Correlating Speech Rhythm in Spanish: Evidence from Two Peruvian Dialects

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1. Introduction

The categorizations of stress-timed, syllable-timed and mora-timed have been used to differentiate between languages according to the domain used in assigning rhythmic patterns in speech. In this view, duration is relatively equal between stresses in stress-timed languages, between syllables in syllable-time languages, and between morae in mora-timed languages (Pike 1946, Abercrombie 1967, Ladefoged 1975). A prediction stemming from this proposed isochrony is that the duration between stresses in syllable-timed languages would be longer with the addition of more unstressed syllables. However, as summarized in Dauer (1983) and Grabe and Low (2002), phonetic research on several languages has not upheld this hypothesis, while others describe the presence of isochronous units as a tendency. Nonetheless, given that speakers often intuitively describe alternate rhythms when comparing languages and dialects, research has continued to examine the acoustic signal to determine the extent to which these rhythmic distinctions may still be perceptually real.

In the study by Ramus, Nespor and Mehler (1999) a cross-linguistic analysis of eight languages was conducted in order to observe rhythmic differences by exploiting the simple distinction between vocalic and non-vocalic sequences used in infant speech perception of contrasting rhythms. That is, the duration of vocalic versus consonantal intervals was measured. As noted in Dauer (1983), at least three factors may contribute to the perception of distinct rhythms: the structure of the syllable, the reduction of vowels, and how stress is realized phonetically. Accordingly, one prediction that can be made is that a more complex syllable structure in conjunction with shorter, reduced unstressed vowels, as is typical of stress-timed languages, will result in both a lower vowel/consonant ratio and also a higher variability of consonantal durations than syllable and mora-timed languages. The results of the Ramus et al. study showed that the acoustic measures of percentage of vocalic sequences (%V) and consonantal variability (ΔC) did coincide with traditional rhythm categorizations: languages typically described as stress-timed, such as English and Dutch, grouped separately from typical syllable-timed languages, such as Spanish and French, and mora-timed languages, such as Japanese. Specifically, the %V increased from stress to syllable to mora-timed languages while the ΔC decreased.

Subsequent research by Frota and Vigário (2001) on European and Brazilian Portuguese provides evidence for the possibility of mixed-rhythm classes which do not fall into the groupings previously described nor along a continuum between those groupings. Their study showed that European Portuguese demonstrates stress-timed qualities in terms of consonantal variability but syllable-timed properties according to the percentage of vocalic sequences compared to total sentence duration. Likewise, Brazilian Portuguese also showed another combination of mixed timing features: along the consonantal dimension, Brazilian Portuguese was more similar to other syllable-timed Romance languages but along the vocalic dimension it was more similar to mora-timed languages such as Japanese. These findings are described as consistent with characterizations of European and Brazilian Portuguese, the former having reduced vowels in unstressed position and the latter showing a tendency to simplify consonant clusters through epenthesis. In addition, the work on these Portuguese varieties

 Selected Proceedings of the 10th Hispanic Linguistics Symposium, ed. Joyce Bruhn de Garavito and Elena Valenzuela, 276-287. Somerville, MA: Cascadilla Proceedings Project.

underscores the importance of incorporating more than one variable (such as %V) into the analysis of rhythm in order to be able to observe alternate rhythm possibilities, such as either mixed rhythms or additional rhythm classes.

Recent research has continued to examine the acoustic string in order to compare differences in rhythm patterns among languages, such as Bulgarian, German and Italian (Barry et al. 2003), Russian and Latvian (Bond et al. 2003), as well as in cross-dialectal studies, for example British and Singapore English (Ling et al. 2000), Taiwan and American English (Jian 2004), and Eastern and Western varieties of Arabic (Ghazali et al. 2002). Grabe and Low (2002) also examined the durational differences of eighteen languages in order to compare stress, syllable and mora-timed languages with those that are unclassified according to rhythm. They observed degrees of rhythm timing which were either more stress-timed or more syllable-timed, giving support to a 'weak categorical distinction' between rhythm classes.

As previously noted, Spanish has been described as a syllable-timed language (Pike 1946, among others). However, little is currently known about cross-dialectal differences in the rhythm of Spanish. What needs to be examined is whether or not other varieties of Spanish also demonstrate the same or similar features of syllable timing in both consonantal and vocalic features as appears in Ramus et al. (1999) or if some varieties have become distinctively different as was shown for European and Brazilian Portuguese in Frota and Vigário (2001). Therefore, two regional varieties of Peruvian Spanish have been selected for cross-comparison with each other and with findings in the literature. First, Lima Spanish has been chosen since some dialect features such as /s/-aspiration and deletion would potentially predict a different overall vocalic ratio as well as provide greater consonantal variability (Caravedo 1983, Escobar 1978). Second, Spanish as spoken in Cuzco has been analyzed since Andean Spanish has been described as often showing unstressed vowel reduction, thus decreasing the overall vocalic ratio. In addition, /s/ is maintained in Cuzco Spanish, which will provide contrast with the Lima variety (Escobar 1978, Lipski 1990). Also, since Quechua and Spanish have historically been in contact in Cuzco, data from Cuzco native Spanish speakers and bilingual Quechua-Spanish speakers will be analyzed in order to determine if alternate rhythms may have developed through contact.[1]

In a broader context, the purpose of this study is to determine if features present in the acoustic signal related to vowel and consonant durations for Peruvian Spanish varieties coincide with existing rhythm classes, or if they support a continuum between classes or alternate rhythm classes (as mixed or additional class types). By knowing the types of rhythm found, the way in which rhythm is acquired and interacts with other languages and varieties in contact can be better understood, whether the process involves changing to another rhythm class or if it involves moving along a gradient scale of timing of phonetic segments. A second goal of this paper is to highlight a methodological approach which may provide greater comparability between past and future studies on the speech rhythm of Spanish as well as in the cross-comparison of rhythm in other languages.

The remainder of the paper is structured as follows: section 2 gives a description of the experimental procedures employed; section 3 includes a presentation of the results; section 4 offers an analysis and discussion of these results; and section 5 provides a summary of the findings.

2. Experimental Procedures

2.1. Materials

The current data are drawn from a set of recordings of utterances read by Peruvian Spanish speakers which were collected in order to examine the type of intonation contours found in

[1] While beyond the scope of the current study, also relevant to this discussion is a description of rhythm in Cuzco Quechua using the same framework of analysis. At present, Quechua has been described according to syllable structure and stress assignment but not specified as belonging to one rhythm class or an other (Cerrón-Palomino 1987: 256-261): Quechua maximally can have one consonant in onset and coda position, although the percentage of CVC, CV, VC, and V is not given; also, stress is columnar, falling on the penultimate syllable in Cuzco Quechua, and therefore not phonemic, with few exceptions.

declaratives and questions (O'Rourke 2005). The declaratives are examined here since they are short, neutral utterances which were produced without focus on any one particular item, similar to the news-like declaratives described in previous studies on rhythm (e.g., Frota & Vigário (2001), Ramus et al. (1999)). Each target utterance follows an SVO word order with three content words within each sentence (e.g., *Su madre admira la lana.* 'Her mother admires the wool' where the stressed syllable of each content word is underlined). While the noun in the subject NP, the verb and the noun in the object NP receive sentence-level prominence, the function words (e.g., *Su* 'Her' and *la* 'the') do not.

There were twelve target declaratives that contained between 9-13 syllables per sentence, or 16-27 intervals of alternating consonant and vowel sequences. Each set of target utterances was read twice, giving 24 declarative productions per speaker (see Appendix). These data will be compared to Ramus et al.'s (1999) findings on 5 sentences with 4 repetitions (20 sentences total) produced by four speakers from each of eight languages considered, including Spanish, and Frota and Vigário's (2001) findings on European and Brazilian Portuguese with 2-4 speakers and 10-20 sentences with two repetitions (20-40 sentences total) depending on the corpus considered.

2.2. Speakers

Three groups of Peruvian Spanish speakers are considered for this analysis of rhythm. The first group includes three native Spanish speakers from Lima who did not report knowledge of Quechua and whose parents were also from Lima (termed L_NSS). The second group consists of three native Spanish speakers from Cuzco who grew up speaking only Spanish (termed C_NSS). The third group was made up of three speakers who were also from Cuzco but who reported speaking both Quechua and Spanish during childhood and considered themselves to be bilingual as adults (termed C_NQSS or "Native Quechua-Spanish speakers"). All participants from both Lima and Cuzco were male speakers, ages 18-39, who had completed or were enrolled in post-secondary education at the time of the study.

2.3. Measurements and Calculations

The measurement of consonantal and vocalic intervals follows that described in Ramus et al. (1999), among others. That is, adjacent vowels are considered part of one vocalic sequence; likewise, adjacent consonants are considered part of a single consonantal sequence regardless of the syllable in which they occur. This examination is based on the premise that speech rhythm is perceived beginning with infants according to vowel sequence duration and the interruption thereof (see Ramus et al. 1999 for discussion). An example of this division using a target sentence from this data set is shown in (1):

(1)	*Su madre admira la lana.*	/s/ /u/ /m/ /a/ /dr/ /ea/ /dm/ /i/ /r/ /a/ /l/ /a/ /l/ /a/ /n/ /a/.
	"Her mother admires the wool".	C V C V C V C V C V C V C V C V

Segmentation was carried out by examining the wave form and spectrogram with the use of the *Praat* speech analysis software (Boersma & Weenink 1992-2008). In keeping with previous studies (Ramus et al. 1999; Frota & Vigário 2001), the first element of rising diphthongs was grouped with the preceding consonant as part of the syllable onset (e.g., *fa.mi.lia* "family" /f/ /a/ /m/ /i/ /lj/ /a/). Conversely, although not present in this data set, the second element of falling diphthongs would be grouped with the previous vowel (e.g., *deu.da* "debt" /d/ /ew/ /d/ /a/).[2]

The percentage of vocalic sequences (%V) was derived from the total duration of vocalic sequences divided by the total duration of the utterance. The standard deviation of vocalic sequence durations (ΔV) and consonantal sequence durations (ΔC) was also calculated. However, in order to maximize the possibility of comparison between sentence productions and between speakers, the

[2] This segmentation procedure was applied to allow for maximum comparability between the current study and data in Ramus et al. (1999) and Frota and Vigário (2001). However, it should be noted that in other research on rhythm, such as in Grabe and Low (2002), glides both before and after the vowel were generally included with the vowel due to the continuous nature of the formant transitions between the glide and the vowel.

normalized ΔV and ΔC were calculated ($\Delta\%V$ and $\Delta\%C$) by first calculating the ratio of each vocalic sequence compared to the total sentence duration and then computing the standard deviation of these percentage values (as done also by Frota and Vigário (2001)). [3]

An additional consideration not previously discussed in the literature has been employed in the use of this data set: the ratio of vocalic and consonantal sequences is noted. Specifically, the number of vocalic and consonantal sequences may be even, or there may be more of one or the other. As will be demonstrated, this difference may introduce variation in %V and other calculations across sentence items. A hypothetical example in which all vocalic and consonantal sequences are of equal duration may illustrate this point: one may predict that a sentence with 5 vocalic sequences and 5 consonantal sequences would produce a %V value of 50%. However, 4 vocalic sequences and 6 consonantal sequences would produce a %V value of 40%, and so on. Therefore, the number of vocalic and consonantal sequences produced by each speaker is noted. Even numbers of V and C sequences are grouped as V, C; sentences with one more vocalic segment than consonantal segments are grouped as V+1, C; sentences with one more consonantal segment than vocalic ones are grouped as V, C+1. The majority of target utterances fall into the even category (V, C n:7x2=14), two fall into having more vocalic sequences (V+1, C n:2x2=4), and three have more consonantal sequences (V, C+1 n:3x2=6).

Although the total number of target utterances for each speaker is 24, the actual number that was measured and included in subsequent calculations was fewer due to the following. As in Frota and Vigário (2001), the unit of rhythm was considered to be the intonation phase. Therefore, those productions which included disfluencies, such as the insertion of pauses, led to the removal of that utterance from further analysis. The number of utterances analyzed per speaker per type is included in Table 1. To distinguish between Cuzco speakers, the native Spanish speakers (NSS) are numbered C01, C02, C03, while the native Quechua-Spanish bilingual speakers (NQSS) are labeled C21, C22, C23. In some cases in which the target utterance has an even number of vocalic and consonantal sequences, speakers may have produced more consonantal sequences than vocalic ones if, for example, the final vowel was not pronounced.[4] A total of 175 utterances have been measured, including 97 utterances with an even amount of V, C sequences. The results of these measurements are discussed in the following section.

Table 1. Total number of utterances analyzed per speaker grouped according the ratio of vocalic to consonantal sequences.

Speaker	*V+1, C*	*V, C*	*V, C+1*	*Total*
L01_NSS	4	14	6	24
L02_NSS	3	10	6	19
L03_NSS	3	8	2	13
C01_NSS	3	11	7	21
C02_NSS	4	13	4	21
C03_NSS	4	13	6	23
C21_NQSS	3	5	7	15
C22_NQSS	3	12	5	20
C23_NQSS	3	11	5	19
TOTAL	30	97	48	175

[3] The present study has employed the calculations described above as a starting point for comparison of Peruvian Spanish varieties with the previous studies mentioned. However, other analyses may provide further insight into rhythmic differences such as calculation of a *Pairwise Variability Index* (PVI), which takes into account local differences in variation between successive intervals, as used in Asu and Nolan (2005), Barry et al. (2003), and Grabe and Low (2002). See Ramus (2002) for a comparison of the PVI with the %V, ΔC and ΔV calculations.

[4] Conversely, if a consonant is not produced (such as with /s/ deletion), then the relationship between vowels and consonants would shift also, e.g., from V, C+1 (more consonant than vowel sequences) to V, C (an even number of each).

2.4. Predictions

In terms of differences between dialects, predictions can be made for the two Peruvian Spanish varieties under consideration. Lima Spanish, which is characterized by /s/ aspiration and deletion syllable and word-finally, may be expected to have greater vocalic durations (%V) than Cuzco Spanish since fewer consonants will increase the overall vocalic versus consonant ratio. In addition, unstressed vowel reduction present in Andean Spanish may contribute to a greater vocalic deviation (ΔV), and to an increase in consonant clusters, thus a greater variability in consonantal variation (ΔC), as summarized in (2)[5]:

(2)	Lima Spanish		Cuzco Spanish Varieties
	ΔC	<	ΔC
	%V	>	%V
	ΔV	<	ΔV

3. Results

An overview of the results for the analysis of rhythm is presented in Table 2 below, divided according to speaker. For maximum comparison with data found in the literature, values for %V, Δ%C, Δ%V, ΔV, ΔC are given. Several initial observations can be made regarding these results. First, the Lima native Spanish speakers show a higher percentage of vocalic interval durations (an average of 54.2%) compared to Cuzco native Spanish speakers (49.6%) and Cuzco bilinguals (49.3%). Also, Cuzco speakers do not appear to behave differently according to knowledge of Quechua in this measure. Likewise, the normalized standard deviation of %V (Δ%V) is higher for the Lima group (2.1 on average) compared to the Cuzco native Spanish speaking and bilingual groups (1.5 and 1.6). Therefore, Lima speakers show longer overall vocalic durations. Yet, contrary to the prediction, more variation of vocalic durations was observed than in either of the Cuzco groups. Other factors may contribute to the higher vocalic variation for Lima, such as how stress is realized, possibly with greater lengthening of stressed syllables that found in Cuzco. In addition, vowel reduction in Cuzco may not be a strong contributing factor in this corpus of read speech. The reverse is true for consonantal intervals (Δ%C) with less variation being observed for the Lima group (2.4) compared to the Cuzco native Spanish speakers (2.9) and Cuzco Quechua-Spanish bilinguals (2.7).

The results in Table 3 are divided according to the ratio of vocalic to consonantal intervals: one additional vocalic interval (V+1, C), an even number of intervals (V, C), and one additional consonantal interval (V, C+1). As expected, the division according to the ratio of intervals in Figure 1 below shows a trend in the data: when there are greater vocalic intervals, the %V is higher than when there is an even number, which is still higher than when there is one less vocalic interval, i.e., one more consonantal interval. This calculation demonstrates that the ratio of intervals should be taken into consideration when analyzing speech rhythm according to a vocalic versus non-vocalic measurement. Including this factor in data calculations may facilitate the comparison of findings across research studies and across languages.

Differences in the standard deviation of consonantal and vocalic intervals can be observed for individual speakers in Figure 2 and for groups of speakers in Figure 3.[6] Greater consonantal variation is found for all speakers, although Lima speakers show the least amount of difference between consonantal and vocalic variation. In this way, the Lima group is similar to Ramus et al.'s previous findings for French, Italian and Catalan. Both Cuzco groups, on the other hand, show a greater

[5] As noted by an anonymous reviewer, the actual realization of these processes may be less frequent in read speech compared with semi-spontaneous conversation. Therefore, any observed differences may be accentuated in more natural speech contexts.

[6] Note that since the weighted averages included in Table 4 are nearly identical to the overall average for each speakers, and since the values for sentences with an even number of vocalic and consonantal intervals is very close to the overall average and weighted averages, the graphs are made using the overall average.

difference between consonantal and vocalic variation than previously observed for Spanish or European Portuguese. A comparison of standard deviations of %V and %C normalized for differences in overall sentence duration was also conducted with the Portuguese data, as seen in Figure 4 below. The greatest degree of difference is found for the Cuzco native Spanish group followed by the Quechua-Spanish bilingual group. The Lima group shows fewer differences than either Cuzco group and fewer than European Portuguese, although the relationship is still that of greater consonantal variation rather than the reverse seen for Brazilian Portuguese.

Table 2. Measure of %V, Δ%C, Δ%V, ΔC and ΔV according to individuals within groups

Speaker	*N*	*%V*		*Δ%C*		*Δ%V*		*ΔC*		*ΔV*	
L_NSS											
ALL	**56**	**54.2**	**(6.15)**	**2.4**	**(0.60)**	**2.1**	**(1.04)**	**36.7**	**(9.74)**	**31.7**	**(14.80)**
L01_NSS	24	57.0	(5.05)	2.1	(0.41)	1.8	(0.59)	33.0	(6.51)	28.5	(7.82)
L02_NSS	19	51.9	(6.81)	2.6	(0.68)	2.3	(1.32)	38.7	(10.59)	34.4	(18.65)
L03_NSS	13	53.6	(6.59)	2.5	(0.71)	2.1	(1.22)	38.3	(12.12)	32.2	(17.92)
C_NSS											
ALL	**65**	**49.6**	**(5.13)**	**2.9**	**(0.94)**	**1.5**	**(0.38)**	**45.0**	**(14.12)**	**23.8**	**(6.21)**
C01_NSS	21	49.3	(4.64)	2.7	(0.84)	1.2	(0.24)	38.1	(11.31)	17.8	(4.28)
C02_NSS	21	49.3	(5.32)	3.0	(0.96)	1.6	(0.43)	49.7	(15.41)	26.4	(7.28)
C03_NSS	23	50.4	(5.44)	3.0	(1.02)	1.7	(0.47)	47.3	(15.65)	27.3	(7.07)
C_NQSS											
ALL	**54**	**49.3**	**(6.11)**	**2.7**	**(0.96)**	**1.6**	**(0.52)**	**44.0**	**(15.23)**	**25.6**	**(7.81)**
C21_NQSS	15	51.3	(6.17)	2.5	(1.00)	1.6	(0.46)	38.5	(13.70)	25.4	(5.29)
C22_NQSS	20	48.4	(5.20)	2.6	(0.66)	1.7	(0.73)	46.0	(12.03)	30.2	(13.08)
C23_NQSS	19	48.2	(6.95)	2.9	(1.21)	1.3	(0.38)	47.5	(19.96)	21.2	(5.08)
AVG		49.3	(6.11)	2.7	(0.96)	1.6	(0.52)	44.0	(15.23)	25.6	(7.81)

Table 3. Measure of %V, Δ%C, Δ%V, ΔC and ΔV according to interval ratio within groups

Speaker	*N*	*%V*		*Δ%C*		*Δ%V*		*ΔC*		*ΔV*	
L_NSS											
ALL	**56**	**54.2**	**(6.15)**	**2.4**	**(0.60)**	**2.1**	**(1.04)**	**36.7**	**(9.74)**	**31.7**	**(14.80)**
Weighted Avg		*57.1*	*(4.95)*	*2.4*	*(0.52)*	*2.1*	*(0.85)*	*36.34*	*(8.10)*	*31.6*	*(12.60)*
V+1, C	10	60.1	(5.38)	2.3	(0.53)	2.4	(1.29)	35.0	(11.27)	33.5	(17.20)
V, C	32	57.6	(4.32)	2.4	(0.56)	2.3	(1.00)	36.6	(8.15)	34.3	(14.78)
V, C+1	14	53.7	(6.10)	2.3	(0.44)	1.3	(0.20)	36.7	(5.74)	24.0	(4.32)
C_NSS											
ALL	**65**	**49.6**	**(5.13)**	**2.9**	**(0.94)**	**1.5**	**(0.38)**	**45.0**	**(14.12)**	**23.8**	**(6.21)**
Weighted Avg		*49.6*	*(3.90)*	*2.9*	*(0.89)*	*1.5*	*(0.32)*	*45.0*	*(13.0)*	*23.8*	*(5.37)*
V+1, C	11	55.2	(3.05)	2.5	(0.61)	1.9	(0.36)	38.3	(9.69)	29.6	(4.39)
V, C	37	49.1	(3.34)	2.9	(1.05)	1.5	(0.29)	44.6	(15.16)	22.7	(5.19)
V, C+1	17	47.0	(5.66)	3.0	(0.73)	1.3	(0.35)	50.3	(10.36)	22.3	(6.39)
C_NQSS,											
ALL	**54**	**49.3**	**(6.11)**	**2.7**	**(0.96)**	**1.6**	**(0.52)**	**44.0**	**(15.23)**	**25.6**	**(7.81)**
Weighted Avg		*49.3*	*(4.11)*	*2.7*	*(0.91)*	*1.5*	*(0.49)*	*45.2*	*(14.0)*	*25.3*	*(7.52)*
V+1, C	9	57.5	(2.16)	2.4	(0.51)	1.8	(0.57)	46.9	(11.55)	24.8	(10.61)
V, C	28	49.1	(3.47)	3.1	(1.16)	1.6	(0.50)	46.5	(15.43)	26.5	(6.87)
V, C+1	17	45.4	(6.19)	2.3	(0.70)	1.3	(0.44)	42.0	(13.01)	23.6	(6.94)

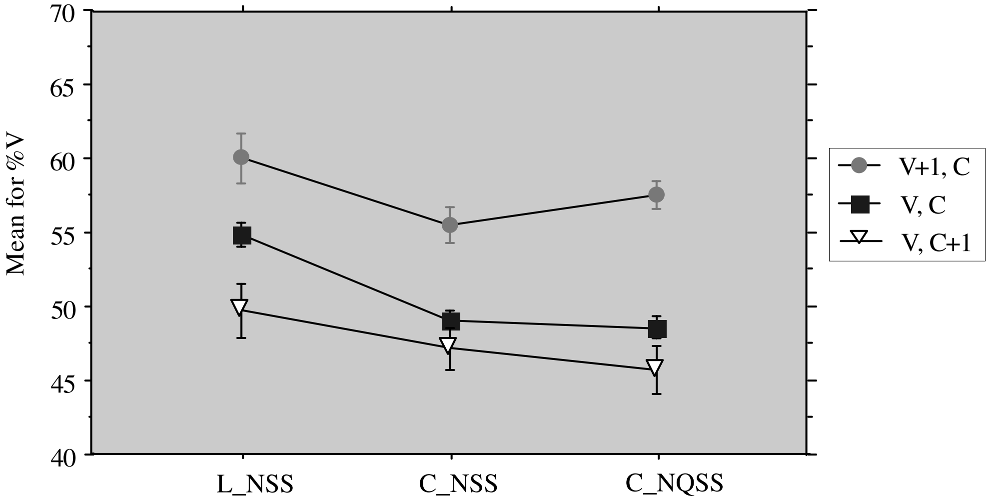

Figure 1. %V for Lima native Spanish speakers (L_NSS), Cuzco native Spanish speakers (C_NSS) and Cuzco native Quechua-Spanish bilingual speakers (C_NQSS) grouped according the ratio of intervals in utterance: one additional vocalic interval (V+1, C), an even number of vocalic and consonantal intervals (V, C) and one fewer vocalic interval, i.e., one additional consonantal interval (V, C+1); shown with error bars.

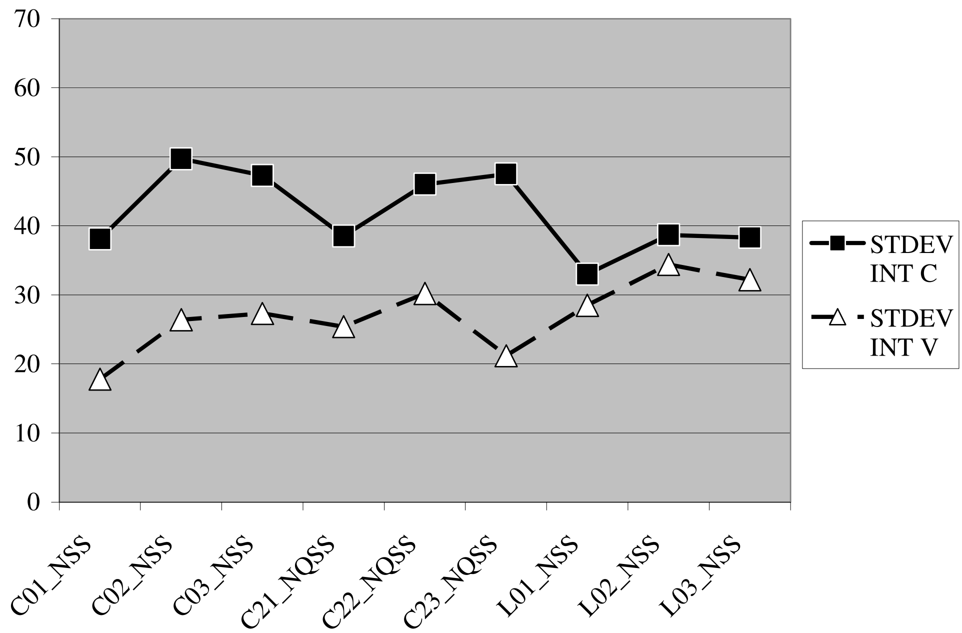

Figure 2. Comparison of standard deviation of intervals (in ms) for C, V for individual Cuzco and Lima speakers.

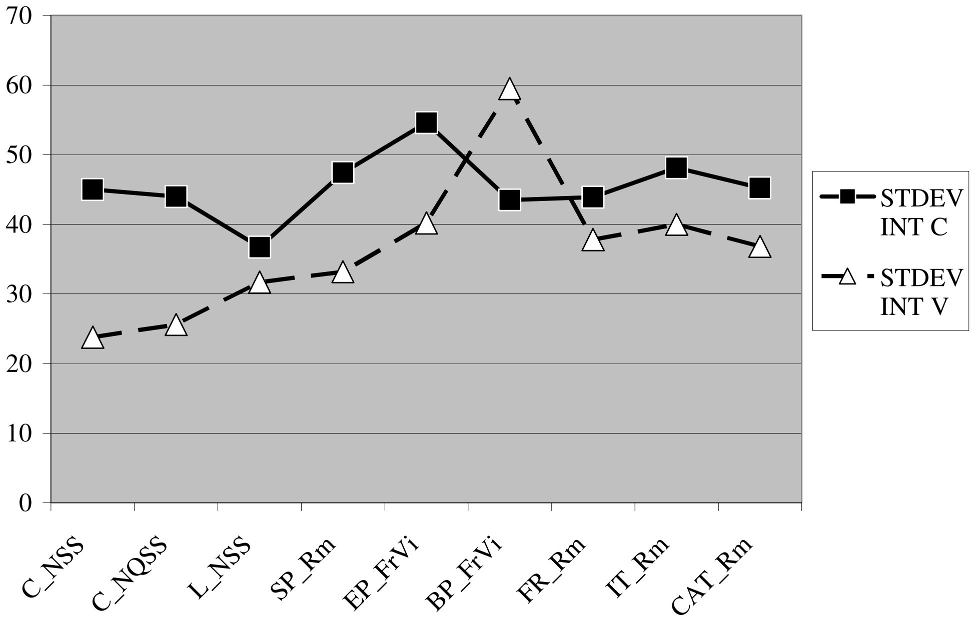

Figure 3. Comparison of standard deviation of intervals (in ms) for C, V across varieties of Spanish and other Romance languages. Rm indicates comparison with data from Ramus et al. (1999); FrVi indicates data from Frota and Vigário (2001); EP=European Portuguese; BP=Brazilian Portuguese; FR=French; IT=Italian; CAT=Cataln.

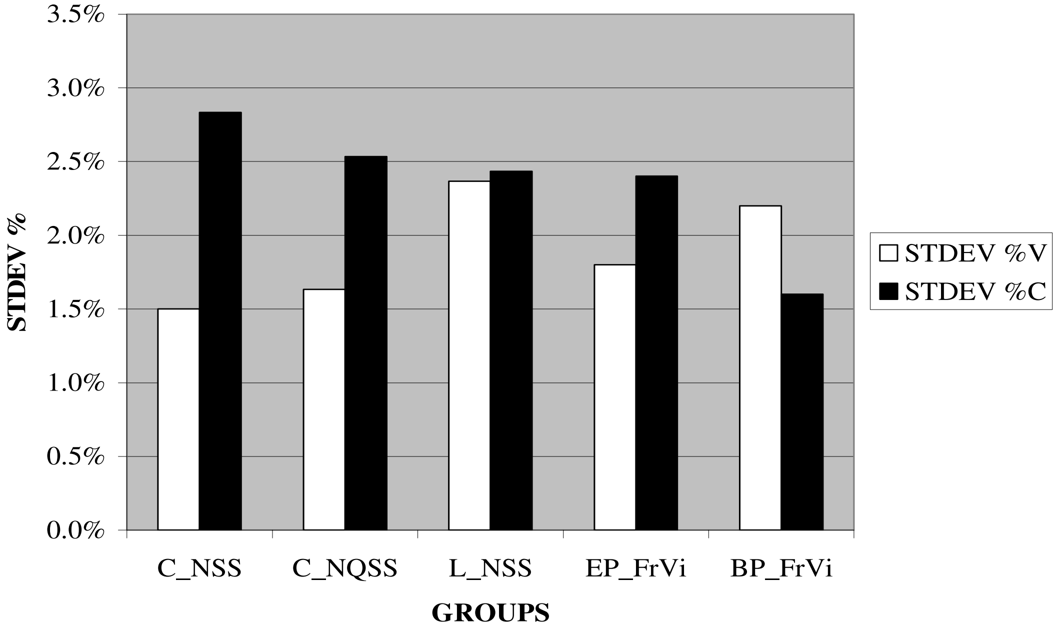

Figure 4. Comparison of normalized standard deviation of %V, %C across Peruvian Spanish groups and European Portuguese (EP) and Brazilian Portuguese (BP) groups; FrVi indicates data from Frota and Vigário (2001)

4. Analysis and Discussion

Statistical analysis of these data was conducted to examine differences according to factors of *origin*, V-to-C *interval ratio*, and *native language* within the Cuzco group. Given that %V, Δ%C, and Δ%V represent a system of relationships between vowels and consonants in a given utterance, a MANOVA was conducted with these measures taken as dependent variables. For the analysis by *origin*, two levels were present, (Lima) and (Cuzco); for the analysis by *interval ratio*, three levels were present (V+1, C) (V, C) and (V, C+1); for the analysis by native language within the Cuzco group, there were two levels (native Spanish speaker NSS) and (native Quechua-Spanish bilingual NQSS)

The results of the analysis by *origin* show significant differences for %V [F(1,173)=28.60, p<0.0001], for Δ%C [F(1,173)=10.72, p<0.0001], and for Δ%V [F(1,173)=20.43, p<0.0001]. The analysis by *interval ratio* shows significant differences for two of the dependent variables: %V [F(2,172)=34.34, p<0.0001], and Δ%V [F(2,172)=11.33, p<0.0001]. However, Δ%C approached significance [F(2,172)=3.02, p=0.0514]. Fisher's PLSD posthoc analysis shows that significant differences appear between all three types of interval ratios for %V; for Δ%V significance is found between intervals with one additional consonant and the other two types; for Δ%C a significant difference is observed only between utterances with an even number of intervals and those with one additional vocalic interval. In the *native language* analysis for the Cuzco group, no significant differences were found for any of the dependent variables: %V [F(1,117)=0.263, p=0.6093], Δ%C [F(1,117)=1.40, p=0.2399], and Δ%V [F(1,173)= 0.14, p=0.7137].

Based on the analysis of segmental durations, these findings indicate that the speech rhythm for the Cuzco groups is significantly different from the Lima group. Also, the interval ratio may be considered an important variable in conducting an analysis of rhythm. However, the Cuzco groups do not differentiate themselves according to speech rhythm. This result is offered with the caution that the speakers in both groups, male speakers with post-secondary education, may be speaking the same sociolect. Influence on Spanish rhythm from Quechua may still need to be examined with other groups differing in age, gender and education, etc. as well as examining other speech modes (e.g., read speech vs. semi-spontaneous conversation).

In terms of rhythm classes, the Spanish speakers in this study did not group with the Romance languages from the Ramus et al. (1999) study, as shown in Figure 5 below. Rather, Peruvian Spanish varieties show a higher percentage of vocalic sequences (%V) and a lower degree of consonantal variation (ΔC) than shown in Ramus et al. for Spanish. Nonetheless, all three sets of speakers are clearly demonstrating features that are not within the stress-timed grouping of English, Dutch and Polish. In this way, these calculations support the acoustic analysis of rhythm through the use duration measurements of vocalic and consonantal sequences. If a continuum of speech rhythms is assumed, the Cuzco groups appear to be between the syllable-timed Ramus et al. group and Japanese and Portuguese. However, the Lima group is much farther afield in %V, extending beyond both Japanese and Brazilian Portuguese, with a lower degree of consonantal variation than previously seen for Spanish. The weakening of /s/ in coda position in Lima Spanish resulting in open syllables may bring Lima Spanish into closer range to Japanese rhythm based on mora, which do not have a coda. Also, the lack of vowel reduction in both Lima Spanish and Japanese may further contribute to their proximity in acoustic measurements related to rhythm.

Similarly, Peruvian Spanish segmental variation, as appears in Figure 6, does not pattern directly with predicted rhythm classes. The Cuzco groups show ΔC values similar to those found for French and Catalan, whereas the lower amount of variability for the Lima group is still closer to that of Japanese. In both cases, ΔV values are lower than languages with similar consonantal variability: Cuzco groups have lower vocalic variation than French and Catalan in the syllable-timed group while the Lima group has lower vocalic variation than Japanese. In addition to demonstrating segmental variation that does not coincide with previously established rhythm groupings, this data set also leaves open the possibility of mixed rhythms. For example, both Cuzco groups show a consonantal variation similar to syllable-timed languages but a higher percentage of vocalic intervals and lower vocalic variation than that found for other syllable-timed languages, as seen in Ramus et al. (1999). However, the cross-comparison with previous data is offered with the precaution that corpora from different studies may contribute to differences in scale in how distinct the rhythm of one language may appear from another.

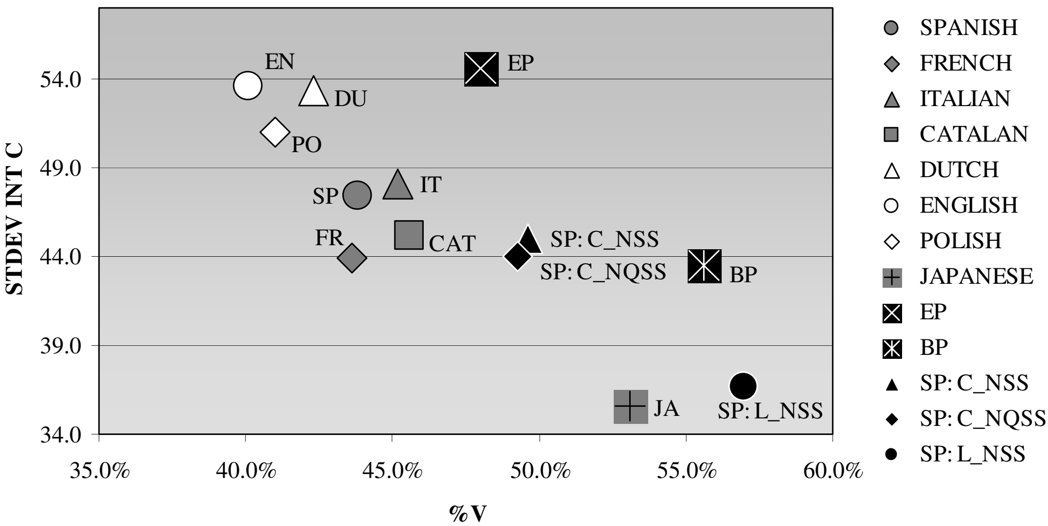

Figure 5. Results summary of ΔC vs %V. For comparison, data shown for Spanish, French, Italian, Catalan, Dutch, English, Polish and Japanese from Ramus et al. (1999) and for European Portuguese (EP) and Brazilian Portuguese (BP) from Frota and Vigário (2001); Data on Spanish from present study include Lima native Spanish speakers (L_NSS) and Cuzco native and bilingual groups (C_NSS) and (C_NQSS).

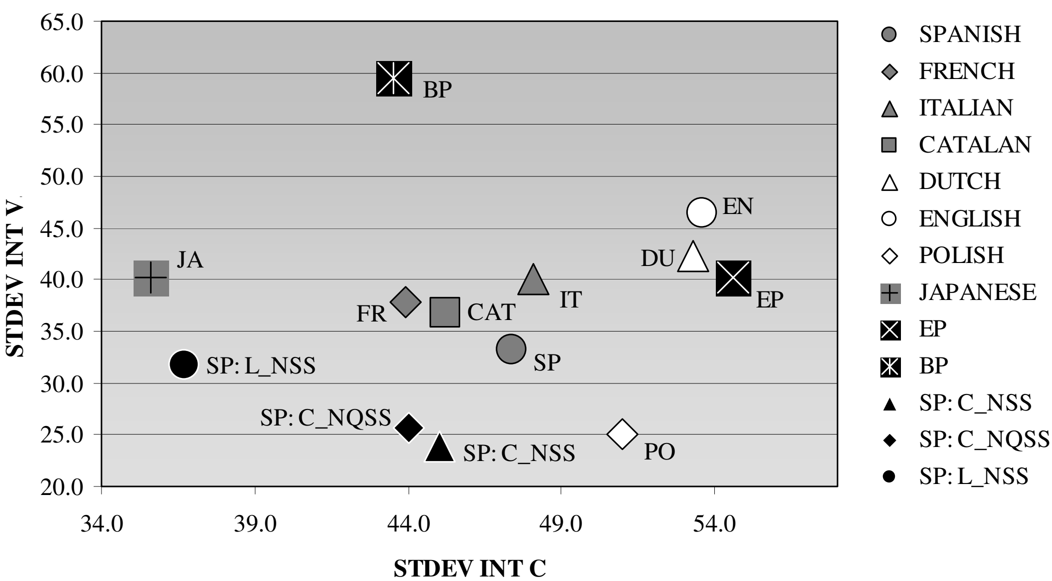

Figure 6. Results summary of ΔC vs. ΔV. For comparison, data shown for Spanish, French, Italian, Catalan, Dutch, English, Polish and Japanese from Ramus et al. (1999) and for European Portuguese (EP) and Brazilian Portuguese (BP) from Frota and Vigário (2001); Data on Spanish from present study include Lima native Spanish speakers (L_NSS) and Cuzco native and bilingual groups (C_NSS) and (C_NQSS).

5. Summary of Findings

Results from the calculation of %V and normalized ΔC indicate that significant durational differences at the segmental level are observed between Lima and Cuzco, suggesting that distinct rhythms are employed in each variety. However, both of these results show a higher overall percentage of vocalic sequences and lower consonantal variation than has previously been reported in the literature for Spanish and other Romance languages (Ramus et al. 1999). In this way, measurement of vocalic and consonantal sequences shows Peruvian Spanish varieties to be outside the stress-timed grouping and between the syllable-timed and mora-timed languages. Like the Frota and Vigário (2001) study of Portuguese, differences were observed between varieties of Peruvian Spanish. While Cuzco Spanish is similar to European Portuguese in terms of %V, Lima Spanish is more similar to Brazilian Portuguese in having a higher overall duration of vocalic sequences. Comparing the standard deviation of vocalic and consonantal intervals, both Cuzco native Spanish speakers and Quechua-Spanish bilinguals show greater consonantal variability, similar to European Portuguese. Examination of the acoustic signal for durational differences affecting rhythm may be dependent on language-specific features related syllable structure, vowel reduction and the realization of stress (Dauer 1983). Weakening of the coda in Lima Spanish and unstressed vowel reduction in Andean Spanish have been suggested to contribute to these observed differences.

Since this Peruvian Spanish data does not fall directly into the rhythm classes previously described, these findings highlight the need for more research on Spanish in both contact and non-contact situations in order to determine if some varieties of Spanish, like Portuguese, may exhibit mixed rhythms, or if Spanish rhythms lie along a continuum. An additional methodological consideration, that of the ratio of consonantal to vocalic intervals, has been discussed since this factor may contribute to differing results across studies. Consideration of other variables may also help to refine the analysis, such as balancing the data set for syllable type (open and closed) and consonant clusters (See also Ramus (2002) for discussion of other methodological considerations, such as speech rate).Variation across dialects, as shown for Portuguese, has also been observed for Arabic (Ghazali et al. 2002) and English (Jian 2004, Ling et al. 2000). More research on Spanish will help to demonstrate how rhythm may differ across varieties, and how it may change or be maintained under conditions of language contact.

Appendix

Table A1. Target broad focus declaratives

Spanish declarative	*English translation*
Amalia podaba los árboles.	"Amalia used to prune the trees."
Su madre admira la lana.	"Her mother is admiring the wool."
Su hermana retirará la demanda.	"Her sister will withdraw the complaint."
El niño añade los rábanos.	"The child is adding the radishes."
Su familia mandará los violines.	"His family will send the violins."
Bernardo venderá los mangos.	"Bernardo will sell the mangos."
Yolanda domina el castellano.	"Yolanda has a mastery of Spanish."
El criminal llevaba el ídolo.	"The criminal was carrying the idol."
El albañil moverá los barriles.	"The mason will move the barrels."
El vándalo agarra los baldes.	"The vandal is grabbing the buckets."
El águila guardaba el nido.	"The eagle was guarding the nest."
La víbora devoraba los animales.	"The snake was eating the animals."

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Selected Proceedings of the 10th Hispanic Linguistics Symposium

edited by Joyce Bruhn de Garavito and Elena Valenzuela

Cascadilla Proceedings Project Somerville, MA 2008

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ISBN 978-1-57473-427-0 library binding

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O'Rourke, Erin. 2008. Correlating Speech Rhythm in Spanish: Evidence from Two Peruvian Dialects. In *Selected Proceedings of the 10th Hispanic Linguistics Symposium*, ed. Joyce Bruhn de Garavito and Elena Valenzuela, 276-287. Somerville, MA: Cascadilla Proceedings Project.

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O'Rourke, Erin. 2008. Correlating Speech Rhythm in Spanish: Evidence from Two Peruvian Dialects. In *Selected Proceedings of the 10th Hispanic Linguistics Symposium*, ed. Joyce Bruhn de Garavito and Elena Valenzuela, 276-287. Somerville, MA: Cascadilla Proceedings Project. www.lingref.com, document #1803.