A variationist account of trill /r/ usage in the Spanish of Málaga

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Abstract

This study analyzed trill variation in the Spanish of Málaga, Spain, and the factors that conditioned this variation. Data from twelve sociolinguistic interviews with men and women of different ages were analyzed acoustically with Praat and classified as the canonical trill or a different variant. Each token was then coded according to the following linguistic and extralinguistic factors: following vowel backness, position of **/r/** in the word, grammatical category, number of syllables, syllable stress, corpus frequency, number of phonological neighbors, speaker age, and speaker sex. Results revealed that stressed syllables and the middle and older age groups favored the canonical trilled variant. Word-medial position and word-initial position after a consonant also favored the trill, while word-initial after a vowel or a pause disfavored the trill. Corpus frequency was negatively correlated with canonical **/r/** production, i.e. higher frequency disfavored trills, while number of phonological neighbors was positively correlated, i.e. words with more phonological neighbors favored the trill. These findings suggest that future research should define word position in more detail and also consider corpus frequency and phonological neighborhood as variables.

Keywords: trill, variation, frequency, sociolinguistics

1. Introduction

The realization of the trill in Spanish has been shown to exhibit substantial variation throughout the Spanish-speaking world. Different variants have been recorded not only across dialects but within dialects and the speech of individuals as well (e.g. Bradley, 2006; Bradley & Willis, 2012; Díaz-Campos, 2008; Hammond, 1999; Henriksen & Willis, 2010; Willis, 2006). Nevertheless, dialects of Spain remained underrepresented in the trill variation literature, and to date only one study has been conducted on an Andalusian dialect (Henriksen & Willis, 2010), despite the fact that the phonology of the Spanish spoken in southern Spain has been shown to diverge significantly from that of the rest of the country (e.g. Alvar, 1996a). Therefore, the first purpose of this investigation is to analyze trill variation in the speech of individuals from Málaga, Spain, a previously unstudied variety of Andalusian Spanish.

Previous research has shown that many linguistic and extralinguistic factors condition trill variation, such as phonological context, position of /r/ in the word, number of syllables in the word, syllable stress, grammatical category, speaker age, and speaker sex, to name a few (e.g. Díaz-Campos, 2008; Diez Canseco, 1997; Henriksen & Willis, 2010; Lastra & Butragueño, 2006; Lewis, 2004); however, most studies consider only a select number of variables. As such, the second purpose of this study is to explore the possible effects of a wide range of factors that have previously been found to condition trill variation in other dialects.

Lastly, although Díaz-Campos (2008) highlights the importance of looking at lexical frequency, no previous research has included frequency as a variable conditioning trill variation. Moreover, phonological neighborhood properties also remain unexplored as a potential factor in variationist studies, despite research that has demonstrated their importance in vowel production variation. Thus, our third research goal is to examine the possible effects of lexical frequency and phonological neighborhood properties on the production of trills.

This paper is organized as follows: In Section 2, we describe previous research on trill variation and the factors that condition this variation. Section 3 outlines the purpose of the present study and specifies our research questions. Section 4 explains the method of the study, more specifically the corpora involved, the dependent variable, the initial independent variables under investigation, and the final list of factors examined due to interactions among the linguistic variables. In Section 5, we describe the statistical analysis, and in Section 6 we report the results of the study. Section 7 is a discussion of our findings, with special attention paid to the role of frequency. Finally, Section 8 provides our conclusions regarding this investigation.

2. Previous Literature

2.1 Trill Variation in the Spanish-speaking world

Spanish has two rhotics, the tap **/ɾ/** and trill **/r/**. According to the norms prescribed by the Real Academia Española (RAE), the tap occurs in onset clusters such as in the word *broma* **/bɾoma/** 'joke,' while the trill occurs in word-initial position, for example in *rama* **/rama/** 'branch,' and after a consonant in a preceding syllable, as in *honra* **/onra/** 'honor.' Therefore, these segments are in complementary distribution, with two exceptions: in intervocalic position where they contrast, e.g. *pero* **/peɾo/** 'but' vs. *perro* **/pero/** 'dog,' and in the coda where [ɾ] is most common but [r] is possible in emphatic speech, e.g. *dar* **[daɾ]** ~ **[dar]** 'to give' (RAE, 2005). Hualde (2005) provides additional details, stating that only the tap is possible word-finally before a vowel, e.g. *ser amigos* **/seɾ amigos/** 'to be friends,' while either rhotic is possible before a consonant or pause, e.g. *ser caro* **[seɾ ~ seɾ kaɾo]** 'to be expensive.'

The canonical production of the trill is that of a voiced alveolar trill with 2-3 occlusions, produced by a series of rapid contacts of the tongue tip with the alveolar ridge (Hualde, 2005). However, this realization is not the only variant across dialects. In fact, Hammond (1999) goes so far as to say that "in normal Spanish discourse, the segment **[r]** simply does not occur in the speech of the vast majority of native Spanish speakers" (p. 136).

Various studies lend credence to Hammond's (1999) assertion, including his own finding that in speech samples from 229 native speakers representing over 35 dialects across Latin America, Spain, and the Canary Islands, only 16 of the 1603 occurrences of **/r/** by were produced as a voiced alveolar trill (p. 141-142). Common variants of the trill include voiceless velar or uvular fricatives in Puerto Rico (Lipski, 1990), pre-breathy voiced trills or taps in the Dominican Republic (Willis, 2006), and a range of approximants to fricatives in Argentina (Colantoni, 2006; Quilis & Carril, 1971). An assibilated variant has also been documented in the production of speakers from Bolivia (Bradley, 2006; Sessarego, 2011), Colombia (Bradley, 2006), Guatemala (Bradley, 2006), Honduras (Bradley, 2006), Mexico (Bradley, 2006; Rissel, 1989), Ecuador (Bradley, 1999, 2006), Costa Rica (Bradley, 2006; Quilis & Carril, 1971; Vásquez Carranza, 2006), Peru (Diez Canseco, 1997), Paraguay (Alvar, 1996b), and Chile (Hammond, 1999; Quilis & Carril, 1971).

The realization of **/r/** varies not only across dialects, but within dialects and individual speakers as well. For example, Díaz-Campos (2008) found that in data from a corpus gathered in Caracas, Venezuela, speakers produced **/r/** as trills, taps, taps followed by approximants, and approximants with no accompanying occlusion. In Henriksen and Willis's (2010) study of Jerezano Andalusian Spanish, trills, approximants, fricatives, and taps followed by r-coloring or frication were all attested realizations of **/r/**, with each speaker producing a variable amount of occlusions. All the participants in Bradley and Willis's (2012) study of Veracruz Mexican Spanish also produced a variable number of lingual contacts; their productions were characterized as voiced and voiceless

approximants and fricatives, a single occlusion followed by frication or r-coloring, and variants with two or more occlusions, some of which were followed by r-coloring. Similarly, Willis (2006) found seven different variants of the **/r/** in Santo Domingo Dominican Spanish: a trill, a tap, a voiced glottal fricative, a voiceless alveo-palatal fricative, pre-breathy voice followed by a single tap, pre-breathy voice followed by multiple occlusions, and post-tap frication. All ten participants in this study produced at least three of these different variants of the trill.

From this review of previous research, it is clear that there is substantial variation in the realization of **/r/** throughout the Spanish-speaking world. Nevertheless, while trill variation has been studied in many dialects, one of the least studied varieties is Peninsular Spanish (Hammond, 2000). Most investigations that have been carried out on Peninsular Spanish characterize **/r/** productions as almost categorically normative trills, although some instances of taps, assibilation, and voiced and voiceless approximants have also been reported (Almeida & Dorta Luis, 1993; Lewis, 2004; Quilis, 1999). However, this research has been conducted on the Spanish of northern Spain, which differs considerably from southern varieties (e.g. Alvar, 1996a). The only study to date that has investigated trill variation in a variety of Andalusian Spanish is Henriksen and Willis (2010), who used narratives spoken by 16 urban, middle class natives of Jerez de la Frontera, a city in southern Spain. In their analysis of intervocalic **/r/** (both within and across words), they found that variants with two or more occlusions occurred in only 29.8% of their data, while a realization with a single closure, including those followed by r-coloring or frication, accounted for the majority of tokens at 44.2%. Variants with no occlusions, both voiced and voiceless, were reported for 26% of tokens. Therefore, Jerezano Andalusian Spanish exhibits substantial trill variation and many non-canonical productions, which is quite different from what has been described for the Spanish of northern Spain. The current study aims to extend our understanding of trill variation in Andalusia by conducting a sociolinguistic analysis of data from a previously unstudied dialect, that of Málaga, Spain, and expanding the linguistic and extralinguistic factors analyzed. These factors are explored in the following section.

2.2 Factors Conditioning Trill Variation

Previous studies have found that trill variation in several dialects is conditioned by a variety of factors, both extralinguistic and linguistic. In the following review, relevant research is outlined, first by discussing the extralinguistic factors shown to affect trill production and then by reviewing the linguistic factors.

2.2.1 Extralinguistic factors

Prior research has found several differing effects of extralinguistic factors on trill variation according to the dialect studied. In data from Peruvian Spanish, Diez Canseco (1997) determined that social class was the most significant single

predictor of /r/ variation, with the trill being favored by the middle class. Sex, origin, and social network density were also significant; male speakers, speakers from urban areas, and those with diffuse social networks favored the production of /r/ as a trill. In regard to speech style, Diez Canseco (1997) observed a higher rate of trill usage in a word-naming task than in interviews or conversations. Lastly, she found that speakers' attitudes toward Peruvian Spanish varieties as well as their attitudes toward Quechua significantly constrained variation for the trill, though the direction of effect depended on the variety of Peruvian Spanish.

Table 1. The effects of extralinguistic factors on trill variation

Factor	**Effects**	**Speaker Sample**
Sex	a. Women produced more trills (Bradley & Willis, 2012)	Veracruz, Mexico
	b. Males favored trills (Diez Canseco, 1997)	Cuzco, Peru
	c. Woman favored trills (Díaz-Campos, 2008)	Caracas, Venezuela
	d. Women produced more trills; older men produced the least trills (Henriksen & Willis, 2010)	Jerez, Spain
	e. Women favored assibilated variant (Lastra & Butragueño, 2006)	Mexico City, Mexico
	f. Women favored assibilated variant (Rissel, 1989)	Potosí, Mexico
Age	a. 61 or older favored trills (Díaz-Campos, 2008)	Caracas, Venezuela
	b. Younger speakers produced more trills (Henriksen & Willis, 2010)	Jerez, Spain
	c. Older speakers favored assibilation (Lastra & Butragueño, 2006)	Mexico City, Mexico
Social class	a. Middle class favored trills (Diez Canseco, 1997)	Cuzco, Peru
	b. Middle class favored trills (Díaz-Campos, 2008)	Caracas, Venezuela
	c. Middle and lower class favored assibilated variant (Lastra & Bustragueño, 2006)	Mexico City, Mexico
Location	a. Speakers from urban areas, as opposed to rural areas, favored trills (Diez Canseco, 1997)	Cuzco, Peru

Beliefs	a. Speakers' attitudes toward Peruvian Spanish and Quechua had differing effects on trill production (Diez Canseco, 1997)	Cuzco, Peru
	b. Women with traditional gender role views favored assibilation (Rissel, 1989)	Potosí, Mexico
Style	a. Speakers produced more trills in a word-naming task than in interviews or conversations (Diez Canseco, 1997)	Cuzco, Peru
Social network density	a. Diffuse social networks favored trills (Diez Canseco, 1997)	Cuzco, Peru

Looking at data from Venezuelan Spanish, Díaz-Campos (2008) concluded that women, the middle class, and those speakers 61 years of age or older favored the trill. Lastra and Butragueño (2006) found that sex, social class, and age affected the pronunciation of trills in Mexico City as well, with an assibilated variant favored by women, the middle and lower classes, and older speakers. Similarly, Rissel (1989) reported that young women assibilated more than young men in San Luis Potosí, Mexico, and this phenomenon was more pronounced in the speech of women that held traditional attitudes toward gender roles. In Henriksen and Willis's (2010) study, older male Jerezano Andalusian speakers produced less occlusions overall than other groups, an average of fewer than one occlusion, and therefore were less likely to produce a normative voiced alveolar trill than women and younger speakers. Bradley and Willis's (2012) findings in Veracruz Mexican Spanish echo these results: male speakers were more likely to produce non-normative trills than female speakers. These results are summarized in Table 1, which demonstrates that the three extralinguistic factors most commonly studied are those of sex, age, and social class, and the effects of these variables differ across dialects.

2.2.2 Linguistic Factors

Linguistic factors that have been reported to condition trill variation include phonological context, position within the word, syllable stress, syllable length, and grammatical category. For phonological context, Lewis (2004), who looked at trill usage in Spain, Mexico, Argentina, and Chile, found that the trilled variant was less common after **/s/** as compared to after **/l/**, **/n/**, vowels or a pause, and Diez Canseco (1997) observed fewer trills after **/s/** or a pause than after other consonants. Bradley's (2006) results from seven different Latin American countries are similar to these earlier findings; he reported that strident rhotics were more common after **/s/** and to a lesser degree after a pause, while non-strident realizations tended to occur after vowels and after **/n/**. In terms of position within the word, Díaz-Campos (2008) identified word-initial position as favoring the realization of **/r/** as a voiced alveolar trill, while word-internal position disfavored

this production; this finding was also reported by Diez Canseco (1997). Willis (2006, 2007) found that word-initial trills tended to be longer than word-medial trills. However, Henriksen and Willis (2010) reported a somewhat different effect of word position: wordmedial **/r/** had a higher number of occlusions on average than word-initial **/r/**.

Table 2. The effects of linguistic factors on trill variation

Factor	Effects	Speaker Sample
Phonological context	a. Strident rhotics (a non-trill variant) more common after **/s/** and pause (Bradley, 2006)	Latin America
	b. Trills disfavored following /s/ or pause in Cuzco, Peru (Diez Canseco, 1997)	Cuzco, Peru
	c. Trills less common after /s/, more common after **/l/**, **/n/**, vowels, and pause (Lewis, 2004)	Spain, Mexico, Argentina, Chile
Word position	a. Word-initial position favored trills (Diez Canseco, 1997)	Cuzco, Peru
	b. Word-initial position favored trills (Diaz Campos, 2008)	Caracas, Venezuela
	c. Word-initial trills longer than word-medial trills (Willis, 2006, 2007)	Dominican Republic
	d. Word-medial **/r/** had more occlusions than word-initial (Henriksen & Willis, 2010)	Jerez, Spain
Syllable stress	a. Unstressed syllables favored trills (Henriksen & Willis, 2010)	Jerez, Spain
Number of syllables	a. 4+ syllables favored trills (Díaz-Campos, 2008)	Caracas, Venezuela
Grammatical category	a. Adjectives and verbs favored trills (Díaz-Campos, 2008)	Caracas, Venezuela

Henriksen and Willis (2010) also discovered an effect of syllable stress, and noted that unstressed syllables favored a trill with multiple occlusions. In addition, Díaz-Campos (2008) observed that words with four or more syllables favored the production of a trill, while words with one to three syllables disfavored it, and that grammatical category affected the production of the trill, with adjectives and verbs favoring multiple occlusions and nouns and adverbs disfavoring this realization. The effects of linguistic factors found in prior research are summarized in Table 2.

The extralinguistic factors described earlier, as well as others, can often interact with these linguistic factors. Adams (2002) examined **/r/** variation in Costa Rican Spanish and found that speakers who more strongly assibilated **/r/** in

intervocalic position and after a consonant were female, 25-45 and 50-70 years of age, from rural areas, and with less formal education. For trills following a pause, results were similar, with the exception that male speakers favored strong assibilation instead of female speakers. Willis (2006) reported that male speakers of Santo Domingo Dominican Spanish tended to have a longer duration of pre-breathy voice in their trill productions, as well as a longer segment duration overall than female speakers in word-initial position, but not in word-medial position. Speaker sex combined with syllable stress was important in Willis (2007), in which Cibaeño Dominican females' pre-breathy-voiced tap productions **[ɦɾ]** occurred more often in unstressed syllables, while males favored stressed syllables for this realization. Similarly, females produced more pre-breathy-voiced trills **[ɦr]** in stressed syllables while males tended to produce this variant in unstressed syllables. These interactions between social and linguistic factors demonstrate the importance of considering both kinds of variables in a regression analysis in order to better explain variation.

Díaz-Campos (2008) suggests that frequency may also play a role in trill variation, although he did not investigate this in his study. In particular, he states that "we would expect a pattern according to which more frequent lexical items show more innovative variants than less frequent ones" (p. 57). This hypothesis is consistent with research on the effect of language use on language structure which has found that high frequency is associated with phonetic and/or phonological reduction (Bybee, 2001, 2002). Therefore, lexical frequency may be yet another factor that conditions trill variation.

Since frequency effects remain unexplored, it is also possible that other types of frequency affect the production of **/r/**, specifically the frequency measures associated with phonological neighbors. A word's phonological neighbor is another word that differs by only one phoneme through either substitution, deletion of addition: for example, *pero* **/pero/** 'but' is a phonological neighbor of *perro* **/pero/** 'dog' because only their third phoneme is different. Additionally, *erro* **/ero/** 'I fail' and *puerro* **/pwero/** 'leek' are also phonological neighbors of *perro*. Words that have more phonological neighbors may have more need to be phonetically distinguished from similar sounding words, and, as such, canonical or more distinctive productions may be more likely to occur in these words. This prediction is in line with what Munson and Solomon (2004) reported for the effect of phonological neighborhood density on vowel production. They found that participants' vowel space was more expanded with high-density words than low-density words, i.e. vowels were more distinct in words with many phonological neighbors than those with few phonological neighbors. Several studies examining vowel dispersion corroborate their results (Kilanski, 2009; Munson, 2007; Watson & Munson, 2007); however, other studies reported the opposite finding: words with more dense phonological neighborhoods had higher amounts of phonetic reduction in terms of vowel dispersion and duration (Gahl, 2012; Gahl, Yao, & Johnson, 2012; Yao, 2011). The effects of phonological neighborhood density have yet to be examined on phonetic variation in the

production of segments other than vowels. Therefore, it is possible that phonological neighborhood properties also play a role in trill variation.

3. The current study

As described in the previous section, a myriad of extralinguistic and linguistic factors have been found to condition trill variation. However, the majority of studies include only a small number of these factors. At the same time, not much is known about trill variation in Andalusian Spanish in particular. Furthermore, although Díaz-Campos (2008) specifically suggests that lexical frequency may play a role in conditioning trill variation, frequency in general remains an unexplored area of possible variables. For this reason, we have chosen to include different frequency measures in addition to a range of linguistic and extralinguistic factors in the present study, which aims to determine which factors favor the production of the canonical trill variation in the Spanish of Málaga through a variationist analysis. The following research questions guide this investigation:

1. What is the frequency of the voiced alveolar trill with two or more occlusions in Málaga Spanish as compared to other variants?
2. What linguistic and extralinguistic factors examined in previous research condition trill variation in this dialect?
3. What is the role of lexical frequency and phonological neighborhood properties in determining trill production?

4. Method

4.1 Corpora

Two corpora were used for the current study. The data analyzed in this study come from a subset of the *Corpus de Málaga* (Múñoz, Manuel, Lasarte, & Villena, 2008), which consists of sociolinguistic interviews with native Spanish speakers from Málaga. The interviews last between 45 and 60 minutes and cover various topics such as family, children, work, education, society, religion, and childhood. A total of 12 interviews were analyzed for the current study, all from speakers with a high level of education. These were evenly divided between male and female speakers and age groups, as illustrated in Table 3.

Table 3. Distribution of participants according to sex and age

Age Group	Men	Women
20-34	2	2
35-54	2	2
55+	2	2

The *Corpus de Málaga* was also used to calculate corpus frequency, while a second corpus, *EsPal* (Duchon, Perea, Sebastián-Gallés, Martí, & Carreiras, 2013), was employed to measure overall lexical frequency, the number of phonological neighbors for each word analyzed, its number of higher frequency phonological neighbors, and the average frequency of its phonological neighbors. *EsPal* (from *Español Palabras* 'Spanish Words') is an online database of Spanish word properties, based on a corpus of movie subtitles as well as a corpus of written data from the internet. The decision to use *EsPal* as well as an explanation of these frequency measures is given in Section 4.5.1, in which the linguistic factors analyzed in this study are further discussed.

4.2 Dependent Variable

Tokens of **/r/** were considered in all possible contexts of occurrence: in word-initial position such as in *rico* 'rich,' intervocalically and represented orthographically with *rr* as in the word *barrio* 'neighborhood,' and in syllable-initial position after **/n/**, **/l/**, or **/s/**, as in *alrededor* 'around.' In total, 963 tokens of **/r/** were identified and analyzed acoustically with Praat (Boersma & Weenink, 2011), then classified as either the canonical alveolar trill with two or more occlusions or a different realization. The trill production was defined as the visible appearance of two or more occlusions, which appear as white stripes, in the Praat spectrograph (Figure 1). All other variants, such as assibilated productions (Figure 2) and tap productions (Figure 3), were grouped as non-trill variants. While the canonical trill tokens were clearly distinct from other variants due to the presence of two or more occlusions, other realizations that were more similar in appearance in the spectrograph were less clearly distinguishable due to occasional background noise that darkened the spectrograph. For example, taps and assibilated tokens were sometimes difficult to differentiate. Due to this limitation of the corpus, we grouped all variants other than the trill into one category for the sake of replicability, and thus cannot report on the proportion of individual variants other than the trill. Additionally, the dependent variable was defined in this way in order to allow for a statistical analysis that determines the factors that produce the canonical trill in comparison to all other possible productions.

Figure 1. Canonical trill with two occlusions: *tu relación* (participant 58)

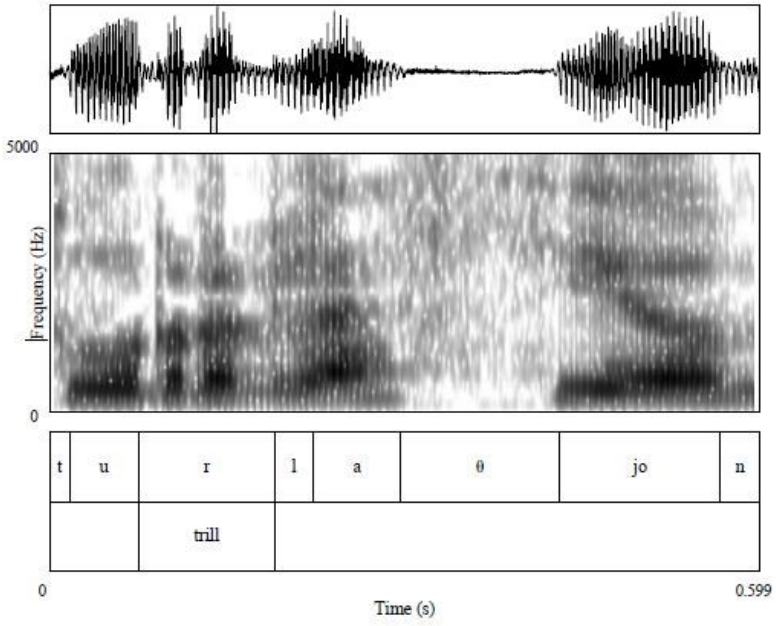


Figure 2. Example of an assibilated variant: *muy romántica* (participant 58)

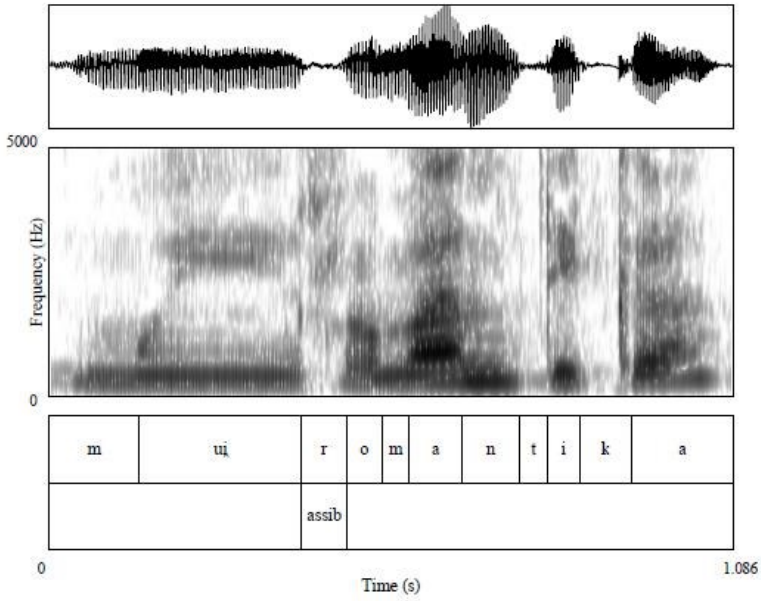
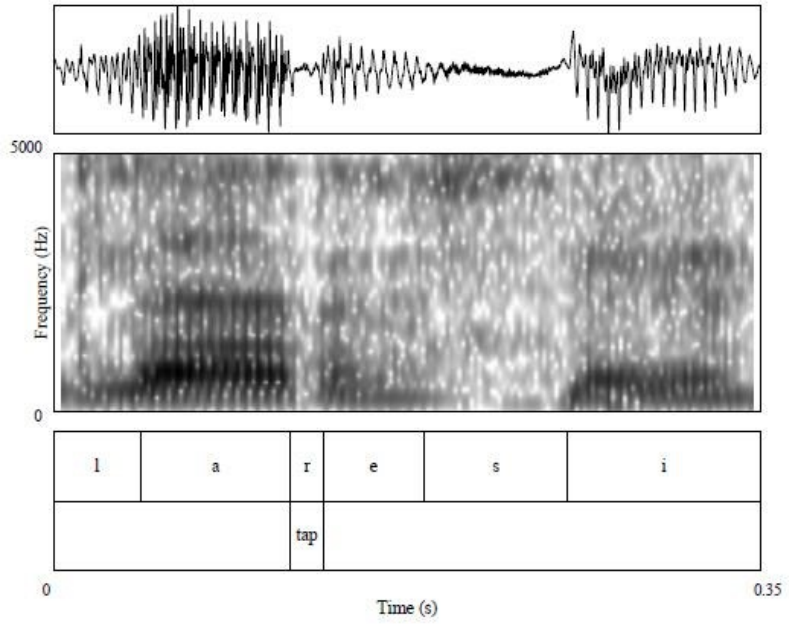


Figure 3. Token of a tap in trill context: *la resi(dencia)* (participant 58)



4.3 Independent Variables

4.3.1 Linguistic

Several independent linguistic variables were considered in this study, based on the research described in previous sections. These factors are outlined in Table 4, and their respective subcategories are presented. The preceding phonological context was considered in terms of both point of articulation and manner of articulation in order to determine which manner of defining phonological context more accurately predicted trill production. The following vowel was considered in both terms of vowel height and vowel backness. Additionally, the position of the trill phoneme **/r/** within the word, syllable stress, the number of syllables in the word, and grammatical category were included as factors.

In addition to these linguistic variables that have been explored in previous research, two measures of lexical frequency and three measures pertaining to phonological neighborhood properties were also considered. In terms of lexical frequency, the first measure was the frequency of the surface form of each word within the entire *Corpus de Málaga*, which is composed of 24 interviews. For example, the term *barrio* 'neighborhood' occurred 112 times across the 24 interviews. Word frequency in the *Corpus de Málaga* was calculated in order to have a measure that reflected language use in the local community, following the methodology of Erker and Guy (2012). However, since a few hours

of interviews do not give a complete picture of the use of words throughout a person's life, we also chose to include a more global gauge of lexical frequency. We used *EsPal*, an online database of Spanish word properties, to determine lexical frequency, which is calculated by analyzing one or both of two subcorpora, a written database and a database of subtitles (Duchon, Perea, Sebastián-Gallés, Martí, & Carreiras, 2013). We used word property information from the 460 million token subtitle database as opposed to the written database in the belief that subtitles more accurately reflect spoken language. Additionally, the written corpus contains several types of sources that are more formal or academic in nature, such as government sources, newspapers, and fiction. In calculating lexical frequency, we used the corpus's word frequency measure for the surface form of each word (that is, *barrio* 'neighborhood' and *barrios* 'neighborhoods' were considered two different words).

The last set of measures focused on phonological neighbors and was also obtained using *EsPal*, with the phonology specified as Castilian Spanish and the corpus limited to subtitles. Since phonological neighborhood effects remain an unexplored set of variables in trill variation, all measures possible through *EsPal* that concern phonological neighbors were included: the number of phonological neighbors a word has, its number of higher frequency phonological neighbors, and the average frequency of its phonological neighbors. As previously mentioned, a phonological neighbor of a word is any word that differs from that word by only one phoneme through addition, substitution, or deletion.

Table 4. Independent Linguistic Variables

Variables	**Categories**
1. Dependent variable	Voiced alveolar trill with two or more occlusions All other realizations
2. Manner of the preceding segment	Stop Affricate Fricative Nasal Lateral Rhotic High vowel Mid vowel Low vowel Pause
3. Place of the preceding segment	Bilabial Labiodental Dental Alveolar Palatal Velar Front vowel Central vowel Back vowel Pause
4. Following vowel height	High vowel Mid vowel Low vowel

5. Following vowel backness	Front vowel Central vowel Back vowel
6. Position within the word	Word-initial, after a pause Word-initial, after a consonant Word-initial, after a vowel Intervocalic Word-internal, after **/s/**, **/l/**, or **/n/**
7. Number of syllables	Monosyllabic Two or three syllables Four or more syllables
8. Syllable stress	Stressed Unstressed N/A (i.e. monosyllabic)
9. Grammatical category	Noun Verb Proper noun Pronoun Adjective Conjunction Adverb
10. *Corpus de Málaga* word frequency	*continuous variable*
11. *EsPal* word frequency	*continuous variable*
12. Number of phonological neighbors	*continuous variable*
13. Number of higher frequency phonological neighbors	*continuous variable*
14. Average frequency of phonological neighbors	*continuous variable*

4.3.2 Extralinguistic

The tokens were also coded according to two extralinguistic variables: age and sex. Age was divided into three categories: 20-34, 35-54, and 55 or more years of age. These divisions mirror the divisions of age from the corpus used. Sex was categorized as either male or female.

4.3.3 Interactions between independent variables

While all the independent variables detailed above were initially included in order to facilitate a thorough investigation of factors possibly conditioning trill variation, several of the variables interacted. Consequently, not all the factors could be included in the regression analysis. The first set of factors that interacted were following vowel height and following vowel backness: there are multiple one-to-one correlations between several of the categories within the factor groups. For example, under following vowel height, the only sound that could be coded as a

low vowel was **/a/**, which was also the only sound that could be coded as a central vowel under following vowel backness. In other words, the only central vowel in Spanish is also the only low vowel. There is no possible combination of low vowel with either a front or back classification. As such, the height and backness of the following vowel created interactions in the statistical analysis.

The second set of factors that interacted were preceding context (point of articulation), preceding context (manner of articulation), and the position of **/r/** within the word. For instance, an intervocalic trill, one of the classifications of position within the word, could only occur after a vowel, one of the classifications of preceding context. Thus, there could be no instances of an intervocalic trill following a stop, affricate, fricative, nasal, lateral, vibrant, or a pause. Similarly, trills in syllable-initial position following **/s/**, **/n/**, or **/l/** all follow an alveolar segment (since **/s/**, **/n/**, and **/l/** are all alveolar phonemes), and thus could never follow a sound with a bilabial, labiodental, dental, palatal, or velar point of articulation. These are two of the many interactions that occurred between these three factors groups.

Thirdly, the two lexical frequency measures interacted. Corpus frequency from the 24 interviews as well as the *EsPaL* frequency count significantly correlated with a p-value of 3.1e-43 (as calculated using Rbrul [Johnson, 2009]). This result is to be expected since the words that are used most frequently in the corpus are also more than likely frequent in general. Thus, it was anticipated that there would be some level of correlation between the two measures.

Lastly, all three measures related to phonological neighbors interacted. This result was not unexpected since the words that have the highest number of phonological neighbors overall were also expected to have a higher number of high frequency phonological neighbors as well as a higher average frequency of phonological neighbors. Thus, only one count measure of frequency and one phonological neighbor-related frequency measure would be ideal in a regression analysis. Specifically, the number of phonological neighbors interacted with the number of higher frequency phonological neighbors, with a p-value of 7.57e-67, as well as with the average frequency of phonological neighbors, with a p-value of 2.37e-24. At the same time, the number of higher frequency phonological neighbors statistically correlated to the average frequency of phonological neighbors with a p-value of 1.91e-27. Thus, all three measures highly correlated with each of the other two.

In order to determine which factor within each set of interacting factors to include in the regression analysis, the correlation between each factor and the production of the canonical trill variant was determined using Rbrul (Johnson, 2009). This resulted in ten statistical analyses in which each one of the factors that interacted with another factor was considered as an independent variable predicting the production of the trill variant versus all other possible productions.

In Table 5, the results of these ten analyses are presented. The right column displays the p-value from each statistical run, which indicates the level of significance to which each factor predicted trill variation when considered in isolation. For example, corpus frequency had the lowest p-value of 0.000343,

indicating that when considering each factor individually, corpus frequency most significantly predicted the production of the trill (versus all other variants). The different shading indicates which factors belong to which set of interacting factors (following vowel height and backness; position within the word and preceding segment manner and point; the two types of corpus frequency; the three measures related to phonological neighbors), while the bolded row within each shaded area represents the factor with the lowest p-value in its respective set.

Table 5. Correlation between each interacting factor and trill production

Factor	**p-value**
Following vowel-height	0.0207
Following vowel- backness	**0.00957**
Preceding segment- manner	0.992
Preceding segment- point	0.135
Position within word	**0.0021**
Corpus frequency of the word	**0.000343**
EsPaL corpus frequency	0.101
***EsPaL* # of phonological neighbors (PN)**	**0.0338**
EsPaL # high frequency PN	0.171
EsPaL average frequency PN	0.314

As can be interpreted from the table, within the first set of interacting factors, defining the following phonological vowel by backness rather than height most significantly predicted trill variation. In terms of the second set of interacting factors, the position of the trill within the word correlated most to trill production, rather than either of the two manners of defining preceding segment purely by acoustic properties. Lastly, with regard to the five frequency measures, the frequency of the word within the *Corpus de Málaga* as well as the number of phonological neighbors most significantly predicted trill usage. As such, seven linguistic factors were included in the regression analysis: following vowel backness, position of **/r/** within the word, grammatical category, number of syllables, syllable stress, corpus frequency, and *EsPaL* number of phonological neighbors.

5. Statistical Analysis

After coding the tokens for the linguistic and extralinguistic factors outlined in the two previous sections, the data were submitted to a multivariate regression analysis using Rbrul (Johnson, 2009). This type of statistical analysis constructs a model of variation that includes the independent variables that most accurately explain variation of a dependent variable, in this case, the production of the trill versus all other realizations. While 963 tokens were originally coded, 45 were excluded. Eight tokens that had a trill occurring in word-internal position after **/s/**,

/n/, or **/l/** were not considered, due to small numbers. Two trills occurring in monosyllabic words, as well as two tokens occurring in the grammatical category of preposition were excluded for the same reason. Lastly, 33 tokens were excluded due to the lack of an available *EsPaL* frequency or phonological neighbor count. These words were mainly proper names of local landmarks or places that were well known to the participants but were not in the database, such as *Alpujarra*, a region in Southern Spain. As such, 918 tokens were used in the final statistical analysis.

6. Results

This section displays the results of two statistical analyses. The first is that of all linguistic and extralinguistic factors except for corpus frequency and the number of phonological neighbors. The second statistical analysis includes the latter two factors. This division was made due to the fact that when all factors were considered, the regression analysis was incapable of converging on a single model. Upon further investigation, it was determined that corpus frequency significantly interacted with four of the five nonfrequency-related linguistic factors (following vowel backness, position in word, number of syllables, and grammatical category). This relationship between corpus frequency and each of these five factors is displayed in Table 6. A p-value below 0.05 indicates that the factors are significantly correlated, and therefore interact.

Table 6. Correlations between corpus frequency and other linguistic factors

Factor	**p-value**
Following vowel backness	5.88e-08*
Position in word	0.000373*
Syllable stress	0.143
Number of syllables	2.37e-09*
Grammatical category	1.18e-16*

* Indicates statistical significance at α=.05

These interactions were due to several linguistic features related to the Spanish language. For instance, as evidenced by our *EsPaL* frequency counts, nouns and adverbs are much more frequent than verbs and adjectives. In particular, the majority of adverb tokens in this study were highly frequent words such as *arriba* 'upward/above' and *realmente*, 'really' or 'truthfully'. Another such example is related to following vowel: the 13 most frequent words in the corpus were followed only by front vowels, which caused an interaction between frequency and following vowel.

Additionally, the measure of number of phonological neighbors interacted with all five non-frequency-related linguistic factors. These correlations are displayed in Table 7. Due to these interactions, corpus frequency and number of phonological neighbors were run separately from all other factors, both linguistic and extralinguistic, resulting in two regression analyses.

Table 7. Correlations between # of phonological neighbors and other linguistic factors

Factor	**p-value**
Following vowel backness	1.32e-21*
Position in word	0.0302*
Syllable stress	2.99e-54*
# of syllables	2.02e-41*
Grammatical category	9.19e-05*

* Indicates statistical significance at α=.05

6.1 First Regression Analysis

6.1.1 Significant factors

When considering all factors except for corpus frequency and number of phonological neighbors in a regression analysis, three were statistically significant. These factors are presented in Table 8, below. In the table, the significant factors are arranged from those with the lowest p-value, or most significance, to those with the highest. The % trill column indicates the ratio of trill tokens to all tokens in that context, since the application value was marked as the trill. For example, in tokens where the syllable was stressed, 44.8% of these occurrences were produced as the canonical trill.

Table 8. Regression analysis including all non-frequency variables: significant factors

Factor	**Logistic coefficient**	**Token #**	**% Trill**	**Weight**
Syllable stress (p=2.29e-05)				
Stressed	0.265	270	44.8%	0.57
Unstressed	-0.265	648	30.1%	0.43
Age (p=0.00186)				
35-54	0.302	283	39.2%	0.58
55+	0.133	435	35.6%	0.53
20-34	-0.434	200	25.0%	0.39
Position (p=0.0281)				
Word-initial post- consonant	0.335	93	44.1%	0.58
Intervocalic	0.210	298	40.6%	0.55
Word-initial post-vowel	-0.190	501	29.3%	0.45
Word-initial post-pause	-0.354	26	26.9%	0.41

Total tokens		**918**	**34.4%**	

Weight indicates whether a specific context favors or disfavors trill usage. As such, a weight above 0.50 favors, while a weight below 0.50 disfavors. The last line presents the total number of tokens and the overall rate of trill production, which was 34.4%. This indicates that the realization of **/r/** is highly variable in the Spanish of Málaga since 65.6% of all tokens were not produced as a canonical trill.

Syllable stress was the factor with the lowest p-value, meaning that it was the factor that most significantly conditioned trill variation. The trill was favored in stressed syllables and disfavored in unstressed syllables. The factor with the next lowest p-value was age. The middle age group favored the trill the most (weight=0.58), followed by the oldest group, which slightly favored the trill (0.53), while the youngest age group favored the non-canonical variants (0.39). Lastly, the position of the trill within the word was significant. Word-initial post-consonantal position and intervocalic position favored the canonical trill variant (0.58 and 0.55, respectively), whereas all other word-initial variants disfavored this production.

6.1.2 Non-significant factors

The remaining four factors considered in the first regression analysis did not statistically constrain trill variation. There was no significant difference in trill usage according to sex, the grammatical category of the word, the number of syllables, nor the following vowel. Table 9 displays the distribution of trill variants for the non-significant factors.

Table 9. Regression analysis including all non-frequency variables: non-sig. factors

Factor	**Token #**	**%Trill**
Following vowel-backness		
Back vowel	112	42.9%
Central vowel	119	42.9%
Front vowel	687	31.5%
Number of syllables		
2-3 syllables	640	44.8%
4 or more syllables	279	30.0%
Grammatical category		
Adjective/adverb	163	41.7%
Verb	25	34.0%
Noun	466	32.4%
Proper noun	54	31.5%

Sex		
Male	542	36.3%
Female	376	31.6%
Total	918	34.4%

6.2 Second regression analysis

The results of the second regression analysis, containing corpus frequency and number of phonological neighbors, are presented in Table 10.

Table 10. Regression analysis with frequency-related variables

Factor	**Logistic coefficient**
Corpus frequency (p=0.000175)	-0.008
EsPaL # of phonological neighbors (p=0.0207)	0.017

As evidenced by the p-values for both factors, corpus frequency and the number of phonological neighbors statistically constrained trill variation. Corpus frequency had the lower p-value and a negative logistic coefficient, which indicates an inverse relationship with trill production. A higher corpus frequency for a particular word, the less likely the canonical trill was produced. On the other hand, the number of phonological neighbors had a positive correlation with the trill: the more phonological neighbors a word had, the more likely a trill was produced.

7. Discussion

In terms of how these results compare to previous research, our findings corroborate several findings presented in previous studies, while other results from this study diverge from those of previous work. The first comparison to be noted is the overall rate of trill production: 34.4% of tokens were produced as the canonical trill, while 65.6% were produced as other variants. This result indicates that the majority of tokens produced are not the standard variant, as has been evidenced in most studies that examine trill variation.

In regard to syllable stress, our finding that stressed syllables favored the trill variant diverges from Lewis (2004) and Díaz-Campos (2008) who did not find stress to significantly constrain variation, and from Henriksen and Willis (2010) who found that unstressed syllables corresponded with more occlusions. For the effect of word position, previous studies have reported diverging results: Diez Canseco (1998) and Díaz-Campos (2008) found that word-initial position correlated to higher trill use while Lastra and Butragueño (2006) and Henriksen and Willis (2010) observed that word-medial position favored the trill. Our results may explain why previous studies have found opposing effects: when we divided word-initial trills into three categories depending on the preceding sound (consonant, vowel, or pause), the word-initial trills following consonants favored

the trill production, while the other word-initial tokens favored other variants. Given these findings, it may be that a more specific categorization is necessary for classifying word position, or that an interaction with another factor, such as preceding sound, may best explain variation.

Concerning phonological context, Solé (2002) found that trills in an **[i]_[i]** context were shorter, had fewer contacts between the tongue and the alveolar ridge, and had a higher rate of fricative or approximant realizations than in the **[a]_[a]** context. While not statistically significant, our results show a similar trend in that when the vowel that followed the trill was a central or back vowel there was a higher occurrence of the trill than when the following sound was a front vowel. Future research would need to consider both the preceding and following context in order to corroborate Solé's results.

The length of the word (in syllables) in which the trill occurred did not significantly constrain variation in this study; however, trill rate was higher in words with two to three syllables than those with four or more. This trend differs from that of Díaz-Campos (2008), who found that words with fewer than four syllables significantly disfavored the trill, while those with four or more favored the canonical production. In terms of grammatical category, Díaz-Campos (2008) established the following hierarchy in order of the categories that most favored the trill to those that least favored it: adjectives > verbs > nouns > adverbs. Our study evidenced a similar but non-significant trend, with the only difference being the behavior of adverbs: the hierarchy observed was adjectives/adverbs > verb > noun > proper noun.

The independent variables that most differ among previous studies are the extralinguistic factors. Firstly, studies that consider speaker age have found very different results. Díaz-Campos (2008) showed that older speakers favored the trill, while Lastra and Butragueño (2006) and Henriksen and Willis (2010) observed that younger speakers favored this variant more. Our study's results diverge from all three prior studies: Speakers from the middle age group favored the trill most, followed by older speakers, who favored it slightly, and then younger speakers, who disfavored the trill. These results may be evidence of age-grading, which would indicate that speakers of a community vary their speech throughout their lifetime, while the community as a whole remains unchanged (Labov, 1994). The trill, which is the prestigious variant, may be more common in the middle age group due to the fact that this group constitutes the majority of the workforce. Thus, speakers may be using the more prestigious variant in the workforce because they are exposed to and must produce more formal speech, while older and younger speakers use a more informal or colloquial style of speech. Secondly, our findings for speaker sex parallel those of Lastra & Butragueño (2006), who did not find a significant effect. However, Willis (2006) observed that males favored more occlusions, while Díaz-Campos (2008) and Henriksen & Willis (2010) observed the opposite trend. These divergent results demonstrate that the patterning of variation according to extralinguistic factors differs greatly from community to community.

Previous studies have not considered the effects of frequency specifically on trill variation, though the effects of frequency on phonetic reduction have been often discussed (Bybee, 2001, 2002) and frequently observed (e.g. Bybee, 2002; Bybee & Scheibman, 1999; Fidelholtz, 1975; Pluymaekers, Ernestus, & Baayen, 2005). As explained in Bybee (2002), the production of language can be considered to be repeated neuromotor patterns, of which the most frequently practiced patterns, i.e. lexical items or phrases, become more efficient and reduced as they are articulated more often. This reduction can be viewed in terms of the overlap of articulatory gestures, or the decrease in magnitude or omission of extreme gestures. The trill can be considered an extreme gesture, as its production requires precise control over the positioning of the articulators and the amount of air flow (Solé, 2002). That the trill is among the last segments acquired by native speakers also supports the observation that its articulation is complex (Jiménez, 1987). Consequently, it can be predicted that higher frequency lexical items would favor variants with less complex articulation. This prediction was borne out in our results in that higher frequency words disfavored trill production.

Additionally, there is little prior research on the effects of phonological neighbors on phonetic production in general and there are no previous variationist studies that consider the number of phonological neighbors as an independent variable on phonetic variation. However, Munson and Solomon (2004) proposed that more phonological neighbors necessitate phonetic distinction between that word and its neighbors. Applying this reasoning to trill production, a higher number of phonological neighbors would favor the production of the canonical trill in order to distinguish the word containing the trill from other similar sounding words. Our results demonstrate that the number of phonological neighbors was statistically significant, and that words with more phonological neighbors did favor the trill, as expected.

8. Conclusion

Several conclusions can be drawn from the results presented in this study. The first is that trill production is again shown to be highly variable. More than 50% of the productions were non-trill variants, corroborating numerous previous studies. Additionally, the factors that influence trill variation differ significantly according to dialect. Nearly every factor investigated in this study was shown to either have opposing effects in several prior studies, or was found to have a different effect on trill variation in this study than that observed in previous research. The independent variables whose effects are most inconsistent are the extralinguistic factors of age and sex. In fact, our results differ in terms of the effects of age and sex from those of Henriksen and Willis (2010), who studied another variety of Andalusian Spanish spoken less than 250 kilometers from Málaga. Opposing results of several variationist analyses examining multiple dialects of Spanish indicate that the effect of different factors on trill production in and of itself is highly variable.

Additionally, it was shown that corpus frequency and phonological neighborhood density significantly constrained trill variation, at least in this

dialect of Spanish. Future research should consider these measures as independent variables when analyzing phonetic variation, since it may be that a significant portion of phonetic variation can be explained by considering these two constructs. Moreover, further research into the effects of phonological neighborhood density on phonetic variation may provide insight into the cognitive processing of similar words and sounds. Since there are no prior variationist studies that consider phonological neighborhood density as a factor, this area is open to future investigation.

References

Almeida, M., & Dorta Luis, J. (1993). Datos acústicos de las líquidas españolas. In C. Díaz Alayón (Ed.), *Homenaje a José Pérez Pidal* (pp. 97-110).

Alvar, M. (1996a). Andaluz. In M. Alvar (Ed.), *Manual de dialectología hispánica: El español de España*. Barcelona: Editorial Ariel.

Alvar, M. (1996b). Paraguay. In M. Alvar (Ed.), *Manual de dialectología hispánica: El español de América*. Barcelona: Editorial Ariel.

Boersma, P., & Weenink, D. (2011). Praat: doing phonetics by computer (Version 5.3). Retrieved from www.praat.org

Bradley, T. G. (1999). Assibilation in Ecuadorian Spanish: A phonology-phonetics account. In B. E. Bullock, J.-M. Authier & L. A. Reed (Eds.), *Formal perspectives on Romance linguistics* (pp. 57-71). Amsterdam: John Benjamins.

Bradley, T. G. (2006). Phonetic realizations of /sr/ clusters in Latin American Spanish. In M. Díaz-Campos (Ed.), *Selected Proceedings of the 2nd Conference on Laboratory Approaches to Spanish Phonetics and Phonology* (pp. 1-13). Somerville, MA: Cascadilla Proceedings Project.

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

Bybee, J. (2001). *Phonology and language use*. New York: Cambridge University Press.

Bybee, J. (2002). Word frequency and context of use in the lexical diffusion of phonetically conditioned sound change. *Language variation and change, 14*(03), 261-290.

Bybee, J., & Scheibman, J. (1999). The effect of usage on degrees of constituency: the reduction of don't in English. *Linguistics, 37*(4), 575-596.

Colantoni, L. (2006). Increasing periodicity to reduce similarity: an account of deassibilation in rhotics. In M. Díaz-Campos (Ed.), *Selected proceedings of the 2nd Conference on Laboratory Approaches to Spanish Phonetics and Phonology* (pp. 22-34). Somerville, MA: Cascadilla Press.

Díaz-Campos, M. (2008). Variable production of the trill in spontaneous speech: sociolinguistic implications. In L. Colantoni & J. Steele (Eds.), *Selected Proceedings of the 3rd Conference on Laboratory Approaches to Spanish Phonology* (pp. 47-58). Somerville, MA: Cascadilla Press.

Diez Canseco, S. (1997). *Language variation: The influence of speakers' attitudes and gender on sociolinguistic variables in the Spanish of Cusco, Peru.* (Ph.D. Dissertation), University of Pittsburgh.

Duchon, A., Perea, M., Sebastián-Gallés, N., Martí, A., & Carreiras, M. (2013). EsPal: One-stop shopping for Spanish word properties. *Behavior research methods*, 113.

Erker, D., & Guy, G. R. (2012). The role of lexical frequency in syntactic variability: Variable subject personal pronoun expression in Spanish. *Language, 88*(3), 526557.

Fidelholtz, J. L. (1975). Word frequency and vowel reduction in English. *Chicago Linguistic Society, 11*, 200-213.

Gahl, S. (2012). Why So Short? Competing Explanations for Variation. In J. Choi, E. A. Hogue, J. Punske, D. Tat, J. Schertz & A. Trueman (Eds.), *Proceedings of the 29th West Coast Conference on Formal Linguistics*. Somerville, MA: Cascadilla Proceedings Project.

Gahl, S., Yao, Y., & Johnson, K. (2012). Why reduce? Phonological neighborhood density and phonetic reduction in spontaneous speech. *Journal of Memory and Language, 66*(4), 789-806.

Hammond, R. M. (1999). On the non-occurrence of the phone [r] in the Spanish sound system. In J. Gutierrez-Rexach & F. Martinez-Gil (Eds.), *Advances in Hispanic Linguistics. Papers from the 2nd Hispanic Linguistics Symposium*. (pp. 135-151). Somerville: Cascadilla Press.

Hammond, R. M. (2000). The multiple vibrant liquid in U.S. Spanish. In A. Roca (Ed.), *Research on Spanish in the United States: Linguistic Issues and Challenges* (pp. 333-347). Somerville, MA: Cascadilla Press.

Henriksen, N. C., & Willis, E. W. (2010). Acoustic characterization of phonemic trill production in Jerezano Andalusian Spanish. In M. Ortega-Llebaria (Ed.), *Selected Proceedings of the Fourth Conference on Laboratory Approaches to Spanish Phonology* (pp. 115-127). Somerville, MA: Cascadilla Proceedings Project.

Hualde, J. I. (2005). *The sounds of Spanish*. New York: Cambridge University Press.

Jiménez, B. C. (1987). Acquisition of Spanish Consonants in Children Aged 3-5 Years, 7 Months. *Language, Speech, and Hearing Services in Schools, 18*(4), 357-363.

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

Kilanski, K. (2009). *The effects of token frequency and phonological neighborhood density on native and non-native English speech production.* (Unpublished doctoral dissertation), University of Washington, Seattle.

Labov, W. (1994). Principles of language change: Internal factors. Oxford: Blackwell.

Lastra, Y., & Butragueño, P. M. (2006). Un posible cambio en curso: el caso de las vibrantes en la ciudad de México. *Estudios sociolingüísticos del español de España y América*, 35-68.

Lewis, A. M. (2004). Coarticulatory effects on Spanish trill production. In A. Agwuele, W. Warren & S.-H. Park (Eds.), *Proceedings of the 2003 Texas Linguistics Society Conference* (pp. 116-127). Somerville, MA: Cascadilla Proceedings Project.

Lipski, J. (1990). Spanish taps and trills: Phonological structure of an isolated opposition. *Folia linguistica, 24*(3/4), 153-174.

Múñoz, A., Manuel, A., Lasarte, M., & Villena, J. A. (2008). El español hablado en Málaga II. Málaga: Sarriá.

Munson, B. (2007). Lexical access, lexical representation, and vowel production. In J. Cole & J. I. Hualde (Eds.), *Laboratory phonology 9: Phonology and phonetics* (pp. 201-228). Berlin: Mouton.

Munson, B., & Solomon, N. P. (2004). The effect of phonological neighborhood density on vowel articulation. *Journal of Speech, Language and Hearing Research, 47*(5), 1048.

Pluymaekers, M., Ernestus, M., & Baayen, R. H. (2005). Lexical frequency and acoustic reduction in spoken Dutch. *The Journal of the Acoustical Society of America, 118*, 2561-2569.

Quilis, A. (1999). *Tratado de fonética y fonología españolas* (2nd ed.). Madrid: Gredos.

Quilis, A., & Carril, R. B. (1971). Análisis acústico de [r] en algunas zonas de Hispanoamérica. *Revista de filología española, 54*(3/4), 271-316.

Real Academia Española & Asociación de Academias de la Lengua Española. (2005). *Diccionario panhispánico de dudas*.

Rissel, D. A. (1989). Sex, attitudes, and the assibilation of /r/ among young people in San Luis Potosí, Mexico. *Language variation and change, 1*(3), 269-283.

Sessarego, S. (2011). Phonetic analysis of /sr/ clusters in Cochabambino Spanish. In L. A. Ortiz-Lopez (Ed.), *Selected Proceedings of the 13th Hispanic Linguistics Symposium* (pp. 251-263). Somerville, MA: Cascadilla Proceedings Project.

Solé, M.-J. (2002). Aerodynamic characteristics of trills and phonological patterning. *Journal of Phonetics, 30*(4), 655-688.

Vásquez Carranza, L. M. (2006). On the phonetic realization and distribution of Costa Rican rhotics. *Revista de filología y lingüística de la Universidad de Costa Rica, 32*(2), 291-309.

Watson, P. J., & Munson, B. (2007). A comparison of vowel acoustics between older and younger adults. In J. Trouvain & W. Barry (Eds.), *Proceedings of the 16th International Congress on Phonetic Sciences* (pp. 561-564). Saarbrücken, Germany: Universität des Saarlandes.

Willis, E. W. (2006). Trill variation in Dominican Spanish: An acoustic examination and comparative analysis. In N. Sagarra & A. J. Toribio

(Eds.), *Selected Proceedings of the 9th Hispanic Linguistics Symposium* (pp. 121-131). Somerville, MA: Cascadilla Proceedings Project.

Willis, E. W. (2007). An acoustic study of the 'pre-aspirated trill' in narrative Cibaeño Dominican Spanish. *Journal of the International Phonetic Association, 37*(1), 3349.

Yao, Y. (2011). *The effects of phonological neighborhoods on pronunciation variation in conversational speech.* (Unpublished doctoral dissertation), University of California, Berkeley.