Acoustic Characterization of Phonemic Trill Production in Jerezano Andalusian Spanish

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1. Introduction

Production of the Spanish phonemic trill has been a key characteristic for categorization of the Spanish dialect continuum (Lipski, 1994; Moreno, 1988; Resnick, 1975; Zamora & Guitart, 1982). Most dialectal works, however, are based on impressionistic data and/or a limited informant pool. Recent empirical studies have focused on the specific acoustic correlates that distinguish one production of the phonemic trill from another (see Blecua Falgueras, 2001 for Peninsular Spanish; Colantoni, 2006a,b for Argentine Spanish; and Willis 2006; 2007 for Dominican Spanish; and Bradley & Willis, 2008 for Veracruz Mexican Spanish). Other studies have analyzed the diversity of phonemic trill production from an articulatory and gestural perspective (Bradley, 1999; 2006). The most common realizations of the Spanish phonemic trill cited to date include an apico-alveolar trill, an assibilated trill, a uvular trill, a pre-aspirated trill, a pre-breathy-voiced trill, and an approximant. Regarding phonemic trill production in Peninsular Spanish, most accounts report near categorical production of the apico-alveloar trill, with instances of voiced and voiceless approximants being attested as well (Almeida & Dorta, 1993; Blecua Falgueras, 2001; Lewis, 2004; Quilis, 1993). Quilis (1993), in particular, noted that some frication may be present after the last closure. Although some linguists claim that the normative apical trill is virtually nonexistent in Spanish (Hammond, 1999; 2000), that the apical trill is the norm, in spite of this variation, can be concluded from the fact that this is what speakers typically produce when asked to produce minimal pairs in laboratory conditions. To the best of our knowledge, however, no studies have explored the possibility of trill variation in Andalusian Spanish.

In terms of the phonological characterization of Andalusian Spanish, previous works have focused on syllable-final /s/-aspiration, merger of the /s/-/θ/ distinction, velarization of /n/, and the fricative pronunciation of /č/, to name a few relevant phenomena (see Alvar, 1996: 233-258 for general overview). Although analyses have been advanced with regard to liquid-rhotic neutralization in syllable-final position (Mondéjar, 1979) and even loss of /l/ and /ɾ/ in intervocalic position (Moya Corral, 1979), little has been said about the possibility of trill variation in this dialect. The fact that Andalusian Spanish would not exhibit trill variation is almost unexpected, given what has recently been reported for other Spanish dialects known to undergo processes of phonological innovation. The current paper is designed to fill this gap in the literature by analyzing data recorded by 16 native speakers of Jerez de la Frontera, a coastal city located in the province of Cádiz, Spain. It is designed with the goal of providing an acoustic examination of phonemic trill production of urban Andalusian Spanish middle class speakers.

The organization of the remainder of this paper is as follows. Section 2 reviews work on trill production and trill variation in the Spanish-speaking world. Section 3 provides information about the research design, participant pool, and data analysis. Section 4 presents the acoustic findings of the Jerezano Andalusian Spanish (JAS) phonemic trill data and provides a quantitative analysis of the effect of linguistic and social variables on trill production. Section 5 discusses these findings and compares the current JAS findings with those of previous research on trill production and variation in the Spanish-speaking world. Finally, Section 6 concludes.

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2. Background

Spanish has two contrastive rhotic segments: a tap, also known as the *vibrante simple,* and a trill, also known as the *vibrante múltiple.* These segments contrast in intervocalic position only (e.g., *caro* 'expensive' vs. *carro* 'car'; *aroma* 'aroma' vs. *a Roma* 'to Rome'), and phonemic trills are typically found in word-initial position and word-medial position (Real Academia Española, 1992). Most phoneticians working with acoustic data consider the two rhotic segments as articulatorily and acoustically distinct (Martínez Celdrán, 1998; Martínez Celdrán & Rallo, 1995; Quilis, 1993; Recasens, 1991). Standard descriptions of the Spanish trill claim that the production of this rhotic involves two or more brief occlusions between the tongue apex and the alveolar ridge (Hualde, 2005: 181; Martínez Celdrán, 1997; Quilis, 1993: 329-332), as exemplified in Figure 1. Nevertheless, it is a well-known fact that the Spanish phonemic trill is not always realized as prescribed by the Real Academia Española (1992). While prescriptive accuracy of the Spanish voiced alveolar trill is subject to influence by external factors such as dialectal variation, speech style, and various social variables, recent studies also note that aerodynamic conditions and the articulatory quality of adjacent segments must be taken into account when considering multiple-occlusion trill production (cf. Blecua Falgueras 2001; Lewis, 2004; Solé, 2002).

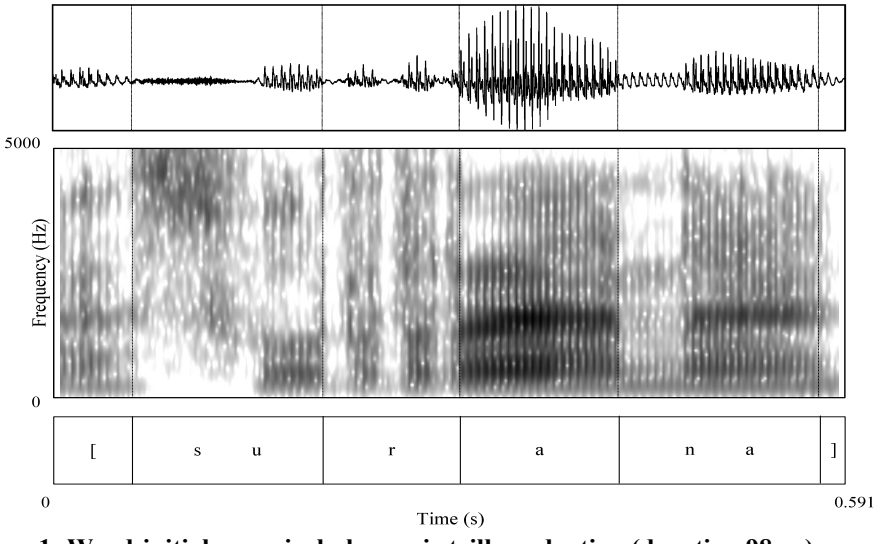

Figure 1: Word-initial canonical phonemic trill production (duration 98ms)

As mentioned, trill variation in Spanish has been widely documented, but only lately has it been examined from an acoustic perspective. Evidence for trill variation in Dominican Spanish was reported in Willis (2006; 2007), who studied unscripted speech data of urban middle class speakers of two Dominican Spanish dialects. The most common phonemic trill productions included a pre-breathy-voiced tap, a pre-breathy-voiced trill, and breathy-voice frication. The pre-breathy-voiced portion of the rhotic segment constituted approximately 60% of its overall duration. Willis' acoustic analysis of naturalistic speech data contrasted with previous claims, based on impressionistic accounts, that the Dominican Spanish trill was characterized by initial pre-aspiration. In terms of the linguistic variables underlying trill variation in this dialect, Willis reported that word-initial trills were on average 10-15ms longer than word-internal trills. Most recently, Willis & Bradley (2008) provided an acoustic comparison of phonemic taps and trills in Dominican Spanish. They noted that 50% of tap tokens were produced with a measurable duration of 22ms, while the other 50% of tap tokens were lenited or completely elided. Overall segmental duration provided the most consistent acoustic cue for differentiation of phonemic tap and trill tokens.

As for trill variation in other varieties of Latin American Spanish, Colantoni studied trill assibilation patterns in Argentine Spanish, and Bradley carried out an acoustic analysis of trill production in multiple Latin American dialect areas. Colantoni analyzed interview speech data of 8 male speakers of Argentine Spanish. She uncovered a number of rhotic variants in her corpus of data, ranging from various fricative-type productions to approximant productions to multiple-occlusion trill productions. Colantoni noted that the acoustic and perceptual similarity between approximant variants and multiple-occlusion trill variants may be linked to similarity in their degrees of periodicity. Bradley (2006) presented an acoustic analysis of /sr/ clusters from speakers of various Latin American dialects. Speech data came from interviews and readings of prepared texts. Bradley noted that three-occlusion trills were unattested in the corpus of data and that strident fricative realizations were common when preceded by a lingual fricative. These assibilated variants also appeared in other syllable-initial environments.

Two studies of the Spanish trill with a sociolinguistic focus are Lastra & Martín Butragueño (2006) for Mexican Spanish and Díaz-Campos (2008) for Venezuelan Spanish. Lastra & Martín Butragueño investigated the social and linguistic factors that contribute to variable production of the phonemic trill. In a corpus of 1289 tokens of the phonological trill, they reported that 65% were produced with multiple occlusions, 19% were produced as a fricative, and 14% were produced as an assibilated variant. The assibilated variant was favored by lower and middle class speakers, by older speakers, and by women. Díaz-Campos (2008) carried out a sociolinguistic analysis of 2,369 phonemic trill tokens extracted from a corpus of 36 sociolinguistic interviews of speakers of various socioeconomic levels, age groups, and sexes of Venezuelan Spanish spoken in Caracas. Acoustic analysis revealed that approximately 35% of the total corpus of phonemic trill tokens consisted of two or more occlusions and that approximately 60% of the tokens were approximant-type variants. Díaz-Campos also found that trill variability was motivated by a combination of linguistic and social factors. Multivariate factor analysis revealed that factors such as word position, number of syllables, grammatical category, age, sex, and socioeconomic class had an effect on the production of trill variants. Younger speakers in particular favored the use of approximant-like variants, whereas older speakers preferred multi-tap variants.[1]

In sum, recent acoustic work conducted on speech data elicited from speakers of various Latin American varieties of Spanish has documented a wide range of phonemic trill variability. Although the acoustic cues leading to the production of one or another variant are subject to a great deal of dialectal, linguistic, and social variability, what is clear is that the multiple-closure trill is not as commonly produced in naturalistic speech as may have previously been assumed. Importantly, research on the variable nature of the Spanish phonemic trill has yet to extend to dialects of Spanish spoken in Spain. Although Blecua Falgueras (2001) and Lewis (2004) analyzed trill tokens produced by speakers originating from Spain, their data collection methodologies and participant pools were not in line with the research trends established by the most recent series of experimental papers published on trill variation. The current project fills this gap in the literature by conducting an acoustic analysis of phonemic trill tokens produced by 16 speakers of Jerezano Andalusian Spanish. It follows the data collection methodology proposed in Willis (2006; 2007) by analyzing speech data extracted from unscripted narratives designed to elicit multiple tokens of intervocalic phonemic trills. The current study also responds to recent sociolinguistic findings of Lastra & Martín Butragueño (2006) and Díaz-Campos (2008) by obtaining a data sample balanced for speaker sex and age.

3. Method

3.1. Data elicitation

The informants for this current study were 16 natives of Jerez de la Frontera, a coastal city located in the province of Cádiz, Spain. Each speaker was recorded in the dialect location to eliminate

[1] Neither of the two sociolinguistic studies mentioned above reported duration data for phonemic trill tokens. Results of this nature could provide important clues to segmental lenition or fortition.

potential dialectal contact interference. Each speaker participated in a sociolinguistic interview with a native of Jerez de la Frontera to elicit natural conversation prior to narrating the children's picture book story by Mercer Mayer, *Frog, Where Are You?* (1969). Speech data produced in the picture book narrative only were analyzed for the current research study. The picture book story is about a little boy, a dog (*perro* /pé.ro/), and a frog (*rana* /rá.na/). Other potential target words containing Spanish phonemic trills were: jar (*tarro* /tá.ro/); branch (*rama* /rá.ma/); run (*correr* /ko.réɾ/); river (*río* /rí.o/; and land (*tierra* /tjé.ra/). A valid token was defined as being uttered in phrase-internal intervocalic position. Speech data were recorded in August 2007 with a SONY HI-MD MZ-RH1 minidisc recorder and a Shure WH20 head-mounted microphone. Sound files were digitally transferred into .wav format and analyzed with the acoustic analysis software PRAAT (Boersma & Weenink, 2008). A total of 572 phonemic trills were produced by the pool of 16 JAS speakers (35.75 tokens/speaker, average). This corpus of 572 phonemic trill productions was then submitted to acoustic analysis.

3.2. Data analysis

The total duration of each phonemic trill segment was extracted from PRAAT. Additionally, the number of occlusions (where applicable) was recorded for each target production. The acoustic cues leading to the determination of an 'occlusion' were a reduction or cessation of formant structure and reduced waveform amplitude (Martínez Celdrán, 1998). Each token was coded for two linguistic variables: word position (i.e., initial or medial) and stress (stressed syllable or unstressed syllable). Additionally, the age group (i.e., 30-40 years old or 60-70 years old) and sex (i.e., male or female) of each speaker were coded for each target production.

4. Results

4.1. Acoustic results

We begin this section with a summary of the JAS phonemic trill productions based on the general acoustic characterization of the number of occlusions produced per target token.[2] Acoustic analysis of phonemic trill production revealed multiple variants based on the number of closures produced, which ranged from 0 to 5 per token.[3] The total number of tokens extracted as well as percentage data for each variant are provided in Table 1. As for variants corresponding to canonical trill productions (i.e., containing 2 or more taps), these comprised 29.8% (171/572) of the total corpus of phonemic trill productions. An example with three occlusions was shown previously in Figure 1.

Table 1. *Distribution of phonemic trill productions by number of occlusions*

Occlusions	0	1	2	3	4	5	Totals
Tokens (*n*)	149	252	130	33	4	4	572
%	26.0%	44.2%	22.7%	5.7%	0.7%	0.7%	100%

The most commonly occurring phonemic trill variant in the Jerezano corpus contained one visible occlusion and was followed by r-coloring, assibilation, or frication. One-closure trills were produced at a rate of 44.2% (252/572) in the current corpus. An example is shown in Figure 2. As can be seen, the beginning of the trill segment has a clear occlusion in both the wave form and the spectrogram. Between this closure and the following vowel, there is long period of r-colored voicing (in this example, 65ms).

[2] At this point we are not distinguishing between voiced or voiceless variants.

[3] Studies often use the term 'tap' in conjunction with a description of the phonemic trill. For the sake of clarity and to avoid confusion of reference with the phonemic tap, we employ the terms 'closure' or 'occlusion' in reference to the tongue movement in the production of a phonological trill.

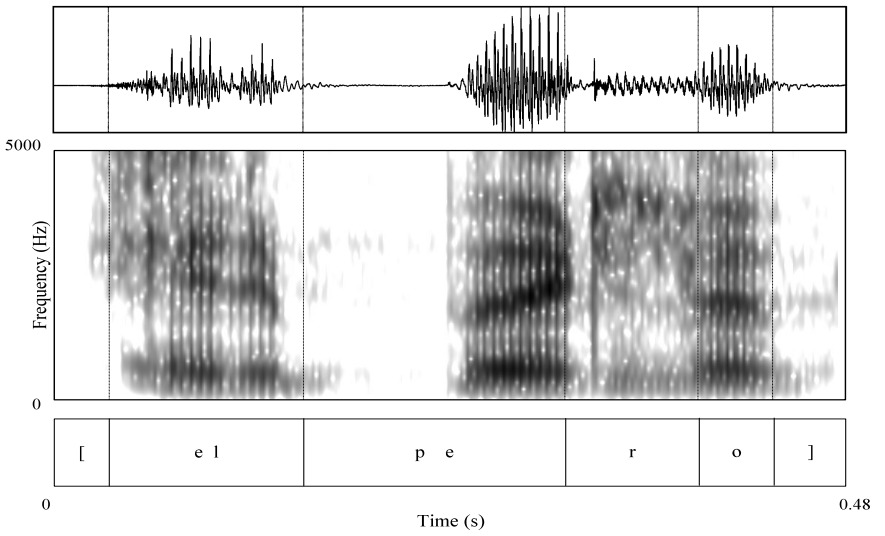

Figure 2: Jerezano phonological trill produced with one-closure and with post closure r-coloring (duration 80ms)

The second most frequently occurring variant in our corpus was the zero-closure variant, produced at a rate of 26.0% (149/572).[4] This variant had several realizations based on voicing and degree of amplitude in the wave form. A typical voiced approximant production is shown in Figure 3, and a voiceless example is shown in Figure 4.[5] The wave form corresponding to the phonological trill in Figure 4 shows minimal amplitude, and there is no voicing bar in the spectrogram.[6]

[4] Díaz-Campos referred to this general description as an approximant trill. What is crucial here is that there was no ballistic or rapid tongue movement as evidenced by a closure or occlusion in the spectrogram or wave form (cf. Ladefoged and Maddieson, 1996).

[5] For the current study, acoustic characterization of each phonemic trill production entailed duration and number of closure measurements only. Spectrograms are provided in this section so that the range of variation can be observed. Characterization of each production based on articulatory terms is left for future research.

[6] Auditorily this token sounds like a velar fricative.

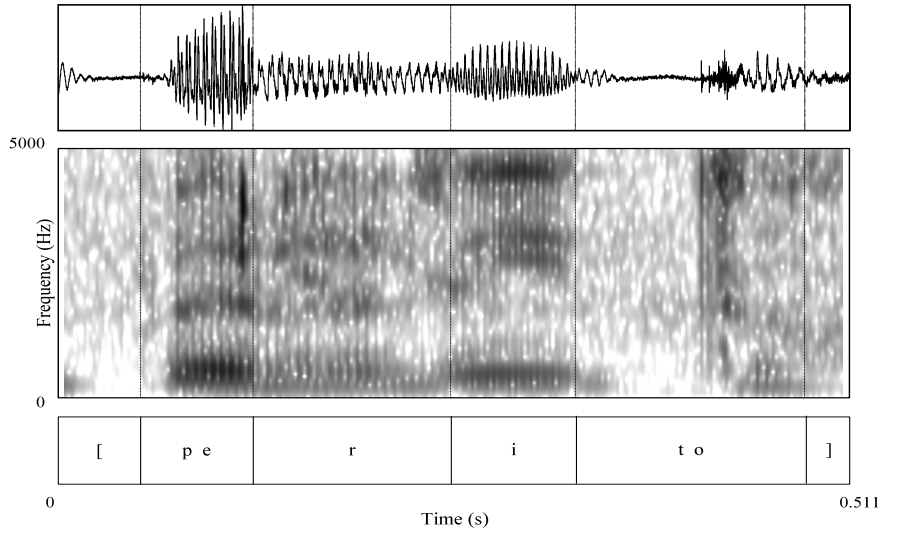

Figure 3: Jerezano phonological trill produced as voiced fricative (duration 126ms)

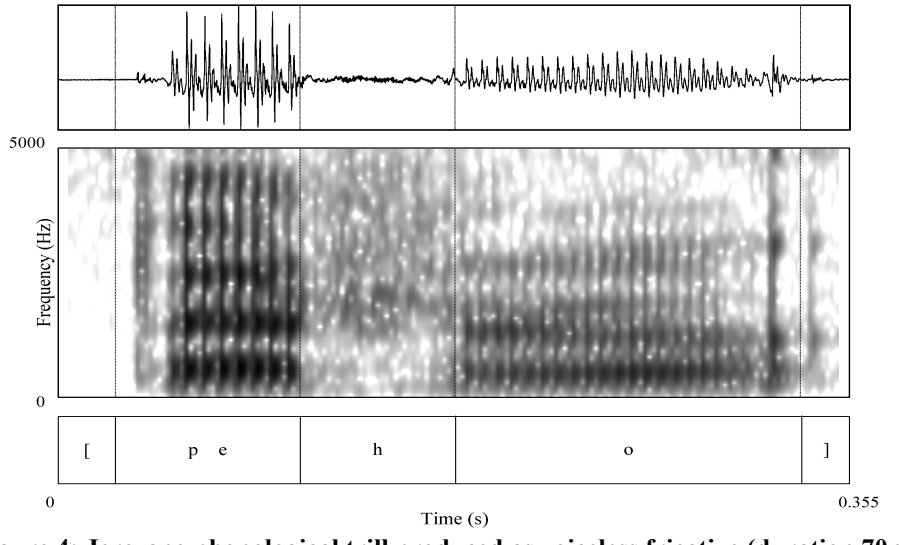

Figure 4: Jerezano phonological trill produced as voiceless fricative (duration 70ms)

The fact that such a large quantity of JAS phonemic trill productions were characterized by either 0 or 1 occlusions calls into question whether or not they are acoustically differentiated from the phonemic tap. Knowing that the duration of the Spanish phonemic tap typically ranges between 20 and 25ms (cf. Martínez Celdrán, 1998; Quilis, 1993), the question that arises, given the data presented in Table 1, is whether JAS trill variants comprised of less than two occlusions are durationally equivalent to the phonemic tap. Duration measurements extracted for each phonemic trill production type are presented in Table 2. As can be seen, one-closure trill productions lasted 66ms on average, and zero-closure productions lasted 71ms on average. Although these averages are somewhat lower than that of the two-closure trill (80ms), they are considerably larger than those known to correspond to the phonemic tap.

Table 2. *Duration measurements for phonemic trill productions by number of occlusions*

Occlusions	0	1	2	3	4	5	Totals
Mean	71ms	66ms	80ms	101ms	115ms	147ms	73ms
SD	24ms	25ms	20ms	23ms	13ms	17ms	26ms

4.2. Linguistic variables

We recall that work by Díaz-Campos (2008) uncovered significant differences for linguistic variables such as word position, number of syllables in a word, and grammatical category on phonemic trill production. Willis (2006; 2007) reported that word-initial trills were 10-14ms longer than word-internal trills in two dialects of Dominican Spanish. The data in Table 3 provide mean and standard deviation results for the number of occlusions and the duration of each phonemic trill in terms of word position. As can be seen, the average number of occlusions was greater in word-medial position than in word-initial position (1.23 to 1.00, respectively). Average duration measurements differed by 1ms between word-medial position and word-initial position (73ms and 74ms, respectively).

Table 3. *Occlusions and duration measurements based on word position*

	Occlusions		Duration		Tokens	
Position	Mean	SD	Mean	SD	*n*	%
Initial	1.00	0.87	74ms	22ms	252/572	44%
Medial	1.23	0.97	73ms	29ms	320/572	56%

The information in Table 4 corresponds to average number of occlusions and average duration measurements for each JAS phonemic trill based on syllable stress. Trills in unstressed syllables contained slightly more occlusions than those in stressed syllables (1.17 to 1.07, respectively). The average duration of stressed syllable trills was slightly longer than that of unstressed syllable trills (75ms to 72ms, respectively).

Table 4. *Occlusions and duration measurements based on stress*

	Occlusions		Duration		Tokens	
Stress	Mean	SD	Mean	SD	*n*	%
Stressed	1.07	.83	75ms	24ms	229/572	40%
Unstressed	1.17	1.00	72ms	28ms	343/572	60%

Next, each token was recoded for the factors *word position* x *stress* to determine the effect of prosodic context: word-initial stressed; word-initial unstressed; word-medial stressed; and word-medial unstressed. The total number of tokens extracted for each of these four contexts as well as the mean number of occlusions and mean duration per context are shown in Table 5. This table also provides the results of ANOVA and post hoc Tukey tests that were conducted. Number of occlusions and duration were separate dependent factors, and prosodic position was the independent factor. The ANOVA results indicated a significant effect of prosodic context ($F(3,568) = 4.60$, $p < .01$) on number of occlusions, and the post hoc Tukey tests revealed that the mean number of occlusions of word-initial unstressed trills (M=0.91) was significantly different from that of word-medial unstressed trills (M=1.28). No statistical difference was found for the effect of prosodic position on duration.

Table 5. *Occlusion and duration measurements based on word position and stress*

	Occlusions		Duration		Tokens	
Position	Mean	SD	Mean	SD	*n*	%
Initial stressed	1.07	0.92	76ms	24ms	146/572	25.5%
Initial unstressed	0.91	0.80	71ms	19ms	106/572	18.5%
Medial stressed	1.05	0.52	74ms	22ms	83/572	14.5%
Medial unstressed	1.28	1.05	73ms	31ms	237/572	41.5%

Note. ANOVA [occlusions]: ($F(3,568) = 4.60$, $p < .01$); Tukey (initial unstressed - medial unstressed): $p < .01$. ANOVA [duration]: ($F(3,568) = 1.09$, $p > .05$).

4.3. Social variables

The JAS participant group was divided equally among age and speaker sex. In terms of age, 8 speakers were between 30 and 40 years old, and 8 speakers were between 60 and 70 years old. In terms of sex, 8 speakers were male, and 8 speakers were female. Keeping in mind that social variables have been suggested to favor phonemic trill variation in other dialects of Spanish (cf. Díaz-Campos, 2008; Lastra & Martín Butragueño, 2006), we provide token distribution results based on age group and sex in the tables below. Table 6 reports mean and standard deviation results for occlusions and duration based on the two age groups. The total number of tokens produced by speakers of each group is also given there. As can be seen, the younger speakers were shown to produce a mean of 1.22 occlusions per phonemic trill, and the older speakers were shown to produce the trill with less occlusions overall, or 1.04 per token. In terms of phonemic trill duration, the older speakers produced longer trills than the younger speakers (76ms to 70ms, respectively).

Table 6. *Occlusions and duration measurements based on age group*

	Occlusions		Duration		Tokens	
Age	Mean	SD	Mean	SD	*n*	%
30-40 yrs.	1.22	0.89	70ms	26ms	286/572	50%
60-70 yrs.	1.04	0.97	76ms	26ms	286/572	50%

The second social variable that this study sought to examine was speaker sex. Table 7 presents mean and standard deviation information for each speaker sex group in terms of occlusions produced and duration. The total number of tokens produced by each speaker group is also given there. Results indicate that females produced slightly more occlusions than males per phonemic trill production (1.21 to 1.05, respectively). Duration measurements, however, were nearly identical (73ms females; 74ms males).

Table 7. *Occlusions and duration measurements based on speaker sex*

	Occlusions		Duration		Tokens	
Sex	Mean	SD	Mean	SD	*n*	%
Male	1.05	0.89	74ms	25ms	282/572	49%
Female	1.21	0.98	73ms	27ms	290/572	51%

Finally, a speaker-by-speaker analysis of average occlusions and duration measurements is provided in Table 8. In terms of occlusions produced, the younger males yielded the highest average (M=1.33), followed by the older females (M=1.30), the younger females (M=1.10), and finally older males, who yielded the lowest average (M=0.74). Interestingly, no older male averaged more than 1.0 occlusions across his sample of phonemic trill tokens. In terms of duration, the younger females produced the shortest phonemic trills overall (M=63ms). The older females produced the longest trills overall (M=82ms), but this higher average may be due to the fact that one speaker (15F) produced an average 2.89 closures per trill, leading to longer duration results as well. The average trill duration for the younger males was 77ms, and the average trill duration for the older males was 70ms. In order to determine the effects of speaker age and sex on number of occlusions produced, an ANOVA test and post hoc Tukey tests were conducted. Number of occlusions and duration were separate dependent factors, and *age* x *sex* subgroup (i.e., younger males, older males, younger females, older females) was the independent factor. The ANOVA results indicated that there was a significant effect of *age* x *sex* subgroup on number of occlusions ($F(3,568) = 73.36$, $p < .001$), and the post hoc Tukey tests revealed three statistically significant pair wise comparisons. Specifically, the older male subgroup was significantly different from each of the other subgroups. Lastly, no effect was found on trill duration.

Table 8. *Average occlusion and duration measurements for all speakers*

Age	30-40 yrs.			60-70 yrs.		
Sex	Speaker	Occlusions	Duration	Speaker	Occlusions	Duration
Males	1M	1.61	72ms	5M	0.31	71ms
	2M	1.56	78ms	6M	0.82	63ms
	3M	0.48	69ms	7M	0.80	65ms
	4M	1.89	91ms	8M	0.94	81ms
	Average	1.33	77ms	Average	0.74	70ms
Females	9F	0.97	70ms	13F	0.79	61ms
	10F	1.59	59ms	14F	0.71	98ms
	11F	1.10	55ms	15F	2.89	102ms
	12F	0.88	70ms	16F	1.18	81ms
	Average	1.10	63ms	Average	1.30	82ms

Note. ANOVA [occlusions]: $F(3,568) = 73.36$, $p < .001$; Tukey (older males - younger males): $p < .01$; (older males - younger females): $p < .01$; (older males - older females): $p < .01$. ANOVA [duration]: $F(3,568) = 1.36$, $p > .05$.

5. Discussion

This study sought to provide an acoustic investigation of phonemic trill production in unscripted speech samples of speakers of the variety of Spanish spoken in Andalusia, Spain. Variation in trill production was shown to be conditioned by a number of linguistic and social variables, and the acoustic findings have implications for phonetics, phonology, dialectal studies, and sociolinguistics. We recall that previous experimental research on phonemic trill production and variation had not investigated the realization of the trill in the variety of Spanish spoken in Andalusia, Spain, and that of the work conducted on speakers of northern varieties of Peninsular Spanish, the overwhelming majority of variants produced by such speakers contained two or more closures (cf. Blecua Falgueras, 2001; Martínez Celdrán & Rallo, 1995; Quilis, 1993). Before we begin our discussion of the empirical results of the current study, it is important to highlight a number of differences between our research design and those previously cited. Previous research has typically focused on an acoustic (Blecua Falgueras, 1999, 2001; Lewis, 2004), articulatory (Recasens, 1991) or aerodynamic (Solé, 2002) understanding of the trill as a segment. The current study, however, sought to understand phonemic trill production representative of normal usage, as understood within a variationist framework. Speech data for the current study were elicited in an unscripted picture book narration task, and speakers were recorded within the dialect region by a native speaker of the dialect. While exact comparability across studies is impractical due to differences in task design, participant pool, and region of origin, we use Blecua Falgueras (2001), Martínez Celdrán & Rallo (1995), and Quilis (1993) as reference points for Peninsular and/or Andalusian Spanish trill norms, since they provide, to the best of our knowledge, the most accessible experimental research on phonemic trill production by speakers of Spain. Keeping this in mind, we note that the range of variability in trill production uncovered in the current paper is considerably greater than what was reported in the above-cited studies, due in great part to the distinct set of research goals that motivated each research project.[7] We feel that our larger participant pool, comprised of speakers from the same region participating in unscripted narratives, more appropriately allows for an examination of the full range of variation of trill production in a particular dialect area, and thereby strengthens the claims and application of the claims.

[7] We note that Blecua Falgueras (1999) also examined unscripted speech with two speakers. Her findings indicate more variation than found in her controlled laboratory data from (2001).

5.1. Phonetic and phonological implications

On the phonetic level and regarding the acoustic findings, examination of each token revealed that the two most frequent variants were a one-closure trill (44.2%) and a zero-closure trill (26.0%). Prescriptive trill variants (i.e., those with two or more occlusions) occurred in 29.8% (171/572) of the total set of tokens. The prescriptive variants were further divided into those with two occlusions (22.6%) and those with three or more occlusions (7.2%). Díaz-Campos (2008) reported similar findings for canonical trill productions in Venezuelan Spanish, that is, that approximately one-third of the analyzed tokens contained two or more closures. In terms of the effects of linguistic variables on phonemic trill production, average number of occlusions was shown to be greater in word-medial position than in word-initial position (1.23 to 1.00, respectively). As for the influence of word position on duration, the results of the JAS corpus did contrast with those of Willis (2006; 2007), where word-initial trills were found to be 12-14ms longer than word-medial trills. Follow-up analysis on *word* x *stress* position revealed that word-medial unstressed trills (i.e., *pé**rr**o* 'dog', *tá**rr**o* 'jar') contained significantly more closures than word-initial unstressed trills (i.e., ***r**aníta* 'little frog', ***r**iachuélo* 'stream'), implying that the most normative-like (i.e., multiple-closure) trills were dispreferred in the stressed syllable typically associated with increased articulatory effort.

The findings of the current study indicate that the canonical two-closure trill is considerably less common than had previously been claimed in prescriptive sources such as the Real Academia Española (1992). Phonologically, the fact that such a large quantity of target tokens was comprised of either one-closure or zero-closure trills brings into question whether the phonemic tap-trill distinction is neutralized in this dialect. Although occlusion measurements were not taken for phonemic taps in the JAS corpus, average duration measurements for zero-closure trills and one-closure trills (71ms and 66ms, respectively) were considerably greater than what has been reported for phonemic taps (20ms; cf. Martínez Celdrán & Rallo, 1995; Quilis, 1993; Willis & Bradley, 2008), implying that tap-trill rhotic neutralization is not prevalent in the JAS dialect (cf. Hammond 1999; 2000). The phonemic distinction between the Spanish tap and the Spanish trill has been argued to hold in terms of segmental duration elsewhere, despite non-canonical trill productions (Willis & Bradley, 2008). The data extracted from the current corpus have similar implications, since contrast is maintained through durational means when the normative distinction between single and multiple occlusions does not operate.

The notion that the tap-trill contrast is robust in the JAS corpus was further corroborated by follow-up spectrographic inspection of each trill token. Specifically, it was shown that the portion of trill variants not corresponding to lingual occlusion included moments of frication, assibilation, approximantization, or r-coloring. Lastly, although the current study was not designed to test phonological claims concerning the Spanish trill, i.e., claims of the trill as a geminate (cf. Baković, 2009; Núñez Cedeño, 1994), the JAS data pose the same theoretical challenge as discussed recently by Willis (2007). That is, two-part trills occur in word-initial position and are produced with variants that include one or multiple closures plus additional r-coloring, rendering the proposed syllabic association of each component unclear.

5.2. Dialectal and sociolinguistic implications

Dialectal studies of Spanish have tended to focus on the realization of a particular segment as representative of a given dialect (e.g., production of voiceless interdental fricative /θ/ in many areas of Spain). However, Blecua Falgueras (1999) concludes her study of the spontaneous speech of two speakers by noting that different productions were often attested within the same phonological context. In our data no single non-canonical variant could be selected as the prototypical JAS variant, and in most cases, variation in production related to idiosyncratic differences. A remarkable amount of individual variation was found (even among speakers of the same age and/or sex), with some speakers producing mostly trills and other speakers, instead, providing almost no instances of this articulation. Willis (2006) reported a similar distribution for trill variants extracted from a corpus of Santo Domingo Dominican Spanish speakers. The situation is thus reminiscent of English /r/, where variation at the level of the individual speaker is known to be very important (Boyce & Espy-Wilson,

1997; Zhou, Espy-Wilson, Boyce, Tiede, Holland & Choe, 2008). As in the case of American English, a question that arises is the extent to which speech signals that are articulatorily, and even acoustically, very different may in fact produce very similar auditory effects. Establishing this point would require a perception-based experimental design, which we leave open to investigation in future research. Clearly, though, no single rhotic variant predominated in the JAS corpus, and characterization of the JAS trill is best achieved by acknowledging a multiplicity of productions.

Variation in trill production was conditioned in part by two social variables. Age and speaker sex were shown to correlate with the realization of /r/ in terms of number of closures produced. Post hoc Tukey tests revealed that the average number of occlusions for the older male subgroup was significantly different from those of the other *age* x *sex* subgroups. In fact, each older male speaker averaged fewer than 1.00 occlusions per trill token across his speech sample, a generalization that did not hold for any other subgroup. These findings suggest that older JAS males are least expected to produce canonical multiple-closure trills. Sociolinguistic connections can also be made between the findings of this study and those of Lastra & Martín Butragueño (2006) and Díaz-Campos (2008). In particular, Lastra & Martín Butragueño (2006) reported that Mexican youth preferred a standard multiple-closure trill, a move away from the typical assibilated variants of central Mexico as first documented in Matluck (1951). Díaz-Campos (2008), however, reported that younger generation speakers preferred innovative forms (labeled as 'approximants') more than older generation speakers. In both the Mexico City and Caraqueño dialects, younger speakers were shown to shift from older speaker norms in terms of trill production.[8] In the case of the Mexican youth, this change was away from a stereotypical and long-standing pattern of /r/ assibilation. In the current dialect of Jerezano Spanish, as well as for the Caracas Venezuela dialect, we lack documentation of earlier trill variants. Nevertheless, the pattern that emerges from these three studies is that younger generation speakers prefer phonemic trill variants distinct from those of older generation speakers. This point is corroborated by recent sociolinguistic work on Jerezano Spanish indicating that younger generation speakers show deviations from phones favored by older generation speakers in terms of categorical ceceo production (García-Amaya, 2008). The preference for a trill variant that is different from that of older generation speakers in the current study suggests that the Jerezano trill is likewise conditioned by perceived prestige. This claim will need to be corroborated with additional research.

6. Conclusion

The goal of this paper was to examine the extent to which the articulation of the trill is subject to variation in unscripted speech samples taken from 16 native speakers of Andalusian Spanish. Our speakers were from Jerez, Andalusia, Spain, an area where no dialectally remarkable production of the trill had been reported prior to this research study. Our acoustic analysis was based on speech data obtained from 16 speakers of both sexes and a wide age spectrum. We analyzed a total of 572 tokens corresponding to the phonemic trill in intervocalic word-initial and word-medial positions. Results indicated that approximately 30% of all phonemic trill productions included two or more apical closures, and that the remainder of the corpus was distributed among fricatives, approximants, and r-colored variants. No single non-canonical variant could be selected as the prototypical JAS variant, a distribution reminiscent of that of English /r/, where variation at the level of the individual speaker has been well-documented. Examination of the linguistic variables underlying trill variation revealed an effect for prosodic position, and in particular, that the number of occlusions produced in word-medial unstressed trills was significantly greater than that of word-initial unstressed trills. In terms of social variability, older generation males were shown to produce the least number of closures per phonemic trill production. Although the full extent of the sociolinguistic implications was left for future research, important connections were made to recent work on socially-motivated trill variation in other dialects of Spanish. In sum, what has become increasingly clear, given the findings of the current investigation, is that trill variation may be considerably more complex than had previously been

[8] Almeida & Dorta (1993) report similar patterns of trill reduction for both old and young speakers, while speakers between 36 and 55 years of age showed less weakening (p. 109).

imagined for the variety of Spanish spoken in Andalusia, Spain. In this regard, the full extent of trill variation throughout the Spanish-speaking world remains largely unexplored, and until more research is carried out, the complex of factors that underlie this variability remains to be uncovered.

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