Dialectologia 6 *(2011), 1-24.*
ISSN: 2013-2247

Received 29 March 2010.
Accepted 30 June 2010.

AN ACOUSTIC ANALYSIS OF LIQUID GEMINATION IN THE SPANISH OF HAVANA, CUBA

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Abstract

Among the most salient and extensively researched phonological processes of Caribbean Spanish after the categorical weakening of /-s/ is the prolific behavior of the implosive or post-nuclear liquids /ɾ/ and /l/. It has been repeatedly claimed yet remarkably unsubstantiated that the gemination of word-medial, post-nuclear liquids to a following consonantal segment is a pervasive characteristic of Cuban Spanish, particularly of the western dialect region. To this end, the fundamental objective of the present study was to acoustically investigate said-phenomenon as it is purported to occur in the province of Havana, whose capital city models the linguistic norm for the rest of the country. Speech samples were elicited from twenty-four native speakers and spectrographic analysis was performed on these collected tokens in order to precisely identify the characteristics of both liquids in the above-mentioned segmental environment. Although we did not find any evidence of liquid gemination in the 120 words under analysis, we did observe two systematic and conditioned processes that may potentially help account for the impressionistic identification of gemination in word-internal position: 1) the insertion of an excrescent vowel between all [ɾ.C] sequences; and 2) an increase in the duration of the closure of the stop positionally subsequent to /-L/ → [Ø] by an average 30.9%. In light of the evident lack of empirical studies dedicated to the allophony of final liquids, we believe the implications of the findings in this investigation to be important for Caribbean Spanish in general and Cuban Spanish in particular and hope that this study may provide a foundation for future work on the phenomenon of liquid gemination.

Keywords
post-nuclear liquids, liquid gemination, excrescent vowel, Cuban Spanish, Caribbean Spanish

Resumen

El prolífico comportamiento de las líquidas implosivas o postnucleares /ɾ/ y /l/ es uno de los procesos fonológicos más relevantes y más ampliamente investigados en el español del Caribe después del debilitamiento categórico de la /-s /. Se ha afirmado repetidamente, aunque sin fundamento, que la geminación de las líquidas postnucleares seguidas de un segmento consonántico en posición medial de palabra es una característica dominante del español de Cuba, en particular del área dialectal occidental. El objetivo principal de este estudio es investigar acústicamente el mencionado fenómeno que pretendidamente se produce en la provincia de La Habana, cuya capital ofrece el modelo de la norma lingüística para el resto del país. Se han elicitado diversas muestras de voz de veinticuatro hablantes nativos y se ha efectuado un análisis espectrográfico con estas muestras para identificar con precisión las características de ambas líquidas en los contextos antes mencionados. Aunque no se ha encontrado ninguna prueba de geminación de líquidas en las 120 palabras analizadas, observamos dos procesos sistemáticos y condicionados que potencialmente pueden ayudar a explicar la identificación

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impresionista de la geminación en posición interior de palabra: 1) la inserción de una vocal agregada entre todas secuencias [ɾ.C], y 2) un aumento en la duración del cierre de las oclusivas en posición posterior a /-L / → [Ø] en un promedio del 30,9%. Ante la evidente falta de estudios empíricos dedicados a la alofonía de las líquidas finales, creemos que las implicaciones de los hallazgos en esta investigación son importantes para el español del Caribe en general y el español cubano en particular, y esperamos que este pueda proporcionar una base para futuros trabajos sobre el fenómeno de la geminación de las líquidas.

Palabras clave
Líquidas post-nucleares, geminación de liquidas, vocales agregadas, español cubano, español del Caribe

1. Introduction

One of the most salient, prolific, and extensively researched phonological processes of Caribbean Spanish (after the categorical weakening of /-s/) is the behavior of the post-nuclear liquids /ɾ/ and /l/ in both syllable and word-final positions.[1] Speakers of these so-called linguistically innovative dialects share a wide variety of allophonic variants resulting from various phonological tendencies: lambdacism, rhotacism, hybridism, devoicing, liquid gliding, deletion, and gemination (to mention the most widely attested). "Without a doubt more allophones have been attributed to the family of liquids than to any other group of sounds in the literature on Spanish dialects" (Hammond 2001:268), highlighting not only the relative instability of the syllable coda but also that of this specific group of resonants compared to the rest of a limited number of consonants permissible in post-nuclear environments.

To this end, the primary objective of the present study is to acoustically investigate one of the most prominent of these tendencies as it is purported to occur in the province of Havana, whose capital city models the linguistic norm for the rest of the country. Specifically, we will examine the alleged phenomenon of the gemination of word-medial, syllable-final liquids; in other words, their partial or total assimilation to a following consonantal segment.[2] Gemination is said to be nearly categorical in the speech of all social status groups and most frequently although not exclusively affects

[1] See parenthetical citations in Section 2 entitled Previous Research.
[2] The term *gemination* derives from the Latin past participle *geminātus* from *gemināre* 'to duplicate' or 'to repeat'. For purposes of our analysis, gemination will refer exclusively to a sequence of adjacent identical consonantal segments. Given the rules of syllabification in Spanish, a geminated sequence cannot be considered merely a lengthened segment because it must occupy two distinct syllables whereby the first geminated element forms the coda of the previous syllable and the second element the onset of the following syllable.

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syllable-final /ɾ/, /l/, and /s/ (Almendros (1958); Goodgall de Pruna (1970); Isbăşescu (1965, 1968); Tristá & Valdes (1978)). Be that as it may, our current analysis will exclude all other consonants influenced by said phonological process barring the two above-mentioned liquid phonemes. Moreover, any detailed analysis of liquid gemination should not disregard any other allophonic possibilities in the same environment. As a result, the potential gamut of liquid allophony will be considered against two (socio)linguistic variables: gender and segmental environment.

Considering the articulatory difficulties posed in casual discourse by the presence of two identical adjacent segments in a language that lacks geminates at the phonemic and/or phonetic levels coupled with the apparent and overwhelming dearth of empirical data in support of word-medial, syllable-final liquid gemination in all previous dialectal investigations of Cuban Spanish, the following research questions provided the organizational framework for our acoustic study: 1) if regressive liquid assimilation does occur, what is the precise nature of the phenomenon; that is, which liquid is more likely to be affected, what are their specific phonetic manifestations, to what extent does the subsequent segment bear influence, and are there notable distributional patterns according to the subjects' genders?; 2) if regressive liquid assimilation does not occur, why has it been so widely attested in the literature? What acoustic information might help account for the frequently unsubstantiated identification of the phenomenon?

The organization of the remainder of the paper is as follows. Section 2 provides a comprehensive overview of the literature as a detailed analysis would have to be the focus of an entire monograph in and of itself. Section 3 details the methods used to collect and analyze the data. Section 4 presents and discusses the results from the acoustic examination of the data, and Section 5 recounts the principal findings of the analysis and offers conclusions as well as recommendations for future research on gemination in Caribbean Spanish.

2. Previous research

The evident lack of empirical studies not only dedicated to the allophony of final liquids but also to Cuban Spanish in general is surprising. Almendros (1958) who is

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credited as the first linguist to have taken a non-lexical approach to the analysis of Cuban Spanish noted a complete absence of previous studies (171-2). Similarly, Isbăşescu (1965: 571) observed an almost total lack of linguistic studies with respect to Cuban Spanish. Historically, the vast majority of linguistic studies centered on the Spanish of Cuba beginning towards the end of the 18th century until the first half of the 20th century has been characterized by its inharmonious development and impressionistic nature.

Following is an account of only those studies of Cuban Spanish substantiated by their own empirical research. It should be noted that although most affirm the presence of gemination, Costa Sánchez (1984), Fails (1984), Ruiz Hernández & Miyares Bermúdez (1984), and Santana Cepero (2006) are the only investigations to have published spectrographic evidence. Furthermore, approximately half of these analyses are of a more general character; that is, focused on subjects from a variety of provinces rather than one specific dialect area: Alfárez (2000, 2007, 2008), Almendros (1958), Bertot (1969), Casanellas & Alamo (1985), Castellanos (1978), Choy López (1984, 1985, 1988, 1989), Costa Sánchez (1984, 1987), Darias Concepción (2001, n.d.), Dohotaru (1998/1999, 2002, 2007), Fails (1984), Figueroa & Dohotaru (1994), Figueroa et al. (1990), Goodgall de Pruna (1970), Guitart (1976, 1980), Haden & Matluck (1973, 1974, 1977), Hammond (1976, 1980, 1988), Hulme (1973), Isbăşescu (1965, 1968), Lamb (1968), Levina (1970), López Morales (1965, 1971), Montero Bernal (1998, 2002, 2007a,b), Repilado Moreno & Reyes Guerrero (1999 a, b), Ringer Uber (1986), Ruiz Hernández (1974, 1977, 1978), Ruiz Hernández & Miyares Bermúdez (1984), Santana Cepero (2006), Sosa (1974), Terrell (1976, 1982), Trista & Valdés (1978), Valdés Acosta (1980), Vallejo-Claros (1970), and Vera Riverón (2000).

The existing literature pertaining to the neutralization of final /ɾ/ and /l/ for the whole of the Antillean region presents a spectrum of distinct phonetic manifestations. Nevertheless, the following should not be interpreted as exhaustive given that most of the forms can be devoiced and/or weakened to varying degrees. The principal variants of /ɾ/, as attested in the literature, are multiple vibrantization [r], retention [ɾ], assibilation [r̆], lambdacism [l], hybridism [ɾˡ], aspiration [h], liquid gliding [j], regressive assimilation, nasalization [ɾⁿ] or [n], and deletion [Ø] while those of /l/ are

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multiple vibrantization [r], retention [l], rhotacism [ɾ], hybridism [lʳ], liquid gliding [j], regressive assimilation, and deletion [Ø].

A preliminary glance at the above allophony gives the erroneous impression that the lateral phoneme is the more stable of the two for its comparatively reduced number of phonetic realizations. However, if one were to take into consideration the marked infrequency of /l/ in final environments, primarily though not exclusively due to its lack of grammatical productivity, one would conclude that /ɾ/ and /l/ are equally unstable segments. Bearing this in mind, Table 1 illustrates that of the 120 speech samples exhibiting word-internal, syllable-final /ɾ/ or /l/, the underlying lateral liquid represents a little less than one-fifth (20.8%) of the total number of occurrences for the tokens under study:

	# of Tokens	% of Occurrences
/ɾ/	95	79.2
/l/	25	20.8
Total # of Occurrences	120	100.0

Table 1. Total number of tokens: syllable-final /ɾ/ versus /l/

Therefore, given the markedly reduced total number of occurrences of post-nuclear /l/ in our data set one would anticipate that the diversity of the allophonic inventory of said-phoneme will also be comparatively reduced as well. However, before exploring and discussing the results of our findings, we must briefly digress to detail the methodology followed in this investigation.

3. Methodology

Speech samples were elicited by means of the Internet from twenty-four subjects (eleven male and thirteen female) who participated via telephone in a call-in radio program sponsored by Radio Rebelde (96.70 FM), broadcast from the city of Havana, Cuba. The software program used to record these tokens, Any Recorder v. 3.10, was manually configured by the researchers to capture the signal as it was transmitted

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through their computer's sound card and store it in WAV format. The sampling rate was set to 44,100 kHz and encoded in 16 bit. All participants are native speakers of Cuban Spanish and hail from the province of Havana. Neither consent of the Committee on the Use of Human Research Subjects at Purdue University nor that of the subjects themselves were necessary given the apparent anonymity of the subjects. Unfortunately, the nature of the data collection process is not without its methodological limitations: 1) we could not investigate the potential influence of such sociolinguistic variables as age, socioeconomic or educational levels; 2) we could not control for potential auditory interference from ambient noise.

Spectrographic analysis was performed on the collected speech samples in order to precisely identify the characteristics of both of the post-nuclear liquids under investigation. The normative Spanish tap is acoustically characterized by a brief interruption (approximately 25 *ms* in duration) of energy in all formants which articulatorily corresponds to a short contact between the tip of the tongue and the alveolar ridge. According to Delattre (1965), the three formants of /ɾ/ have medium frequencies. The lateral liquid is acoustically quite similar to nasal segments whereby they exhibit a marked reduction in energy of all formants when compared to surrounding vowels. However, they differ significantly in that the lateral liquid has notably greater intensity of F_2 and F_3. The median frequency measurements for /l/ are F_1 (333 Hz), F_2 (1,544 Hz), and F_3 (2,564 Hz) (Quilis 1993:313). The spectrograms for these 120 tokens were created using Praat 4.4.20 (Boersma & Weenink 2006).

4. Results and Discussion

The liquids /ɾ/ and /l/ in syllable-final position within the word demonstrate the following variants in the regional variety of Cuban Spanish examined in this paper. Presented in order consistent with the frequency of their appearance, the principal allophones of the 95 occurrences of the simple vibrant, which constitute 92.4% of these tokens, are retention [ɾ] (36.8%), deletion [Ø] (28.4%), lateralization [l] (12.6%), lateralization with accompanying devoicing [l̥] (7.3%), and approximation [ɹ] (7.3%). The remainder, too insignificant in number to be able to draw any meaningful conclusions, comprises six additional variants: weakened lateralization [ˡ] (2.1%),

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multiple vibrantization [r] (1.1%), weakening [ˠ] (1.1%), devoicing [r̥] (1.1%), aspiration [h] (1.1%), and fricativization [ð̞] (1.1%). For the 25 occurrences of the lateral liquid, the principal variants constituting 88.0% of these specific tokens are retention [l] (60.0%) and deletion [Ø] (28.0%). The remaining 12.0% comprise three additional phonetic realizations: devoicing [l̥] (4.0%), rhotacism [ɾ] (4.0%), and approximation [ɹ] (4.0%). For both liquids, absolute retention appears to be the preferred pronunciation followed by deletion. Despite being a relatively unstable class of sounds in Spanish, the data under analysis in the present study show that of the two phonemes the lateral liquid is undeniably the more stable for having manifested notably less allophonic variance than the simple vibrant. Nonetheless, in keeping with the fundamental objective of our acoustic investigation, we must stress that not one of the 120 analyzed tokens exhibited any form of gemination (total or partial regressive assimilation).

Tables 2 and 3 present the different phonetic manifestations of /ɾ/ and /l/ and their respective rates of occurrence (number and percentage) as articulated by the twenty-four subjects classified by gender (eleven male and thirteen female):

Female			Male		
Allophone	#	%	Allophone	#	%
[ɾ]	13	26.0	[ɾ]	22	48.9
[Ø]	15	30.0	[Ø]	12	26.7
[l]	10	20.0	[l]	2	4.5
[l̥]	3	6.0	[l̥]	4	8.9
[ɹ]	6	12.0	[ɹ]	1	2.2
[h]	-	-	[h]	1	2.2
[ˠ]	1	2.0	[ˠ]	-	-
[r]	-	-	[r]	1	2.2
[ˡ]	2	4.0	[ˡ]	-	-
[r̥]	-	-	[r̥]	1	2.2
[ð̞]	-	-	[ð̞]	1	2.2
Total	50	100.0	Total	45	100.0

Table 2. Allophones of /ɾ/ according to gender

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Female			Male		
Allophone	#	%	Allophone	#	%
[l]	9	64.3	[l]	6	54.6
[Ø]	3	21.5	[Ø]	4	36.4
[ɾ]	1	7.1	[ɾ]	-	-
[ɹ]	-	-	[ɹ]	1	9.0
[l̥]	1	7.1	[l̥]	-	-
Total	14	100.0	Total	11	100.0

Table 3. Allophones of /l/ according to gender

When the rates of retention for /ɾ/ and /l/ are compared for both gender groups, a few noteworthy differences surface, particularly with respect to the simple vibrant. Even though the female subjects preferred retention over the ten other possible allophonic variants of /ɾ/, they did so at a significantly lower rate than did the male subjects (compare 26.0% to 48.9% respectively). This asymmetry was evidently compensated for by means of a higher use of the lateral liquid (20.0% for females and 4.5% for males) as well as the rhotic approximant (12.0% for females and 2.2% for males). In general, the gender of the speaker was not a significant variable in the determination of which surface variant was more frequently used as both groups favored the phonological forms of the liquids over all others; that is /ɾ/ → [ɾ] and /l/ → [l].

When one considers the frequency with which liquid gemination has been recurrently referenced in the linguistic literature as not only a phonological process that differentiates Cuban Spanish from other Caribbean varieties but also as one of the most salient phonetic features in the identification and classification of Cuban regional dialects,[3] the utter lack of supporting linguistic evidence from the data analyzed for this research project, especially from the province notorious for said phenomenon, begs the following question: What then is acoustically being perceived if not gemination? In hopes of providing some potential explanations for this perceptual quandary, two very

[3] Traditionally a feature associated with the western dialect region (that is, Pinar del Río, Havana, and Matanzas), gemination has more recently been attested at varying albeit decreasing rates the further eastward one travels (Almendros 1958; Choy López 1986).

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specific segmental variables were considered: 1) possible quantitative compensation via lengthening of the vowel preceding a deleted word-medial, post-nuclear liquid; 2) possible quantitative compensation via lengthening of the consonantal segment that follows a deleted word-medial, post-nuclear liquid.

Compensatory lengthening (CL) broadly refers to a phonological process whereby the deletion of one segment is followed by a concomitant increase in the length of another segment, usually though not always contiguous. While the most prevalently attested form of CL involves the loss of a coda consonant accompanied by a lengthening of a neighboring nuclear vowel,[4] it is definitely not uncommon to find cases where the elimination of a vowel or even of a word-initial onset become the phonological impetus for CL (Kavitskaya 2001). All other things being equal, the deleted segment is the *trigger* for the compensatory process and the remaining adjacent segment becomes the *target* of the same process.

In order to examine the possibility of an increase in the duration of the vowel immediately preceding a deleted word-medial, post-nuclear liquid as well as to assess its potentiality for misinterpretation as gemination, spectrographic data from two subjects (one female and one male), both of whom produced the greatest number of tokens overall, were further analyzed to determine and compare the lengths of the vowels preceding the [Ø] allophone of /ɾ/ and /l/ and those of the vowels tautosyllabic with any retained implosive variant exhibited in their speech. Tables 4 and 5 compare the vowel length measurements in *ms* of the above-mentioned sequences for both the female and male subjects respectively:

[4] See Hammond (1978), Figueroa (200), and Carlson (2008). All three studies found sufficient acoustic and perceptual evidence for the phonemicization of the duration of the vowel preceding /-s/ → [Ø] in word-medial position with average increases of 36.3% (Miami-Cuban Spanish), 46.7% (Puerto Rican Spanish), and 24.4% (Andalusian Spanish) respectively.

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Token	Length: V + [Ø]	Length of word	Ratio: V + [Ø]/word	Token	Length: V + [L][5]	Length of word	Ratio: V + [L]/word
nerviosa 'nervous' (adj.f.sg.)	105.0	518.8	20.2%	personas 'people' (n.f.pl.)	83.7	580.6	14.4%
orgullosa 'proud' (adj.f.sg.)	53.8	550.9	9.8%	porque	50.8	199.6	25.5%
orgullosa	80.6	614.1	13.1%	verdad 'truth' (n.f.sg.)	65.1	573.8	11.3%
porque 'because' (conj.)	54.4	170.5	31.9%	verdad	46.9	299.7	15.7%
puerto 'port' (n.m.sg.)	77.1	353.9	21.8%	verdad	44.4	452.9	9.8%
sorpresa 'surprise' (n.f.sg.)	85.3	1011.7	8.4%	verdad	44.8	221.4	20.2%
sorprendieron 'they surprised' (3pl.pret.ind.)	79.4	709.8	11.2%	verdad	39.4	352.1	11.2%
Average:	76.5	357.2	21.4%	Average:	53.6	382.9	14.0%

Table 4.Vowel duration for female subject: vowel + /-L/ → [Ø] versus vowel + [-L]

Token	Length: V + [Ø]	Length of word	Ratio: V + [Ø]/word	Token	Length: V + [L]	Length of word	Ratio: V + [L]/word
pedirle 'to ask him/her something' (inf+pro.io)	64.5	268.0	24.1%	forma 'form' (n.f.sg.)	84.8	553.2	15.3%
preguntarle 'to ask him/her' (inf+pro.io)	78.0	513.9	15.2%	persona 'person' (n.f.sg.)	34.7	359.7	9.6%
realmente 'really' (adv)	47.7	502.2	9.5%	pertenece 'he pertains' (3sg.pres.ind.)	64.8	681.6	9.5%
				poderme 'to be able myself' (inf+pro.refl.)	51.9	311.7	16.7%
				porque 'because' (conj.)	63.3	312.6	20.2%
				realmente	87.8	987.0	8.9%
				Roberto (pn)	42.1	392.2	10.7%
				verbos 'verbs' (n.m.pl.)	85.9	622.9	13.8%
				Norberto (pn)	67.0	615.6	10.9%
					57.6	615.6	9.4%
Average:	54.0	390.6	13.8%	Average:	64.1	524.7	12.2%

[5] Henceforth, /-L/ broadly refers to phonemic forms /ɾ/ and /l/ in coda position and [-L] to any of the possible phonetic forms of either /ɾ/ or /l/ barring deletion.

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Table 5. Vowel duration for male subject: vowel + /-L/ → [Ø] versus vowel + [-L]

The female subject elicited 14 tokens equally distributed between deletion and some type of retention while the male subject provided 15 tokens, four of which demonstrated deletion and the remainder retention of some form. For both subjects, the vowels followed by /L/ → [Ø] were on average slightly longer (compare 21.4% (F) and 13.8% (M)) than the vowels not followed by the zero allophone of either one of the liquid segments (compare 14.0% (F) and 12.2% (M)). The difference between the mean percentages for vowel + /-L/ → [Ø] and vowel + [L] sequences for both subjects combined (7.4% (F) versus 1.6% (M)) as well as the same sequences classified by the gender of the subject (13.7% versus 12.8%) was overall quite insignificant. As a result, one can assume that compensatory vowel lengthening probably did not provide sufficient acoustic data that might be mistakenly perceived as gemination.

Nevertheless, the meticulous examination of vowel duration revealed some thought-provoking acoustic data, specifically with respect to the 37 instances in which implosive /ɾ/ and /l/ → [ɾ]. The entirety of these speech samples exhibited what has cross-linguistically been referenced in the literature by a wide range of descriptive terminology, including but not limited to: svarabhakti vowel (Whitney 1889), vocalic element (Lenz 1892), parasitic vocalic element (Malmberg 1965), epenthetic vowel (Ramírez 2002), epenthetic or excrescent schwa (Davidson 2003), and intrusive vowel (Hall 2003).[6] In short, an excrescent vowel is one that is inserted between two consonants in a contiguous cluster, typically [Cɾ] and [ɾ.C].[7] They represent a unique category of vowel insertion and as such differentiate themselves from epenthetic vowels in two ways: 1) their formant structure is similar if not identical to that of the nuclear vowel; 2) since they never occupy the syllable nucleus, lexical stress placement remains unaffected.

Table 6 summarizes the potential correlation between stress placement and the duration in *ms* of both the nuclear and excrescent vowels in the thirty-seven [ɾ.C] clusters:

[6] See Appendix for a few sample spectrograms.
[7] [C] refers to any permissible consonant in said environment.

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F/M	Token	Length of V	Length of EV	Ratio: EV/V	F/M	Token	Length of V	Length of EV	Ratio: EV/V
Female	incursiones 'incursions' (n.f.pl.)	58.0	52.0	89.7%	Female	reparto 'distribution' (n.m.sg.)	67.9	27.0	39.8%
	partir 'to leave' (inf.)	55.2	23.0	41.7%		bárbaro 'barbarous' (adj.m.sg.)	134.0	46.7	34.9%
						márgenes 'edges' (n.m.pl.)	155.4	50.0	32.2%
						irme 'to leave' (inf+pro.refl.)	145.4	55.2	38.1%
						tártaro 'Tartarian' (adj.m.sg.)	138.9	32.0	23.0%
						turco 'Turkish' (adj.m.sg.)	150.5	57.8	38.4%
						bárbaros 'barbarous' (adj.m.pl.)	106.4	29.0	27.3%
						bárbaro	87.6	31.0	35.4%
						Rebelde 'rebellious' (adj.m.sg.)	85.7	59.3	69.2%
						Burke (pn)	103.4	23.0	22.2%
						Burke	53.4	28.3	53.1%
						Varga (pn)	145.1	57.8	39.8%
Male	Norberto (pn)	67.0	37.0	55.2%	Male	bárbara 'barbarous' (adj.f.sg.)	67.2	54.9	81.7%
	pertenece 'pertains' (3sg.pres.ind.)	64.8	42.0	64.8%		bárbaras (adj.f.pl.)	60.4	52.1	86.3%
	armados 'armed' (pcp.m.pl.)	41.3	23.0	55.7%		Burke (pn)	58.4	28.0	47.9%
	participación 'participation' (n.f.sg.)	63.0	50.0	79.4%		Eduardo (pn)	53.1	59.1	111.3%
	persona 'person' (n.f.sg.)	36.6	32.7	89.3%		forma 'form' (n.f.sg.)	84.8	50.8	59.9%
	personal 'personal' (adj.m/f.sg)	38.0	34.0	89.5%		Norberto (pn)	57.6	31.0	53.8%
	personas 'people' (n.f.pl)	56.7	48.0	84.7%		porque 'because' (conj)	63.3	37.9	59.9%
	personas	37.0	20.0	54.1%		Roberto (pn)	42.1	40.3	95.7%
	recordar 'to remember' (inf)	57.1	35.0	61.3%		verbos 'verbs' (n.m.pl)	85.9	43.0	50.1%
	recordista	89.3	53.0	59.4%		órganos	58.6	39.8	67.9%

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	'recording artist' (n.f.sg)				'organs'			
	Martín (pn)	44.4	34.5	77.7%	*porque* señalarte 'to announce to you' (inf+ pn.io)	157.5 72.6	56.7 34.0	36.0% 46.8%
Average:		54.5	37.2	68.3%	Average:	93.1	42.7	45.9%

Table 6. Stress placement and vowel duration: nuclear and excrescent vowels in [ɾ.C] clusters

A general analysis of these data without accounting for the potential influence of stress assignment in relation to the nuclear vowel as well as gender reveals that the average lengths of both the nuclear and excrescent vowels are correspondingly 79.6 *ms* and 40.8 *ms*. Thus, the latter vowel represents 51.3% of the total average length of the nuclear vowel in all [ɾ.C] clusters. However, the ratios listed in columns five and ten clearly illustrate the heterogeneity of this asyllabic vowel in terms of duration with ranges as low as 22.2% to as high as 111.3% of the total length of its nuclear prototype.

When considering the placement of lexical stress, /-L/ → [ɾ] in stress-bearing syllables accounts for a proportionally higher number of occurrences than in pre-tonic or unstressed position (compare 64.9% to 35.1% or 24 out of 37). On average, stressed vowels are 70.8% greater in length than unstressed vowels and excrescent vowels occurring in tonic syllables are 14.8% greater in length than their pre-tonic counterparts. Interestingly however, the ratio of excrescent vowel to nuclear vowel is noticeably lower (45.9%) in tonic position than in pre-tonic position (68.3%). Furthermore, these pre-tonic asyllabic vowels represent 87.1% of the total average length of those appearing in stressed environments. It should be noted that none of the thirty-seven [ɾ.C] clusters occurred in post-tonic position. The presence of an excrescent vowel, particularly one of marked duration as compared to its nuclear vowel, is a likely factor that could conceivably contribute to the perception of gemination.

Of the total number of contiguous consonant groups exhibiting an excrescent vowel, the female subjects contributed 14 while the male subjects provided 23. The average length of the nuclear vowel was 106.2 *ms* for females versus 63.3 *ms* for males

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and that of the excrescent vowel was 40.9 *ms* for females as compared to 40.7 *ms* for males. Overall, the duration of the excrescent vowel in relation to the total average length of its syllabic counterpart when articulated by a male participant was proportionally longer (64.3%) than for the female participants (38.5%). However, given that the presence of the pre-consonantal alveolar simple vibrant and its subsequent excrescent vowel account for only 30.8% of the total number of tokens analyzed in this present study, we cannot be certain that the relationship between gender and the occurrence of this phenomenon is absolute.

Tables 7 and 8 compare the duration in *ms* of the closure of stops positionally subsequent to implosive /-L/ → [Ø] and /-L/→ [L] respectively except those instances where [L] = [ɾ] thereby triggering the insertion of an excrescent vowel.[8] These length measurements have been further organized according to gender. A preliminary overview of the data without yet taking into consideration the potential influence of segmental voicing nor that of gender reveals that the average duration of the closure of stop onsets in the sequences /-L/ → [Ø.C] and /-L/ → [L.C] is 88.8 *ms* versus 67.8 *ms*. Thus, the length of closure of both voiced and voiceless occlusive onsets combined is 30.9% greater when the preceding implosive liquid is deleted. However, the mean value of the segment-to-word-length ratios does not exhibit such a drastic increase (compare 15.3% to 13.3%), a difference of only 2.0%.

FEMALE				MALE			
[C]	Length of [C]	Length of word	Ratio: [C]/Word	[C]	Length of [C]	Length of Word	Ratio: [C]/Word
[p]	96.2	1011.7	9.5%	[t]	63.1	380.9	25.1%
[p]	83.8	709.8	11.8%	[t]	99.1	897.7	11.0%
[p]	111.1	717.2	15.5%	[t]	90.5	820.1	11.6%
[p]	81.9	551.3	14.9%	[t]	109.4	612.7	17.9%
[t]	109.1	353.9	30.8%	[k]	103.5	459.4	22.5%
[t]	110.4	567.1	19.5%	[k]	72.8	302.4	24.1%
[t]	95.4	723.9	13.2%	[b]	76.8	451.5	17.0%
[k]	35.5	170.5	20.8%				
[b]	89.6	518.8	17.3%				
[g]	73.3	550.9	13.3%				
[g]	97.0	614.1	15.8%				

Table 7. Duration of stop onset following /-L/ → [Ø]

[8] See the Appendix for a few sample spectrograms.

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FEMALE				MALE			
[C]	Length of [C]	Length of word	Ratio: [C]/Word	[C]	Length of [C]	Length of Word	Ratio: [C]/Word
[p]	88.9	467.6	19.0	[p]	77.7	456.6	17.0
[t]	97.8	725.0	13.5	[t]	83.6	412.9	20.2
[t]	86.1	555.8	15.5	[t]	72.9	421.2	17.3
[t]	64.6	438.7	14.7	[t]	56.2	385.6	14.6
[t]	108.2	396.4	27.3	[t]	46.0	612.6	7.5
[t]	60.1	450.8	13.3	[t]	75.0	858.7	8.7
[t]	42.1	1306.2	3.2	[k]	47.5	595.5	8.0
[t]	73.5	360.3	20.4	[b]	54.9	639.2	8.9
[k]	45.2	313.4	14.4				
[k]	41.3	199.6	20.7				
[b]	96.3	747.5	12.9				
[b]	83.5	592.1	14.1				
[b]	82.9	676.5	12.3				
[b]	64.6	473.7	13.6				
[d]	76.5	449.6	17.0				
[d]	119.9	528.5	22.7				
[d]	98.1	447.6	21.9				
[d]	29.0	502.2	5.8				
[d]	62.5	573.8	10.9				
[d]	32.2	299.7	10.7				
[d]	56.2	452.9	12.4				
[d]	15.0	221.4	6.8				
[d]	59.9	352.1	17.0				
[d]	46.7	411.7	11.3				
[g]	93.8	523.1	17.9				

Table 8. Duration of stop onset following /-L/ → [L]

Neither the subject's gender nor the voicing specification of the stop in onset position appears to have any significant positive correlation with respect to the duration of the closure of the occlusive segment. Even though the female participants provided 61.1% of the total tokens in Table 7 (11 out of 18) and 75.8% in Table 8 (25 out of 33), both groups exhibited comparable [C]/word ratios (compare 15.2% for females to 15.7% for males and 14.1% for females and 11.7% for males). Likewise the voicing specification of the stop segment was not an influential factor; for example, stops following /-L/ → [Ø] were on average 90.1 *ms* (voiceless) and 84.2 *ms* (voiced) and those following /-L/ → [L] were on average 69.4 *ms* (voiceless) and 65.9 *ms* (voiced) in duration. However, a comparison of these same segments according to their immediately preceding environments makes evident that the deletion of the post-nuclear liquid is the conditioning factor in the length of closure. Following the zero

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allophone of /ɾ/ and /l/, the voiceless and voiced stops were 29.8% and 27.8% respectively greater in duration than those subsequent to the retention of either liquid thereby feasibly contributing enough salient acoustic information to be impressionistically perceived as gemination.

5. Conclusions

The data presented in this study relative to the different phonetic manifestations of the phonological liquids /ɾ/ and /l/ in the Spanish of Havana support the general qualitative instability of these segments in coda position. In word-medial position, the simple vibrant /ɾ/ showed 11 allophonic variants and the lateral liquid /l/ five. Nevertheless, we were unable to accomplish our primary goal; that of verifying and thereby investigating by means of acoustic analysis the widely claimed phenomenon of liquid gemination. We did, however, find two potential processes that may help explain the impressionistic perception of regressive liquid assimilation, that of the insertion of an excrescent vowel between [ɾ.C] clusters and a prolonged closure of the stop segment in the onset subsequent to the deletion of the liquid in the previous syllable.

We must confess that we began our investigation full of uncertainty as there seemed to be more positive evidence against the existence of said phenomenon than in favor of it, to name the more salient reasons: 1) the articulation of two adjacent identical segments in casual discourse is articulatorily difficult if not impossible. Examples of identical segments that have been simplified, be they consonantal or vocalic, are not lacking in the literature- *alcohol* 'alcohol' [al.'kol] and *innovador* 'innovator' [i.no.βa.'d̪or]); 2) there are only two orthographically geminate segments in Spanish- "cc" of *acción* 'action' [ak.'sjon] and "nn" of *innovador*. However, at both the phonemic and phonetic levels, the first example does not represent a sequence of two identical segments and the second is simplified to one segment in all but the most careful of speech registers; 3) Hammond (1978) found in Miami-Cuban Spanish that in word-medial position when /-s/ → [Ø], the preceding vowel increased in length by an average of 36.4%; 4) gemination embodies the strengthening of a segment which

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contradicts the general tendency of final environments toward instability and weakening.

Since the corpus used for the acoustic analysis consisted of recordings taken from the Internet, it would be ideal to replicate the research in person with a larger group of test-subjects so that we may examine possible influential factors such as educational level, age, etc. In light of the evident lack of empirical evidence in support of liquid gemination in Cuban Spanish, we believe the implications of the findings in this study to be important for Caribbean Spanish in general and Cuban Spanish in particular. However, in order to definitively determine if the presence of an excrescent vowel and/or a prolonged closure of the stop segment in the onset following the deletion of a liquid indeed contribute to the perception of gemination, further detailed empirical and perceptual testing is a must. We sincerely hope that this study may provide a basis for future work on the phenomenon of liquid gemination in Cuban Spanish.

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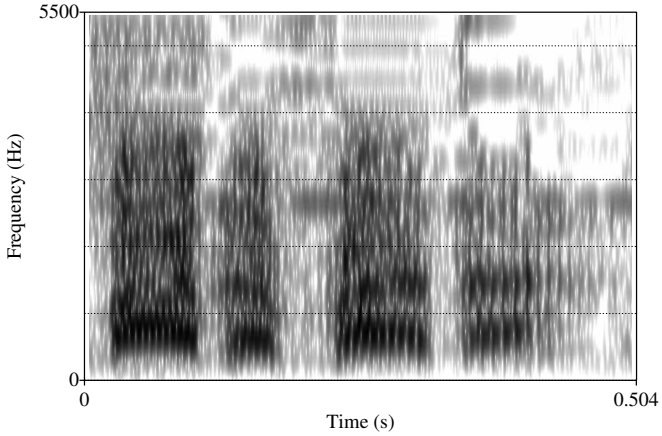
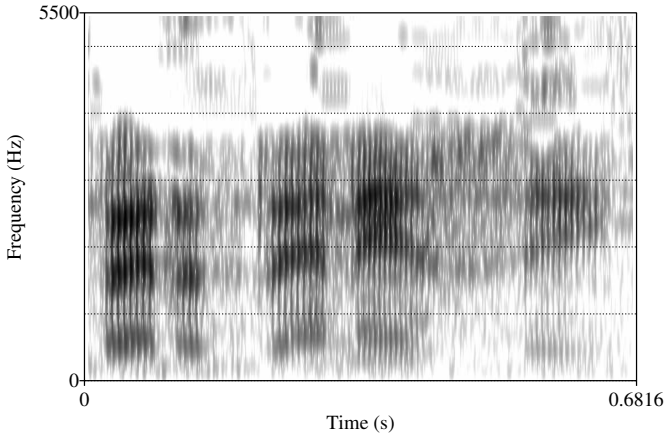
Appendix



Spectrogram 1. Excrescent vowel in tonic syllable

bárbara ‘barbarous’ (adj.f.sg.) ['βáɾʷ.βa.ɾa]



Spectrogram 2. Excrescent vowel in pretonic syllable

pertenece ‘pertains’ (3sg.pres.ind.) [peɾʷ.t̪e.'ne.se]

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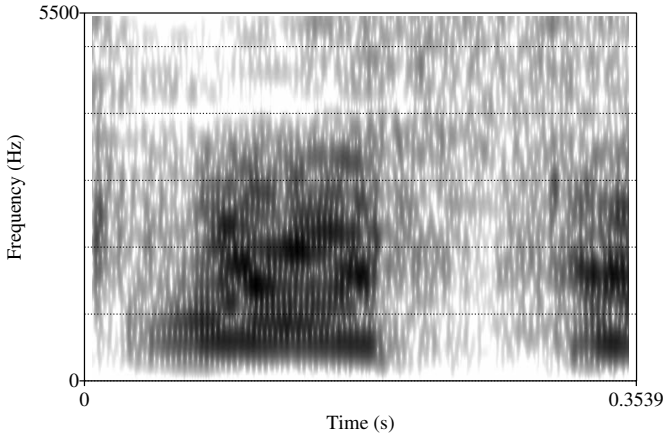
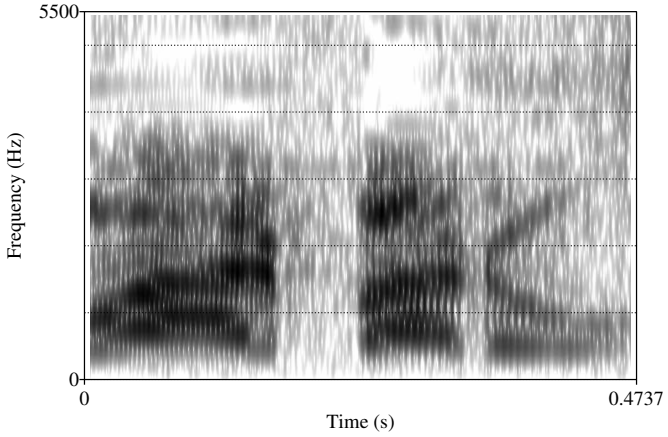


Spectrogram 3. Prolonged stop closure following /-L/ → [Ø]

puerto 'port' (n.m.sg.) ['pweØ.t̪o]



Spectrogram 4. No prolonged stop closure following /-L/ → [-L]

bárbaro 'barbarous' (adj.m.sg.) ['βaɹ.βa.ɾo]

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