Revisiting Incomplete Neutralization: The Case of Puerto Rican Spanish

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1 Introduction

With the advent of widely-available tools for detailed phonetic analysis, a great deal of research has been conducted on neutralization phenomena. These new studies approach neutralization by questioning whether sounds are truly merged. Studies on German (Kleber et al. 2010, Roettger et al. 2014), Catalan (Dinneson and Charles-Luce 1984), English (Zue and Laferriere 1979, Braver 2013), Dutch (Warner et al. 2004), Japanese (Braver 2013), and Spanish (Bishop 2007, Simonet et al. 2008), among other languages, have found that segments previously assumed to be neutralized are actually produced with small phonetic differences. For example, coda stop devoicing in German was thought to apply categorically such that *rat* 'advice' and *rad* 'bike' were pronounced as exact homonyms, [ʁat]. A number of studies (Kleber et al. 2010, Roettger et al. 2014) have shown evidence for differences in vowel length before /t/ and /d/ and gradient voicing of /d/; thus, these sounds have been described in the literature as incompletely neutralized. Other researchers, however, argue that neutralization is indeed complete in natural speech and that the findings for incomplete neutralization are an artifact of hyper-articulation in laboratory settings (e.g. Fourakis and Iverson 1984, Warner et al. 2006). Despite this claim, these phenomena, to my knowledge, have not been examined in conversational speech. The present study sheds light on this debate through the analysis of coda liquids in San Juan Spanish (henceforth, SJS) in spontaneous speech.

The pronunciation of coda orthographic <r> and <l> in Puerto Rico are frequently described as neutralizing to [l] such that *mar* 'sea' and *mal* 'badly' are both pronounced as [mal]. However, even some researchers using impressionistic methods have noted that some coda <r> segments may sound like an intermediate liquid, rather than a canonical [l] (Navarro Tomás 1948, López Morales 1983). Simonet et al. (2008) considered read speech from three SJS speakers and confirmed the existence of intermediate liquid sounds in this dialect. Their study provides a first acoustic examination of these sounds, but like most studies on incomplete neutralization, the data comes from laboratory tasks and considers only a few linguistic contexts. In order to capture the full range of coda liquid variation in SJS, this study uses naturalistic speech to consider the conditioning of a variety of factors on the production of vowel+liquid coda sequences. These factors include the vowel in the sequence, the sounds preceding and following the sequences, the position of the syllable in the word, stress, and the gender and age of the speaker. The fuller picture that this study provides of this phenomenon allows us to posit hypotheses about what conditions how speakers choose among the wide variety of liquid sounds available in this dialect.

2 Methodology

The data for this study comes from 24 sociolinguistic interviews conducted by the author in San Juan in June–July 2013. The sample is evenly divided for gender with ages ranging from 18 to 70. All of the speakers are from the middle to upper classes, live within a 20-minute driving distance from the city center, and work or study in San Juan. Orthographic coda rhotics in SJS, like in other dialects of Spanish, are produced with variable manners of articulation such that taps, trills, fricatives, deletions, and approximants. Laterals, on the other hand, are almost categorically articulated as approximants. Therefore, the potential for neutralization between coda rhotic and lateral sounds is present when they are produced as approximants. Therefore, this paper considers approximant liquids only, which make up for 75.5% of <r> and 96.6% of <l> in the data set. Starting five minutes into each interview, occurrences of syllable-final liquids and their preceding vowel, i.e., vowel+liquid sequences, were manually segmented in Praat using the onset of F2 energy to determine the beginning of the vowel and spectrographic evidence for the sound following the liquid to establish the offset of the liquid.[1] Vowel+liquid sequences that were preceded by a vowel (like *que*

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[1]For further information on coding, see p. 57 of Beaton 2015.

al 'that to the') or followed by an /l/ (like *adoptar los* 'adopt the') were excluded to avoid arbitrary segmentation. The present paper will explore the first three formants (F1, F2, F3). In order to capture the dynamic trajectories of these sounds, the formant measurements were sampled at seven evenly-spaced points over the duration of the sequences starting at 25% into each vowel+liquid sequence and again at 37.5%, 50%, 62.5%, 75%, 87.5%, and 100% of the total duration. Formant values (F1, F2, F3) for each of the time points, served as the dependent variable for regression models, resulting in a total of 21 models (3 formants*7 time points). The linguistic and social factors mentioned in the introduction served as independent variables for each of the models. Coding for these variables is explained for each in the respective results section. The linear mixed effects models were built in R; speaker is included as a random effect.

3 Results

When all of the linguistic and social contexts are considered together, sequences of vowel+<r> and vowel+<l> are not significantly different in their formant structure at most of the time points. With a closer look, however, it becomes clear that while many contexts are neutralizing, the liquids are distinct in other contexts. The independent variables for the vowel in the sequence, the sounds preceding and following the vowel+liquid sequence, word position, and the age of the speaker had significant effects on the difference between sequences with <r> and <l>. Approximant productions of vowel+<r> and vowel+<l> were not significantly affected by the speaker's gender identification or by whether or not the syllable containing the liquid was stressed. The following subsections relate the findings for the independent variables with significant influence on the variation.

The results for the liquids are presented in relation to each other. That is, formant values for vowel+<r> sequences are compared to those for vowel+<l> sequences. In the tables presenting the formant results for the liquids in particular contexts, the direction of effect of the context is denoted using greater than (>) and less than (<) signs such that "/r/ > /l/", which means that the value of the formant for vowel+<r> is higher than that of vowel+<l> in the same context at a minimum of four of the seven tested time points. Another column describes this relationship between the liquids according to the expected direction of effect given the articulatory properties that the acoustic signal suggests in terms of tongue height (F1), frontness (F2), and bunching (F3). Since vowel+<r> sequences were found to be much more variant than vowel+<l> in the data, this column references the production of <r> and describes it as more "r-like" or "l-like" according to the values of the formants. For F1, lateral segments in Spanish generally have a lower value than rhotics because of the greater degree of closure for /l/ (Martínez Celdrán and Fernández Planas 2007, Quilis 1981). Therefore, an <r> production is l-like if the F1 value is lower than the value for <l> in a given context and is r-like if the value is higher. For the second formant (F2), it is generally expected that <l> will have a more forward pronunciation than will approximant <r> because of the coronal occlusion of the tongue tip for /l/. This means that the l-like <r> has a higher F2 value than <l> in the same environment and r-like <r> has a lower value than <l>. Finally, F3 values for rhotics are expected to be lower than those for laterals, since low F3 values are well documented in the literature as a signature feature of rhoticity across languages (Fujimura and Erickson 1997, Johnson 2003, Ladefoged and Maddieson 1996, among others). The lowered third formant is considered to be an acoustic result of tongue bunching often involved in rhotic sounds. For <r> to be considered r-like, therefore, the F3 value needs to be lower than <l> in the same context. L-like <r> displays a higher F3 value to <l>.

3.1 Vowel

The vowel included in the vowel+liquid sequence was found to have a significant influence on the level of distinction of sequences with <r> vs. those with <l>. The extensive variability of orthographic rhotics is strongly influenced by the vowel in the sequence. This section reviews findings for each of the three formants independently in order to capture the differences between <r> and <l> sounds on each of these dimensions.

The trends for direction of effect and the r-like or l-like nature of vowel+<r> sequences are shown for F1 in Table 1 below. This table shows that F1 values are greater for <r> than <l> for

low and mid vowels (/a/, /e/, and /o/); for these vowels, F1 is lower for sequences with <l> than <r>, suggesting that sequences with <r> present less closure. Orthographic rhotics in the context of these vowels are thus considered r-like, since the direction of effect follows the expected direction described in the introduction to Section 3. In the case of the high vowels and glide+/e/ at early time points, the directionality reverses; F1 for vowel+<r> sequences is higher than that for vowel+<l>. The tendency to realize vowel+/r/ sequences in a more constricted way, which is usually associated with a more l-like production, is probable due to the fact that the tongue is already high when there is a preceding high vowel. In other words, the l-like production is a result of coarticulation with the high vowel.

Vowel Height	Vowel	General effect on F1 of Liquids	Production of vowel+<r>
low	a	/r/ > /l/	r-like
mid	e	/r/ > /l/	r-like
	o	/r/ > /l/	r-like
high	i	small effects /r/ > /l/ until time point 6, then /r/ < /l/	l-like
	u	small effects /r/ < /l/	l-like

Table 1: Direction of effect of F1 according to vowel height.

The effects of vowel for F2 values in vowel+liquid production, summarized in Table 2 below, align with what is expected in terms of the frontness or backness of the vowels and liquids. The vowels produced with the tongue furthest back, /o/ and /u/, correlate with lower F2 values for vowel+<r> than those of vowel+<l>. This direction, however, is reversed in the case of more front vowels. With these vowels, it appears that the tongue position stays more fronted, resulting in more l-like rhotics. The more front the vowel, the greater this effect. The influence of the vowel on F2 is much like that on F1 in that the more similar the vowel is to the tongue position associated with <r>, the more r-like the production of sequences with orthographic <r> is. In summary, vowel has a coarticulatory effect on orthographic <r> segments, such that the height (F1) and frontness (F2) of the vowel in the sequence determines where the rhotic will be produced.

Vowel Frontness	Vowel	Effect on F2	Production of vowel+<r>
front	i	/r/ > /l/	l-like
mid-front	e	/r/ > /l/, but less so than /i/	l-like
central	a	/r/ > /l/, but less so than /e/	l-like
back	o	/r/ < /l/	r-like
	u	/r/ < /l/	r-like

Table 2: Direction of effect of F2 according to vowel frontness.

At most of the time points, F3 values for vowel+<r> are lower than those from vowel+<l>, which is expected, given that low F3 values are an attribute of rhoticity. Table 3 below shows the general trends for F3. Orthographic <r> values are lower than those for <l> for all of the vowels except for /i/. The overall trend is especially prominent with the mid vowels (/e/ and /o/), for which sequences with <r> are dramatically lower than sequences with <l>. The degree of bunching of the tongue is likely related to the position of the tongue for the vowel. Thus, the higher, more fronted position of <ir> than <il>, as shown in the results for F1 and F2, may prevent tongue bunching due to the elongated tongue position for this production that results from the forward and high position. The vowel /o/ has the largest difference in F3 values for vowel+<r> and vowel+<l> sequences, which may be due to the low, backed production of <r> in this context. A lower, more back tongue position is compatible with tongue root retraction and tongue bunching.

Vowel	Effect on F3	Production of vowel+<r>
i	/r/ > /l/	l-like
a	/r/ < /l/, but less difference than /e/ and /o/	r-like
u	/r/ < /l/	r-like
e	/r/ < /l/	r-like
o	/r/ < /l/	r-like

Table 3: Direction of effect of F3 by vowel.

3.2 Preceding Sound

Consonant sounds preceding the vowel+liquid sequences were coded according to manner of articulation: nasals ([m], [n], [ɲ]), stops ([p], [t], [k], [b], [d], [g]), fricatives ([f], [s], [x], [h], [ʃ]), laterals ([l]), rhotics ([ɾ], [r]), and approximants ([β], [ð], [ɣ], [j]). Vowel+liquid sequences that occurred utterance-initially with no preceding sound were coded as preceded by a pause. Complex onsets were collapsed with the second member of the onset; for example, [bɾ] was coded as a rhotic.

Table 4 below presents the direction of effect for each of the preceding manners of articulation for the three formants. As can be observed in the F1 column, vowel+<r> sequences behave in the expected way except for in the context of preceding approximants, where these sequences have a more l-like height. In terms of F2 values, vowel+<r> sequences have back production (r-like) when preceded by nasals, stops, and fricatives but have more fronted articulation (l-like) after pauses, laterals, rhotics, and approximants. Sequences spelled with <r> tend have lower F3 values than those spelled with <l> with all preceding sounds, with the exception of approximants. The implications of these findings along with those for following sound will be discussed in Section 4.

Preceding Sound	F1		F2		F3	
nasal	/r/ > /l/	r-like	/r/ < /l/	r-like	/r/< /l/	r-like
stop	/r/ > /l/	r-like	/r/ < /l/	r-like	/r/< /l/	r-like
fricative	/r/ > /l/	r-like	/r/ < /l/	r-like	/r/< /l/	r-like
(pause)	/r/ > /l	r-like	/r/ > /l/	l-like	/r/< /l/	r-like
lateral	/r/ > /l/	r-like	/r/ > /l/	l-like	/r/< /l/	r-like
rhotic	/r/ > /l/	r-like	/r/ > /l/	l-like	/r/< /l/	r-like
approximant	/r/ < /l/	l-like	/r/ > /l/	l-like	/r/ > /l/	l-like

Table 4: Effects of preceding sound on formant structure.

3.3 Following Sound

The sound following the vowel+liquid sequence, like preceding sound, was coded according to manner of articulation. The categories of following sounds are: nasals, stops, fricatives, approximants, vowels ([a], [e], [i], [o], [u], as well as glide+vowel), and pauses. Significant effects for following sound on the difference between vowel+<r> and vowel+<l> sequences were only present for F1. The more open production for vowel+<r> sequences expected for an approximant rhotic production occurs before stops, fricatives, nasals, and pauses whereas vowel+<r> sequences present more closed, "l-like" pronunciations before approximants and vowels. Table 5 summarizes these trends.

Following Sound	F1	
stop	/r/ > /l/	r-like
fricative	/r/ > /l/	r-like
nasal	/r/ > /l/	r-like

(pause)	/r/ > /l/	r-like
approximant	/r/ < /l/	l-like
vowel	/r/ < /l/	l-like

Table 5: Effects of following sound on formant structure.

3.4 Word Position

Syllable-final liquids in Spanish occur both word-medially (*mar̲tes* 'Tuesday') and word-finally (*amor̲* 'love'). The results for word position indicate that liquids tend to be distinct word-medially in terms of F1 and F2, but values for these formants are not significantly different between vowel+<r> and vowel+<l> word-finally. For both F1 and F2, vowel+<r> values are higher than those for vowel+<l>, suggesting a more closed and fronted production of rhotics than laterals. Values for the third formant (F3) showed the reverse of the first two formants; the liquids are distinct word-finally and neutralized word-medially. F3 values for vowel+<r> are lower than those of vowel+<l> in both word-medial and word-final contexts, but this difference is only significant word-finally. In summary, <r> and <l> are distinct in terms of F1 and F2 word-medially and distinct in terms of F3 word-finally. Further research is necessary to determine why these effects occur; word position will not be discussed in Section 4.

3.5 Age

According to López Morales' 1983 impressionistic study of liquids in SJS, younger speakers neutralize <r> and <l> less than older speakers. The findings for the present study support and add nuance to this observation through the comparison of speakers ages 18–28 to an older group of speakers ages 42–62. Younger speakers distinguish <r> and <l> through their manipulation of F3 with significantly lower values for vowel+<r> than for vowel+<l> whereas older speakers do not display a difference. Neither age group displays significant differences in F1 and F2 values.

4 Discussion

The findings presented here have implications both for the study of SJS and, more broadly, for theories of incomplete neutralization. The dialect-specific trends are discussed first and are divided by linguistic context (Section 4.1) and social context (Section 4.2). Then, the contributions of this study to our understanding of neutralization phenomena are discussed in Section 4.3.

4.1 Linguistic Context

One of the most important take-aways from the study of coda liquids in natural SJS speech is that <r> and <l> range from being produced indistinguishably, and hence neutralized, to having very different articulations. Historically, the pronunciation of these sounds in SJS and other dialects where <r> and <l> sounds neutralize has been described in the literature as *trueque de líquidas* ('liquid switching'), which implies that speakers choose between two discrete categories. The results from this study give ample evidence of a continuum of sounds for orthographic <r> that range from very l-like (high, front, unbunched), to a sound similar to English [ɹ] (low, back, bunched). On the other hand, <l> has a more limited range of articulations in this dialect. The production of <r> varies gradiently, rather than categorically, along a liquid continuum. The location of <r> on this continuum and therefore the degree to which it resembles [l] depends heavily upon the linguistic and social context of the sound.

The vowel in the vowel+liquid sequence has a large degree of influence on how similar or different <r> is to <l>. Rhotics in this dialect reflect the tongue configuration for the vowel, whereas laterals are more stable. Thus, <r> will be most l-like in the context of a front, high vowel like [i]. Liquid sounds are unique in that they possess both consonant-like and vowel-like qualities; more precisely they have some degree of constriction but have clear, continuous formant structure.

Some researchers posit that liquids are formed by a vowel-like articulation produced with the tongue dorsum along with a consonant-like gesture of the tongue tip (Proctor 2009, Sproat and Fujimura 1993). In a study that utilizes MRI imaging to examine liquid-inserting dialects of English, Gick et al. (2002) find that the tongue dorsum shapes for the vowels after which /r/ and /l/ are inserted (/ɔ/ and /ʌ/ respectively) are virtually identical to those of the liquids that get inserted. In light of this, the finding in this study that vowels exert a strong degree of influence on liquid production is not surprising. What is particularly interesting is the greater co-articulatory flexibility of rhotics compared to laterals. Rhotics in Spanish, as is the trend cross-linguistically, tend to be more variant than laterals. The notion that some sounds are more influenced by coarticulation effects and present greater flexibility is captured by Recasens et al. (1997, and in subsequent work by Recasens) in their Degree of Articulatory Constraint (DAC) framework. Since rhotics in SJS tend to be coarticulated with the preceding vowel, they could be said to have a lower DAC than laterals, which are more resilient to coarticulatory effects. This directionality could very well be different in other dialects of Spanish, such as the variety spoken in southern Spain, where <r> and <l> both have a rhotic percept. Acoustic analysis of coda liquids in the Andalusian region of Spain would be helpful to determine whether or not similar coarticulatory mechanisms are at play.

Unlike the effect for vowels, the surrounding consonant sounds, both preceding and following the vowel+liquid sequences, generally have dissimilatory effects on liquids. Preceding sounds have effects on all three formants. Orthographic <r> preceded by sounds with the most occlusion (stops, fricatives, and nasals) have more open, back, bunched productions than vowel+<l> sequences. In other words, the most r-like sounds in this dialect occur in the context of constrictive preceding consonants with full or critical closure. Preceding pauses, laterals, and rhotics have the same direction of effect for openness and bunching, but vowel+<r> in these contexts is more fronted, i.e., has a higher F2, than vowel+<l>. The environment of preceding approximant is particularly interesting in that vowel+<r> sequences are l-like in all three dimensions; vowel+<r> is more closed, fronted, and unbunched than vowel+<l> in this position. The effects for sounds following the vowel+liquid sequences only display significant differences between rhotics and laterals in terms of F1. Following stops, fricatives, and nasals show a similar pattern to that found for these same sounds preceding the vowel+liquid sequences in that vowel+<r> sequences are more open than vowel+<l>. In the context of following approximants and vowels, which have more open productions or realizations, coda sequences with <r> have a higher (more closed) tongue configuration than sequences with /l/. The pattern for following sounds in relation to coda <r> sequences, then, is dissimilatory. The only following context that does not follow this pattern is that for pauses, for which <r> has a lower articulation for vowel+/r/ than vowel+<l>. Without a following context, as is the case for pauses, the tongue position for sequences with coda <r> is low, much like we saw in the case of the liquid behavior in accordance with low vowels.

The pattern of coda liquid assimilation to preceding vowels and dissimilation from surrounding consonants in SJS can be better understood by taking sonority specifications into account. A number of theorists claim that syllable structure is governed by sonority requirements (Blevins 1995, Clements 1990, Harris 1983, Hooper 1976, Selkirk 1984). In a syllable, the sonority rises up from the onset to the nucleus and then falls to the coda. Onsets prefer to rise maximally in sonority whereas codas prefer to fall minimally in sonority. This idea is captured by the Sonority Sequencing Principle (SSP), which posits that some sounds in a given inventory of a language are more sonorous than others and that syllables are organized with the most sonorous sounds in the middle, which are usually vowels, with less sonorous sounds towards the periphery. Specifically, post-vocalic environments tend to be more sonorous than pre-vocalic contexts and the tendency to maximize sonority, i.e., have a segment in coda that is as sonorous as possible without being more sonorous than the nucleus, is common across languages (Clements 1990, Prince and Smolensky 1993). One of the main phonetic correlates to sonority, as will be discussed below, is openness of the vocal tract, which is acoustically manifested in F1 values. The coarticulation of coda liquids with vowels in SJS allows for more open, sonorous productions of <r> than in many other dialects of Spanish.

Although sonority was first conceived of by phonologists (Pike 1943, Chomsky and Halle 1968) who did not always use phonetic evidence to support their claims, phonetic correlates have been proposed for sonority both in terms of articulation (Keating 1983, Lindblom 1983) and acoustics (Mattingly 1981, Price 1980). In an investigation of sonority with emphasis on Spanish

and English, Parker (2002) considers F1, intensity, intraoral air pressure, total air flow, and duration as measurements of sonority for various vowels and consonants, including liquids. Although Parker does not look at SJS specifically, the cross-linguistic hierarchy that the author derives from the Colombian Spanish and American English data in his study along with an extensive literature review of other languages yields useful insights for the present study. Figure 1 shows Parker's sonority hierarchy; from top to bottom, it lists the most sonorous to the least sonorous sounds. The most sonorous sounds are vowels, with low vowels being the most sonorous and high vowels being the least sonorous; this ranking corresponds with F1 values, in that higher F1 values represent a lower and therefore more sonorous articulation. Glides are less sonorous than vowels, but more sonorous than other consonants. After the glides, Parker lists four kinds of liquids. The most sonorous liquid, according to his study, is the English approximant retroflex [ɹ], which is represented as "/r/". Laterals are the second most sonorous liquid, followed by taps (labeled "flaps") and finally trills.

low vowels	16
mid vowels (except /ə/)	15
high vowels (except /i/)	14
/ə/	13
/i/	12
glides	11
/r/	10
laterals	9
flaps	8
trills	7
nasals	6
/h/	5
voiced fricatives	4
voiceless stops and affricates / voiceless fricatives	3
voiceless fricatives / voiced stops and affricates	2
voiceless stops and affricates	1

Figure 1: Parker's (2002:240) universal sonority hierarchy.

The occurrence of more open <r> sounds in the environment of more open vowels in SJS can thus be described not only in terms of coarticulation, but also in terms of sonority sequencing. The data for the present study shows that rhotics accompanied by low vowels, which are the most sonorous vowels, tend to have low, back, bunched productions that resemble the retroflex American [ɹ], which Parker finds to be more sonorous than laterals or the Spanish tap <r>. Less sonorous vowels, such as the high vowel /i/, tend to condition more l-like rhotic productions in SJS.

Coda liquids in SJS are sensitive not only to the preceding vowel, but also to the surrounding consonant sounds. Unlike with vowels, the degree of sonority of the surrounding consonants inversely affects liquid production such that less sonorous surrounding sounds elicit more sonorous liquids and vice versa. Since these surrounding consonants are onsets to the syllable containing the liquid in the case of previous sounds and onsets of the syllable following the liquid in the case of following sounds, the result is that coda liquids contrast in sonority with the onsets. This pattern fits sonority sequencing theories in that liquid codas are maximally distinguishable from the surrounding onsets.

To summarize, coarticulatory effects and sonority could be described as working together as central driving forces behind the variability of coda liquids in SJS. Taken separately, coarticulation and sonority each account for part of the picture. A physiological, articulatory view has more explanatory power in terms of the coarticulation observed across formants. The sonority patterning of liquids with vowels in SJS can be seen as emergent from the coarticulation of liquids with vowel openness. While the articulatory hypothesis covers vowel and liquid assimilation across formants, viewing liquid tendencies from a sonority perspective only accounts for F1. However, the dissimilation of liquids from surrounding consonants follows from a sonority perspective in which sonority of coda liquids is maximally different from the surrounding sounds.

4.2 Social Context

The results from this study do not indicate gender as a significant factor contributing to the variation of liquids in this dialect. This lack of an effect for gender in the production of approximant liquids is surprising, given the descriptions in former studies of lateralization as a stigmatized pronunciation (López Morales 1983, Ramos-Pellicia 2007). Sociolinguistic theory holds that in the instance of a nonstandard speech feature that is not undergoing change, men have a higher frequency of these forms, whereas changes in progress tend to be led by women (Labov 1990). The absence of a gender effect could be interpreted as evidence that liquid neutralization is neither a stable stigmatized variant nor a change in progress in San Juan. The findings for age, however, may challenge this notion.

Age has been discussed from two angles in the sociolinguistic literature: 1) differences in linguistic structures with age groups can show historical change of language, 2) changes with age can be due to the linguistic choices of groups as they move through life (Eckert 1997). Younger people in San Juan, then, in the case of (1), may represent a move in the dialect away from neutralization of /r/ and /l/ and towards the more differentiated pronunciations seen in other parts of the Spanish-speaking world. However, it is also possible that lateralization is not undergoing any sort of historical change and that the effect for age is a result of (2), which is commonly referred to in the literature as age grading (Eckert 1997). Further research would be necessary to determine whether the difference in age groups constitutes a historical change away from coda liquid neutralization or a temporary strategy during the years that are most crucial for these speakers to establish a secure career, or some combination of the two. Either strategy makes sense in light of the negative social commentary that speakers express on this feature of their accent. When asked how Puerto Rican Spanish differs from other dialects at the end of the interview process, informants often pointed out that speakers 'say *l* instead of *r*' and most described this phenomenon as 'uneducated' or a 'bad habit.' Some informants claimed that this was something that only lower class people did and were unaware of their own (in)complete neutralization patterns, which, to my impressionistic observation, did not differ from speakers who were aware of this feature in their own speech. An impressionistic study by Medina-Rivera (1999) showed that Puerto Ricans neutralize <r> to [l] more frequently in conversational speech and distinguish the sounds in more formal settings. Thus, the level of control that speakers have over their coda liquid production remains to be acoustically examined. Further study of how well speakers are able to manipulate this variable and more work on language attitudes would be useful to better understand younger speakers' differentiation <r> and <l> F3 values.

4.3 Contributions for Neutralization Theories

As mentioned in the introduction, results from studies on neutralization phenomena conflict with each other. Some researchers have found significant differences between two sounds previously assumed to be merged and have drawn the conclusion that neutralization in these cases is incomplete. Other studies do not find differences and argue that incomplete neutralization is an artifact of hyperarticulation provoked by the formal nature of laboratory experiments. This second group of researchers casts doubt on whether incomplete neutralization actually exists in everyday speech. The present study provides a substantial contribution to this debate by showing that incomplete neutralization does indeed happen outside of laboratory settings. Furthermore, this study demonstrates that the degree of neutralization and distinction depends upon a number of factors. In his work on two incomplete neutralization phenomena, Braver (2013) shows that monomoraic vowel lengthening in Japanese displays a greater degree of difference than American English /t/ and /d/ flapping and proposes a weighted-constraint framework to account for the degrees of difference. The present study shows that even within a single dialect, the degree of neutralization is context-dependent. Methodologically, this work points out the importance of considering naturalistic speech for the study of neutralization phenomena both to counter possible hyperarticulation and to elicit a broad range of contexts. A similar model to Braver's could be constructed to account for the degrees of neutralization of liquid sounds within SJS according to linguistic and social environments. Furthermore, another contentious issue within the (in)complete neutralization debate is whether or not orthography is responsible for all cases of incomplete neutralization. Researchers

have endeavored to test whether or not incomplete neutralization exists independently of orthographic influence by constructing a number of experiments that eliminate or minimize the presence of spelling differences, but the results of these studies are not uniform (Dinnsen and Charles-Luce 1984, Fourakis and Iverson 1984, Roettger et al. 2014, Warner et al. 2006, among others). That is, some authors find complete neutralization while others find incomplete neutralization. Although the Spanish language presents orthographic distinctions between coda liquids, the influence of spelling in the present study is minimized since the data is not from read tasks in which the speakers would be presumably more attentive to orthography than they are in the more unmonitored sociolinguistic interview.

5 Conclusions

This study provides an account of coda liquid variability in San Juan Spanish that shows that the degree to which orthographic <r> resembles <l> depends on the vowel preceding the liquid, the sounds preceding and following the vowel+liquid sequence, the position of the sequence in a word, and the age of the speaker. Rhotics in SJS are far more variant than laterals and tend to react to the surrounding linguistic context such that they assimilate to the nuclear vowel and dissimilate from preceding and following consonants. This organization of liquid sounds can be explained by coarticulatory constraints and sonority requirements. In addition to providing a more complete picture of SJS, this paper contributes more broadly to phonetic and phonological theories by providing evidence for incomplete neutralization in the context of naturalistic speech. It would be beneficial to apply the methodology from this study to incomplete neutralization phenomena in other languages that have yet to be explored in informal speech in a variety of linguistic and social contexts.

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