A Sociophonetic Analysis of Islander Creole Rhotics

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Abstract: This study uses a combination of phonetic predictors and sociolinguistic factors to examine the variable production of rhotics in an English-based Creole in the Island of Old Providence, Colombia. Speech data were collected from five informants by means of sociolinguistic interviews and other-speech elicitation tasks, while 328 Praat-annotated tokens were extracted from a transcribed corpus of approximately 5,700 words. Rhotic production was examined according to several acoustic correlates (i.e., formant frequencies and segmental duration) and linguistic (i.e., word position and stress) and social (i.e., sex) factors. Formant frequencies in the form of F3 and F2 revealed a post-alveolar production, while F4 and F5 values suggested retroflex and bunched-tip realizations conditioned by sociolinguistic factors (Zhou et al, 2008). Mainly, it was found that postvocalic contexts significantly favor a bunched-tip realization. In addition, female informants favored a bunched variant by means of F3 and durational cues. This study sheds light on the relationship of sociolinguistic variables and acoustic predictors in the variable production of approximant rhotics in an English-based Creole in the Western Caribbean.

1.   Introduction

This study examines the phonetic properties and language use of approximant rhotics in Islander Creole: an English-Based Creole spoken in the Archipelago of San Andres, Colombia. This insular territory is located 445 miles from the coast of Colombia and 120 miles offshore of Nicaragua and is composed of three islands: San Andres, Old Providence and Santa Catalina. San Andres is the biggest island of the archipelago and the center of the provincial government, while Old Providence and Santa Catalina are the smaller conjoined islands of the archipelago (see Figure 1).

Figure 1. *(Left) Archipelago of San Andres in the Western Caribbean. (Right) A close-up of the islands of the Archipelago (Google Earth, 2018).*

Despite being the smallest province of Colombia in terms of land size (52.5 mi^2, San Andres 26 mi^2, Old Providence 17.2 mi^2, and Santa Catalina 1 mi^2), its total area, including maritime territory, comprises a vast and strategic territory of 128,000 square miles[1]. The archipelago is home to an English-based Creole known as Islander, a Creole language belonging to the diaspora of Western Caribbean Creoles and an offshoot of Jamaican Creole (Bartens, 2013). The most recent origins of Islander Creole can be traced back to the second half of 1700s with the arrival of slave ships from parts of the British Caribbean, particularly from Jamaica. As Colombia declared independence from the Spanish Crown in 1820, the islands were appended to the new Republic in 1822. Colombia declared the abolition of slavery in 1951 and for almost a century the newly freed Afro-Caribbean Islander speakers were left with little intervention from the Colombian government (for a complete history of the Archipelago, see Ross, 2007).

The main significant economic and social changes started in 1953, when San Andres was declared a free-duty port, bringing huge commercial expansion to the island of San Andres, provoking substantial influx of continental Colombian immigrants, and stripping the Islander communities from vast portions of their territories. Old Providence presents a different

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[1] Due to its proximity and size, this study treats Santa Catalina as part of Old Providence.

sociolinguistic panorama mainly due to its distance from San Andres that has allowed Old

Providence to be more culturally and linguistically preserved. There are 56 miles of maritime

waters between them, and contrary to San Andres, Old Providence was not included in the

expansionist commercial project of a duty-free port. Official numbers indicate a population of

3,645 self-denominated Raizales1[2], accounting for 88% of the entire population, mostly living in

rural areas (DANE, 2005) [3].

Spanish is the language of the education system and has been integrated into the

linguistic repertoire of Raizales. English is occasionally spoken by Raizales but is commonly

absent in everyday interactions unless used in touristic domains or the Baptist church (Morren,

2011). This Caribbean scenario serves as a prime example for the sociophonetic analysis of

rhotics in the acrolectal variety of this Creole language (Bartens, 2013), in which the community

has been in prolonged contact with a national non-lexifier language (i.e., Spanish). Precisely,

rhotic sounds are very diverse in their acoustic properties cross linguistically and can provide a

wealth of research in contact situations, especially in scenarios where the languages that coexist

are lexically unrelated. Hence, Old Providence represents a fertile ground for introducing the

analysis of acoustic correlates to study rhotic variation in a bilingual Creole community.

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[2] Raiz 'root' and -al 'belonging to' (belonging to the root). The ethnic denomination officially
recognized by the Colombian government. This term is used to differentiate this Afro-Caribbean, Creole-
speaking population from other Afro-Colombian population from mainland Colombia.
[3] A new census has been conducted by DANE in 2018 but updated demographic data is yet to be
publicly available.

2.   The Study of Rhotics in this Caribbean Scenario

The main goal of this study is to examine the production of Islander rhotics in the bilingual speech of Raizales as a window to understand the effects of socially derived sound variation in this Caribbean Creole community. The term rhotics is derived from the Greek letter *rho* to characterize a collection of r-like sounds, categorized according to the manner of articulation in different languages. This collection of sounds can be realized as taps, trills, approximants or fricatives (Thomas, 2011). These sounds can be further categorized as vibrant rhotics based on the presence of articulatory gestures resulting in the use of a mouth articulator (i.e., the apical portion of the tongue or the uvula) to produce a vibration or bouncing against another surface (i.e., the palate or tongue dorsum). These vibrant rhotics are classified based on the number of vibrations and the phonotactics of the language as taps or trills (Diaz-Campos, 2008). Contrary to vibrant rhotics, non-vibrant rhotics are produced with other articulatory gestures that don't require any vibration of a mouth articulator. Such sounds are realized with a pharyngeal constriction (i.e., approximant) or with fricative noise (i.e., fricative or assibilated).

Islander Creole, which is lexically derived from English, has been reported to make use of a non-vibrant English-like rhotic (Bartens, 2013). However, these reports were based on perceptual observations and the exact phonetic cues for determining its nature are unknown. Moreover, English has been documented to produce two rhotic variants involving different tongue gestures: a retroflex approximant and a bunched variant (Zhou, Espy-Wilson, Boyce, Tiede, Holland, & Choe, 2008). As a result, the degree of resemblance between Islander Creole and English that accounts for the articulatory tongue retraction and the pharyngeal constriction in both languages merits further analysis.

The present study addresses this gap in the field by studying these non-vibrant rhotic segments in terms of their acoustic properties across social conditions. The research questions guiding this sociophonetic study are "What is the phonemic classification of these segments? As English is known to have a post-alveolar approximant as a phonemic class (Thomas, 2011), Islander Creole is expected to have the same rhotic phoneme. The second research question states "Does Islander Creole exhibit a retroflex/bunched tip distinction?" Depending upon the relationship of F5-F4 formant frequencies, these two phonetic variants might be realized. If this is the case, a follow-up question can further the analysis of these variants and is enunciated as "Is there a linguistic factor and population favoring either production?" Women might be introducing new variants in the community. No hypothesis is made for a linguistic factor as no study to my knowledge has investigated this phenomenon in this scenario.

3.   Methodology

Fieldwork was conducted on the island of Old Providence (including Santa Catalina) over Summer 2017. The data collected here belong to a larger dissertation project investigating the outcomes of language contact between Islander Creole, Raizal Spanish (the bilingual Spanish variety), and Continental Spanish (the immigrant Spanish variety). Each recording took place in informal, non-controlled environments. However, effort was made to obtain noise-attenuated recordings in closed spaces. Speech data were obtained with a digital recorder sampled at 44100Hz/32-bit and two omnidirectional lavalier microphones with mounted preamplifiers. Part of the data was obtained through two sociolinguistic interviews conducted in English. Islander data selected for this analysis consist of the narration of the picture book Frog, Where are you?

(Mercer, 1969) and the recounting of Anansi stories. Anansi stories or the stories of the trickster

spider are traditional folk stories from the Gold Coast in West Africa.

The main data elicitation technique consisted of the adapted versions of the jigsaw task

by Thoms, Liao, and Szuztak (2005), and the Diapix task by Baker and Hazan (2011).

Informants engaged in information-seeking interactions, where they were requested to

collaborate to find the missing words in their graphics. Words were controlled to elicit rhotics in

different contexts. These tasks were conducted in tandem, whenever two Raizal informants

where available on site. Informants were asked to interact in Islander. As a result, two language

pairs were recorded in Creole. Table 1 shows the pool of informants for this study.

Table 1: Background information of the informants.

Age	Sex	Occupation
84	Male	Fisherman
66	Female	Cook
57	Female	Homemaker
34	Female	Homemaker
32	Male	Work in a Cruise Ship

Once the speech data were saved in a personal password-protected laptop, each recording

was labeled and metadata information was obtained from each informant, including occupation,

family, language background, education, and age. For each informant, 80 to 144 fully produced

rhotic tokens were obtained in all word contexts, including word initial, word final, intervocalic,

complex syllable onsets, and preconsonantal word-medial positions. In total, 328 tokens were

obtained from a transcribed corpus of approximately 5,700 words.

Each recording was submitted to Praat (Boersma and Weenik, 2018) and segments were

labeled in a TextGrid, a separate space for annotating linguistic information. Rhotics were

labeled by inspecting changes in the waveform and the lowering of F3 in the spectrogram.

Attention was paid to formant transitions from vowels to liquid and r-coloring of contiguous

vowels (Bradley and Willis, 2012). Likewise, the relative low onset frequency for F3 also served

as a cue to identify this phone (Kent and Read, 2001). Examples of how these rhotics are seen in
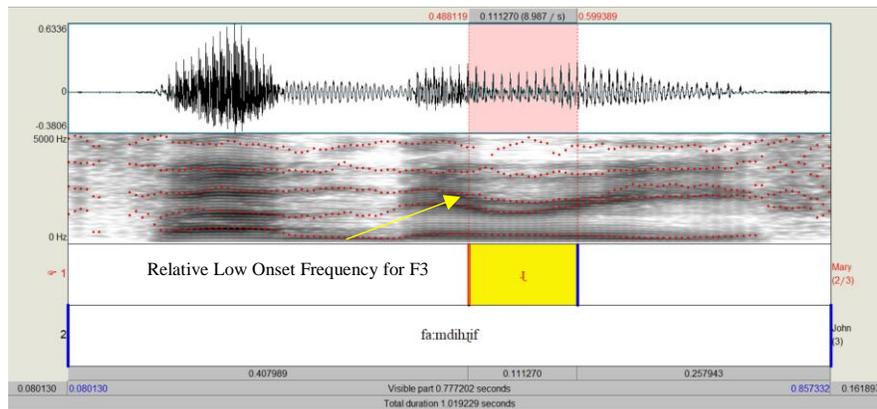
Praat is presented in Figure 2.

Figure 2: *Praat image of the rhotic produced in initial position in the word [ɹif] 'reef' in Islander Creole. Note the lack of occlusion and the F3 lowering curve getting closer to the second formant (F2). There is also coarticulation of the preceding vowel segment (i.e., /i/), which surrounds the rhotic between vowels.*

Finally, two speech properties of rhotics were obtained for each individual token:

duration and formant frequencies. Duration was calculated for each segment in milliseconds

from the rhotic segments previously labeled in the TextGrid and results were saved in a text file

via a Praat script (Lennes, 2002). For formant frequencies, a Praat script was modified to extend

the scope of the measurements and include F4 and F5 frequencies (Kawahara, 2010) as well as

F2 and F3 values. Only one social factor will be used to examine rhotic production in this

population (i.e., sex) due to the uneven distribution of informants and the degree of collinearity

between social variables (i.e., sex and age). Data visualization and statistical analysis were run in

R (R CoreTeam, 2013).

4.   Results

On average, Islander Creole produces an approximant rhotic with a mean F3 of 1993Hz, a F3-F2 distance of 692Hz, and a mean duration of 0.0827 milliseconds. The formant values reported here are consistent with the F3 lowering and the F3-F2 spacing of a postalveolar approximant (Kent & Read, 2002). When these formant frequencies are classified by sex, overlapping regression lines are found between the formant frequencies produced by males and females.
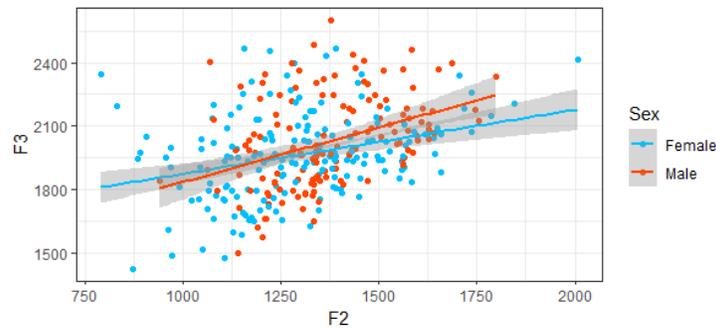

Figure 3. *Mean F3 and F2 frequencies in Raizal Creole classified by sex.*

Males tend to realize rhotics with more variation in the F3 spectrum ranging from 1500Hz to over 2500Hz. Females on the other hand have more variability on the F2 axis, with extreme outliers on both ends. Figure 4 shows the mean F3 frequencies based on the position of the rhotic in the word among males and females. F3 values seem to fluctuate across word positions, but with a clear pattern: female informants produce more lowered F3 realizations across all word positions.
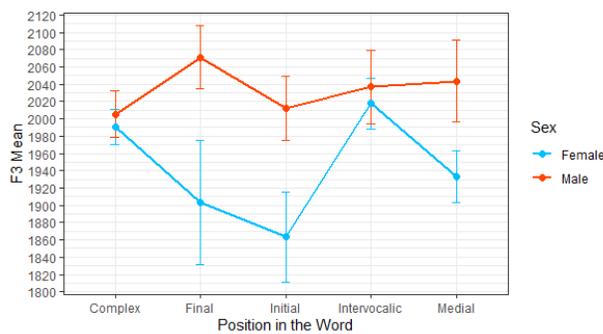

Figure 4. *Mean F3 frequencies based on rhotic word position in males and females.*

Mainly, rhotics in initial word position have the lowest F3 in females (~1860 Hz) while segments in final word position have the highest F3 in males (~2060 Hz). Intervocalic rhotics present the highest F3 in females (~2020 Hz), and a similar mean in males (~2040Hz). Rhotics in this position seem to have the most common F3 ranges (~2020-2040 Hz). Results of a two-way ANOVA showed significant differences in F3 and sex (p = 0.005) but no significant differences in word position (p = 0.156). The same test also revealed no significant interaction between sex and word position (p = 0.135).
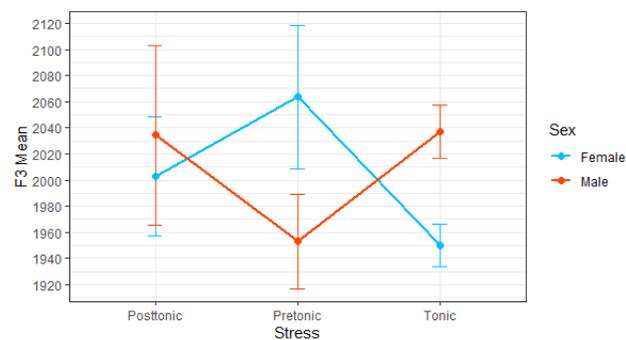

Figure 5. *Mean F3 frequencies based on rhotic stress by sex.*

With regard to rhotic stress, females and males have contrastive patterns of F3 production that seem to interact in different stress contexts. Figure 5 shows that male informants tend to have lower F3 values for pretonic rhotics (~1950Hz) but higher values for posttonic (~ 2030Hz) and tonic contexts (~ 2030Hz). In contrast, tonic rhotics in females appear with the lowest F3 mean frequency (~ 1930Hz), while pretonic (~ 2065 Hz) and posttonic positions (~ 2030Hz) appear with higher values. Corroborating the patterns observed in Figure 5, results from an ANOVA revealed a significant interaction between sex and rhotic stress and indicates that stress is significantly affected by the sex of the informants (F (2, 322) = 3.219, p = 0.041). A Tukey *Post Hoc* test further showed that tonic rhotics appear as the only context approaching statistical significance between males and females (p = 0.083).

In addition to the distinction of an Islander Creole /r/ in the second and third formants, F4 and F5 frequencies also have a predictive value on the nature of the rhotics produced in the Archipelago of San Andres. In an articulatory and acoustic study of American English /r/, Zhou et al (2008) reported two variants based on different tongue configurations: a retroflex tongue-shaped /r/, and a bunched-tip tongue /r/. Differences between these two variants are largely due to vocal tract configurations observable by the distance of F4 and F5, which "are the second and third resonances of the back cavity" (p. 4479) (F3 is the first resonance). Retroflex variants are produced with a half-wavelength back cavity that is represented with a spacing between the resonance in the range of 1300Hz to 1531Hz. On the other hand, a bunched /r/ is produced with a quarter wavelength back cavity and lower resonance distances of about 650Hz to 1150HZ.

According to this distinction between vocal tract configurations based on tongue articulation during the production of postalveolar approximants, the distance between the F5 and F4 was calculated and serves as a classification of two distinct variants of Creole /r/ in Old Providence. Figure 6 shows the distribution of F5-F4 distance as a representation of the spacing of the resonances in the laryngeal region during the production of approximant rhotics across word positions, stress and the social variable of sex.
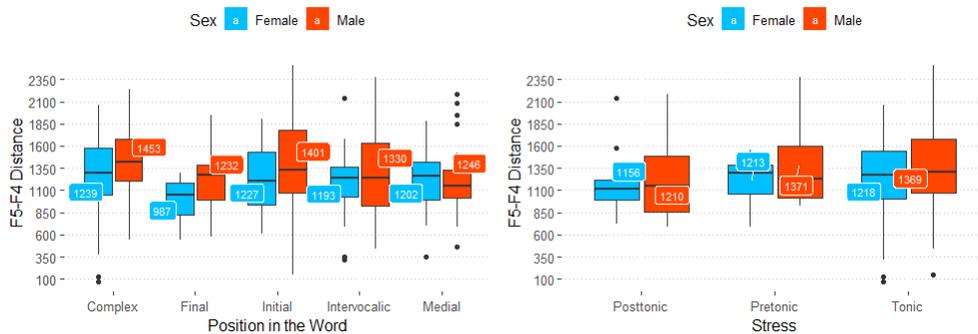

Figure 6. *F5-F4 Distance by word position and stress in males and females.*

Overall, female Raizales have lower F5-F4 distances than their male counterparts across word positions and stress. If we consider a bunched approximant with a spacing below the 1150Hz mark, then bunched rhotics seem to mostly appear in word-final and posttonic positions. With the aim of testing these sociolinguistic linguistic predictors, a multiple logistic regression in the form of a mixed-effects multivariate rule analysis was conducted in Rbrul (Johnson, 2009). This type of analysis reports the effects of the independent predictors in the dependent variable in log-odds, as well as, factor weights for measuring the importance of the predictors in the data. For this analysis, a binomial classification was made between bunched and retroflex /r/: rhotics with distances between F5-F4 above 1300Hz where classified as retroflex; rhotics with F5-F4 distances below 1150Hz were classified as bunched. In total, 60 tokens representing approximants with values between these two ranges were excluded from the analysis. Factors in word position and stress were simplified for the model. Table 2 shows the result of the test.

Table 2: Sociolinguistic factors contributing to bunched rhotics in Islander Creole.

Application Value: **Bunched**			Random Intercept: **Token**		
F3 = p = 5.81^{e-04}					
	Log Odds				
	0.00223				
Word Position = p = 0.0205					
Factors	Log Odds	N	Proportion	Weight	
Postvocalic	0.402	60	0.583	0.599	
Prevocalic	-0.402	208	0.404	0.401	
Range				*19*	
Sex= p = 0.0288					
Factors	Log Odds	N	Proportion	Weight	
Female	0.322	146	0.473	0.58	
Male	-0.322	122	0.41	0.42	
Range				*16*	
Stress = (Not Significant) p = 0.16					
Factors	Log Odds	N	Proportion	Weight	
Other	0.256	50	0.54	[0.564]	
Tonic	-0.256	218	0.422	[0.436]	
Range				*13*	
Duration = (Not Significant) p = 0.296					
	Log Odds				
	[3.892]				
Model Total = 286 DF = 7 Input Prob. 0.00966 Overall R^2 = 0.164 Dev.: 342.016 AIC: 356.016					

Results show that positive values of F3 (Log odds=0.00223) and postvocalic positions (i.e., word-final, complex syllabic onsets, and word-medial positions) appear as the only phonetic and linguistic variables with a significant value that contributes to a bunched realization. Additionally, females favor this variant more than males. The model further predicted a significant interaction between segmental duration and sex (p = 1.18e-03). Figure 7 shows the duration pattern of retroflex and bunched rhotics in female informants.
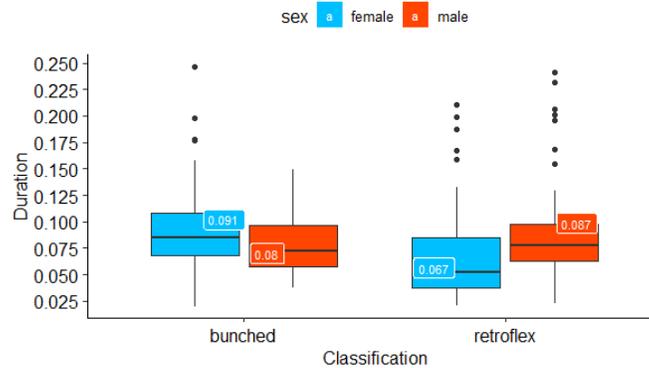
Figure 7. *A comparison of the retroflex/bunched classification and duration.*

This result suggests that the relationship between duration and the spacing of the resonances in males and females is statistically significant and it seems that females lead the production of distinct longer, bunched rhotic variants, and at the same time, a shorter retroflex /r/ in the Archipelago. A difference of 0.024ms can be seen between bunched and retroflex approximants in female Raizales, while male informants seem to maintain a similar duration regardless of the variant (0.080ms and 0.087ms). This analysis has shown the interplay of sociolinguistic and phonetic predictors in the realization of the rhotic variants in Islander Creole.

5. Discussion and Conclusions

The findings of this study have identified that Raizal Creole produces a post-alveolar approximant with different degrees of vocal cavity openness. Significant sociolinguistic differences emerged between sex and position in the word according to the acoustic predictors of formant frequencies and duration. These tests revealed that a retroflex approximant coexists with a bunched tongue rhotic variant in Islander Creole and that certain rhotic positions within the word contributed to this new vocal tract configuration. Moreover, female informants make use of F3 and durational cues to produce a bunched variant. Precisely, these findings respond directly to the research questions posited in this work.

Despite the prolonged and intimate contact situation, Islander Creole exhibits great phonetic differences with Spanish alveolar rhotics, which supports the assumption that decreolization is implausible in contact scenarios with national non-lexifier languages (Aceto, 1999; Snow, 2000). This study is limited by the small sample and the fact that data has been collected only from informants in Old Providence without regards to generation and this should be addressed in future studies. The present sociophonetic analysis has shown the acoustic properties of postalveolar Islander rhotics, offering new insights in the production of these segments in an acrolectal Creole community in the Western Caribbean.

References

Aceto, M. (1999). Looking beyond decreolization as an explanatory model of language change in creole-speaking communities. *JPCL*, *14*(1), 93–119.

Baker, R., & Hazan, V. (2011). DiapixUK: task materials for the elicitation of multiple spontaneous speech dialogs. *Behavior Research Methods*, *43*(3), 761-770.

Bartens, A. (2013). San Andres Creole English. *The Survey of Pidgin and Creole Languages*, 1, 101-114.

Boersma, Paul & Weenink, David (2018). Praat: doing phonetics by computer [Computer program]. Version 6.0.43, retrieved 8 September 2018 from http://www.praat.org/

Bradley, T., & Willis, E. (2012). Rhotic variation and contrast in Veracruz Mexican Spanish. *Estudios de fonética experimental*, 21, 43-74.

DANE -The National Administrative Department of Stastistics (2005). 2005 Census of Colombia. [Online] Accessed on October 2017. Available on the Web: http://systema59.dane.gov.co/cgibin/RpWebEngine.exe/PortalAction?&MODE=MAIN&BASE=CG2005BASICO&MAIN=WebServerMain.inl

Díaz-Campos, M. (2008). Variable production of the trill in spontaneous speech: Sociolinguistic implications. In *Selected proceedings of the 3rd Conference on Laboratory Approaches to Spanish Phonology* (pp. 47-58).

Google Earth v 7.3.1. (2018). Archipelago of San Andres, Colombia. Lat.12.549969°, Long. -81.718758°. Viewed January 2018.

Johnson, D. E. (2009). Getting off the GoldVarb standard: Introducing Rbrul for mixed‐effects variable rule analysis. *Language and linguistics compass*, *3*(1), 359-383.

Kawahara, S (2010) Praat Script for Automatic Extraction of Formant Frequencies [Online] Accessed on January 2018. Retrieved from: http://user.keio.ac.jp/~kawahara/resource.html

Lennes, M (2002) Praat Script for Automatic Extraction of Segmental Duration [Online] Accessed on January 2018. Retrieved from: http://phonetics.linguistics.ucla.edu/facilities/acoustic/praat.html

Mayer, M. (1969). *Frog, where are you?* New York: Dial Press.

Morren R. (2001). Creole-based trilingual education in the Caribbean archipelago of San Andres, Providence and Santa Catalina. *Journal of multilingual and multicultural development*, *22*(3), 227-241.

Ross, J. (2007). Routes for roots: entering the 21st century in San Andres Island, Colombia. *Caribbean Studies*, 3-36.

Snow, P. (2000). Caribbean creole/non-lexifier contact situations: A provisional survey. *Journal of Pidgin and Creole languages*, *15*(2), 339-343.

Team, R. C. (2000). *R language definition*. Vienna, Austria: R foundation for statistical computing.

Thoms, J., Liao, J., & Szustak, A. (2005). The use of L1 in an L2 on-line chat activity. *Canadian Modern Language Review, 62*(1), 161-182.

Thomas, E. (2011). *Sociophonetics: an introduction*. Palgrave Macmillan.

Zhou, X., Espy-Wilson, C. Y., Boyce, S., Tiede, M., Holland, C., & Choe, A. (2008). A magnetic resonance imaging-based articulatory and acoustic study of "retroflex" and "bunched" American English/r. *The Journal of the Acoustical Society of America*, *123*(6), 4466-4481.