic observations of high F1 values and low F3 values for rhotics in contrast with laterals (see Ladefoged & Maddieson 1996). My findings for F4 add to a small but growing understanding of the role of higher formants in consonant production (see Luna 2010). The duration analysis of vowel+approximant /r/ and vowel+approximant /l/ reveals that the segments are not significantly different from each other overall. The previous and following segments, however, have significant impacts on the durational difference between /r/ and /l/. For example, vowel+/l/ sequences followed by vowels are 9.9% longer than vowel+/r/ segments in the same environment. This shows that the degree of differentiation in terms of duration between /r/ and /l/ depends on the surrounding sounds, with adjacent vowels favoring less durational neutralization than other surrounding sounds.

These results substantiate the hypothesis that liquids in PRS are incompletely neutralized in terms of formant values and duration depending on the surrounding linguistic context. Unlike previous studies, this study includes all approximant liquid realizations, rather than discarding /r/ segments that are perceptually mixed or fully neutralized. By considering coda liquids globally, with a large data set from spontaneous speech, this study shows that there are small but statistically significant differences between /r/ and /l/ in this dialect. These differences remain constant across stress contexts and are amplified or downplayed by the phonetic environment. The tap, fricative and trill occurrences of /r/ further contribute to the notion that Puerto Rican speakers have distinct representations for liquid sounds. This study lends support to theories of incomplete neutralization and enhances our understanding of the production of liquid sounds.

References

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