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Segmental duration and rhythm in Spanish

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Abstract: The study of some temporal aspects of Argentine Spanish is undertaken in order to provide experimental evidence about the nature of Spanish rhythm, which has been considered syllable-timed. The duration of vowels, consonants and syllables under different conditions of stress and position, and inter-stress intervals was measured. Results show that segment duration varies according to several factors, contrary to the assumption that Spanish syllables are similar in duration. Inter-stress intervals are found to cluster around an average value and some modifications of segment duraction are observed in order to achieve more regular intervals. The analysis of all these data together with a consideration of the phonetic nature of stress, leads to the conclusion that Spanish rhythm has a tendency to stress alternation.

Introduction

In a recent paper (Pointon, 1980) a critical survey of a traditional statement about Spanish rhythm was undertaken. As Pointon remarked, ever since Pike (1945) used Spanish as the example of a typical syllable-timed language, it has been generally accepted that Spanish has in fact a syllable-timed rhythm.

Following the principles put forward by Pike, American and British linguists have made a clear cut difference between stress and syllable-timed rhythm. In order to achieve a somewhat uniform spacing of stresses in stress-timed languages, the syllables of the longer inter-stress intervals are crushed together. This fact is in part responsible for many syllable abreviations and omissions and for the neutralization of vowels. In shorter intervals, syllables are lengthened. In a syllable-timed language, even though the stressed syllables may be longer, the unstressed syllables tend to be sharp cut; in Pike's words, this results in a recurrent syllable prominence.

Pointon (1980) does not provide new data about the temporal patterns of Spanish but he undertakes a careful review and comparison of the results obtained by the Spanish authors Navarro Tomás and Gili y Gaya and the non Spanish authors Delattre and Olsen.

Navarro Tomás, in a number of works (1916, 1917, 1918) demonstrates that, contrary to previous assumptions that in Spanish all the syllables have similar durations, segmental durations vary due to stress and phonetic context. In the analysis of a poem by Rubén Darío, Navarro Tomás (1922) considers that the metrical units are feet, each begining with a stressed

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syllable. According to Pointon, this makes the poem stress-timed. Gili y Gaya (1940) acknowledges a tendency to syllable-timing in spite of the fact that he finds a 50% increase for stressed over unstressed syllables. In the analysis of a prose passage this author also finds that syllable duration is partly determined by the number of segments per syllable and the nature of the consonant(s) in the syllable. On the basis of these data, Pointon concludes that a typical syllable-timed rhythm cannot be postulated for this passage. On the other hand, the passage cannot be said to be stress-timed since the measurements of the inter-stress intervals made by Pointon show a great variability.

While Navarro Tomás and Gili y Gaya have worked on Peninsular Spanish, Delattre and Olsen have used Latin American informants. Delattre (1966) and Olsen (1972) arrive at similar conclusions: Spanish syllables are much more equal than English syllables since the ratios obtained by these authors for Spanish present smaller values than English; but their ratios differ considerably from the results obtained by Gili y Gaya. Pointon attributes this difference to the practice follwed by Delattre and Olsen in not separating the syllable structure, which leads to the masking of some large differences.

In view of the data presented above, Pointon arrives at the conclusion that "Spanish has no regular rhythm in the sense of an isochronous sequence of similar events, be they syllables or stresses". It is worthing noting that Pointon rejects any type of isochrony in Spanish without regarding the fact shown by several authors that perfect isochrony cannot be found in production.

Lehiste (1977) examines several experimental works (Shen & Peterson, 1962; O'Connor, 1965, 1968; Bolinger, 1965; Uldall, 1971; Lea, 1974) carried out on rhythm in spoken English which have shown that inter-stress intervals vary in duration. According to Lehiste an attempt to consider isochrony must be made taking into account the constraints on production and perception that might affect isochrony.

Lehiste demonstrates that there is a tendency to hear spoken English as possessing a certain degree of isochronicity since listeners tend to impose a rhythmic structure on stretches of sounds and thus to disregard the durational differences above the perceptual threshold. Lehiste's conclusion is that isochrony is primarily a perceptual phenomenon.

It is worth returning again to Navarro Tomás since a careful reading of his works reveals other aspects in his interpretation of Spanish rhythm. Although he does not explicitly define the type of rhythm Spanish has, he makes many interesting comments on the subject. For Navarro Tomás (1967) the primary physical correlate of Spanish stress is intensity (for a review of this feature see Manrique, Signorini & Massone, 1982). When dealing with intensity in relation to stress, Navarro Tomás suggests that certain intensity variations can be attributed to universal rhythmic principles; that is, a general tendency towards the alternation of the same phenomenon. Thus, Spanish syllables can be strong or weak depending on the presence or absence of stress respectively. He considers that, due to rhythm, the degree of strength and weakness may vary. Although he states that the boundaries between both categories are maintained (p. 186), further on he affirms that content words (stressed) are uttered in some cases as unstressed and considers that this fact is relevant for the rhythmic analysis of verse. Navarro Tomás refers to verse only in these comments because he thinks that the rhythmic groups are more regular in verse than in prose (1944, p. 39). Furthermore, he explicitly states (p. 205) that syllable differences in Spanish verse are made in order to achieve regular durations among inter-stress intervals. The fact that rhythm can be more regular in poems than in connected discourse is also suggested for a stress-timed language as English (Klatt, 1975).

It has been shown that there are a lot of factors, besides rhythm, that affect the duration

of segments: inherent durations (Lehiste, 1970), features of adjacent segments (Peterson & Lehiste, 1960), stress (Coker, Umeda & Bowman, 1973), speaking mode (Harris & Umeda, 1975), position within the word and in the sentence (Klatt, 1975). The variability of timing in speech units due to some of these factors has proved to be more important for conveying information than the preservation of a constant rhythm. (Lehiste, 1973; Umeda, 1975, 1977).

Although these effects have been mainly reported for English and languages other than Spanish, some observations by Navarro Tomás and our own experience in the study of Spanish give us grounds for suspecting that the aforementioned factors may also play a role in the temporal organization of Spanish.

The present work was undertaken in an attempt to provide preliminary data about segmental duration and rhythm in Spanish in order to determine the nature of Spanish rhythm in relation to its linguistic function.

Procedure

The material consisted of the spectrograms of a list of 120 sentences registered by a male speaker of Argentine Spanish. Data from this speaker were checked with those of three other male speakers who had registered a different and shorter set of sentences. The criteria used in segmentation were similar to those described by Peterson & Lehiste (1960). Vowels in syllable with plosives were measured from the onset of voicing: the frication period was not included in the duration of the vowel.

A broad phonetic transcription was made of the sentences. Only two levels of stress were distinguished: stressed and unstressed. In the measurement of vowel and consonant duration, stressed vowels included all the vowels in content words and unstressed vowels, lexically unstressed vowels of polysyllabic words and all the vowels in function words; stressed and unstressed consonants included the consonants preceding stressed and unstressed vowels respectively. Consonants following the vowels were set apart. The prepausal condition, which included the vowel and the consonant in the last syllable before a pause, was also considered.

For the measurement of syllable duration the following factors were considered; (1) syllable structure, (2) preceding consonant, (3) type of word (content, function), (4) stress, (5) position of the syllable in the word (initial, medial, final), (6) position of the word within the sentence (prepausal, non-prepausal).

Inter-stress intervals were measured from the consonant/vowel onset of the syllable bearing the stress to the consonant/vowel onset of the next syllable bearing stress.

Results

Segment duration

Data from the measurement of vowel duration is shown in Table I. Results for prepausal position are lacking for some vowels since they do not have enough or any occurrence in the material.

Data were analysed separately for the main speaker (S1) and the other three speakers. In the latter case, as a similar trend of vowel variation was observed, results from these speakers were pooled together (S3).

Absolute duration is one of the differences between S1 and S3 which is due to a higher state of speaking in S1. In S3 data, vowels in prestressed position are slightly longer than those in post-stressed position. This positional effect is not consistent in S1 values. Preceding

Table 1 Average duration (ms) (standard deviation) of Spanish vowels in stressed, unstressed, prepausal and non-prepausal conditions

		Stressed		Unstressed		
		Non-prepausal	Prepausal	Prestressed	Post-stressed	Prepausal
/a/	S1	72 (21.8)		57 (13.5)	54 (12.7)	81 (15.7)
	S3	102 (23.1)	126 (12.4)	66 (14.6)	60 (13.5)	92 (15.9)
/e/	S1	83 (29.5)	82 (8.2)	53 (14)	50 (14.4)	70 (15)
	S3	86 (15)	120 (15.2)	59 (15.7)	53 (16)	91 (20.8)
/i/	S1	89 (31.3)	140 (30)	53 (17)	65 (17)	122 (17.5)
	S3	86 (25.7)	110	55 (22)	46 (12)	
/o/	S1	73 (23.5)		56 (12.6)	50 (15.6)	82 (22.8)
	S3	96 (26.7)		69 (21)	58 (14)	91 (17)
/u/	S1	86 (29.8)		50 (22.5)	63 (20.8)	
	S3	93 (38)	130 (14)	72 (20)	49 (12)	

and following consonants were taken into account firstly in the measurements of vowel duration, but for a number of conditions there were not enough tokens to provide meaningful estimates. These conditions are pooled together here.

The same trend of prepausal and stress condition effects is observed over all four subjects. Vowels in stressed syllables and in final prepausal syllables are consistently longer than vowels in other syllables, being stressed prepausal vowels the longest ones. The average increment (durational difference between stressed and unstressed vowels) is approximately 26 ms for S1 and 36 ms for S3; the durational difference between prepausal and non-prepausal vowels is around 25 ms and 28 ms for S1 and S3 respectively.

There is a considerable amount of variability in the data. For stressed vowels the average standard deviation (about 26.6) is greater than averages for unstressed vowels (15.6) and for prepausal vowels (17.2). This may be partly because the amount of lengthening due to stress is quite different, depending on the position of the stressed vowel in the sentence (Massone, 1982). Furthermore there are a lot of factors known to affect vowel duration which have not been considered in the data and which may account for the variability in them.

In the ratio data (Table II), non-prepausal stressed vowels are compared with non-prepausal unstressed vowels (average values for pre- and post-stressed vowels), prepausal stressed vowels are compared with non-prepausal stressed vowels and prepausal unstressed vowels with non-prepausal unstressed ones.

Ratios thus obtained are averaged across vowels in the final position of Table II. These ratios show that prepausal position has a greater effect on unstressed vowel duration than on stressed vowels, the effect of stress and prepausal position being of a quite similar magnitude.

Results for consonant duration measurements are shown in Table III. The voiced stops [b, d, g] the fricatives [ʃ, ʒ] and the affricate [ʧ] were not included because of an insufficient number of tokens. Since results for voiced fricatives, for voiceless stops and voiceless fricatives respectively showed quite similar durational values, data for the consonants in each group were pooled together. Prestressed and post-stressed consonants did not show a consistent trend in any speaker. Thus, results from both positions were averaged in Table III.

It can be seen from this table that absolute differences in consonant duration between S1 and S3 are slighter than in vowel duration. The rate of speaking, which is higher in S1 than

Table II Ratios of stressed and unstressed, prepausal and non-prepausal vowel durations in Spanish

		Stressed : Unstressed	Prepausal : Non-prepausal Stressed	Unstressed
/a/	S1	1.32		1.47
	S3	1.61	1.23	1.46
/e/	S1	1.62		1.37
	S3	1.53	1.39	1.62
/i/	S1	1.58	1.57	
	S3	1.72	1.27	
/o/	S1	1.37		1.54
	S3	1.53		1.44
/u/	S1	1.53		
	S2	1.55	1.39	
Average				
	S1	1.48		1.46
	S3	1.58	1.32	1.50

Table III Average duration (standard deviation) of Spanish consonants. Ratios of stressed and unstressed, prepausal and non-prepausal consonant duration

		Stressed	Unstressed	Prepausal	Ratio Stressed : unstressed	Prepausal : non-prepausal
β, ð, ɣ	S1	43 (19.7)	27 (8.6)	39 (13)	1.5	1.4
	S3	42 (13.5)	31 (8.5)	46 (13.6)	1.35	1.48
p, t, k	S1	98 (17.3)	88 (18.7)	113	1.1	1.2
	S3	101 (15)	83 (15.2)	111 (22)	1.21	1.33
s, f	S1	108 (27.3)	85 (17.4)	115 (33.5)	1.27	1.4
	S3	109 (17.8)	92 (19.2)	119 (30.2)	1.18	1.29
m	S1	73 (13.3)	64 (17)	97 (11)	1.1	1.5
	S3	81 (17.2)	58 (10)	82 (20.5)	1.39	1.41
n	S1	56 (19.4)	55 (13)	80 (22.9)	1.01	1.4
	S3	74 (20.8)	51 (15.6)	61 (8.5)	1.45	1.19
l	S1	59 (16.5)	55 (15.5)		1.07	
	S3	59 (17.2)	50 (12)		1.18	
r	S1	30 (10.2)	26 (8.4)	45 (10.3)	1.15	1.5
	S3	43 (17.9)	29 (13.3)	45 (17.8)	1.48	1.55
rr	S1	85 (18.9)	81 (19.8)		1.04	
	S3	103 (13.6)	72 (14)		1.04	

in S3, seems to have a greater effect on the vowels than on the consonants, being fricatives slightly longer than stops.

Voiced fricatives and [r] are the shortest consonants, nasals and liquids present values in between, being [m] and [rr] longer than [n] and [l].

With respect to the place of articulation, the general trend seems to be labials longer than dentals and velars the longest in the groups where velar consonants occur. However, this observation must be taken with caution because the occurrences of phones and of conditions under which they occur are very uneven. Furthermore, there are a lot of conditions, such as position of the consonant in the word, content/function difference of the word, effect of adjacent consonant both inside the word and across word boundary, which have not been taken into consideration here and which have proved to affect consonant duration (Umeda, 1977).

With respect to stress and prepausal position, the same durational behavior in all consonants is observed. All the consonants are longer in stressed and in prepausal syllables. The comparison between stressed and unstressed consonants and prepausal and non-prepausal consonants (1.22 and 1.37 respectively) shows smaller ratios than the ones obtained for vowels in the same conditions.

Prepausal : non-prepausal ratio is greater than stressed : unstressed ratio, this fact seems to indicate a greater effect of the positional factor than the stress factor on consonant duration.

Syllable measurement did not provide sufficient tokens for all syllable structures in all the conditions under consideration. Thus, only values for CV syllables in which C was a voiceless stop from S1 are shown in the upper part of Table IV. It is apparent from these results that stress, prepausal position and content/function difference of the word are all factors that affect syllable duration. Syllable position in the word (initial, medial, final) does not show a consistent trend of durational differences.

The comparison between prepausal and non-prepausal syllable values in each condition (stress and position within the word) gives an average ratio of 1.24 (for a more detailed discussion of this effect see Manrique, 1982). The ratio between unstressed syllables in content words and syllables in function words is in average 1.20; between stressed syllables and syllables in function words, 1.36. As can be seen, the latter comparison provides the greatest ratio which seems to indicate that stress and type of word factors have a cumulative effect on syllable duration.

The durational values for CV syllables in which C was a voiced fricative were compared with those for voiceless stop syllables in stressed, unstressed and prepausal conditions in the final portion of Table IV. It was necessary to reduce the number of conditions in order to have sufficient tokens for voiced fricative CV syllables. Average data from S3 were also included.

Results show a clear difference in absolute duration between both groups of syllables which is due to manner of articulation of the consonants. The ratios of stressed non-prepausal to unstressed non-prepausal syllables are 1.58 (S1, voiced fricative); 1.34 (S3, voiceless stop) and 1.3 (S3, voiced fricative). The average ratio of unstressed prepausal to unstressed non-prepausal is 1.36.

The measurement of syllables of more complex structures (CVC, CCV, CVV, CVVC) did not provide sufficient tokens for all consonants and conditions. Thus, results for stressed, unstressed and prepausal syllables whose initial consonant was a voiceless stop or a voiced fricative consonant are reported in Table V. These data show that these syllables have a greater duration than CV syllables, since their duration increases with an increase in the number of segments. In the case of syllables with equal number of segments, CVC, CVV and CCV, the general trend seems to be a shorter duration of CCV. Stress, prepausal position and manner of the articulation of the initial consonant also affects the curation of the syllables. Although the effects were not quantified, variation in duration due to the position of the

Table IV Average duration (ms) of VC syllables in different conditions. Data in the upper part of the table were taken from S1. Average data from this speaker are compared with those obtained from S3 in the final portion of the table

	Content						Function	
	Stressed			Unstressed				
	Initial	Medial	Final	Initial	Medial	Final	Initial	Final
Non-prepausal	157	155	160	142	150	127	112	119
Prepausal	207	200	205	148	150	171		

	Stressed		Unstressed			
			Non-prepausal		Prepausal	
	S1	S3	S1	S3	S1	S3
Voiced fricatives	138	130	87	100	115	146
Voiceless stops	157	175	130	130	156	191

Table V Average duration (ms) of Spanish syllables classed according to syllable structure

Syllable structure	Initial consonant	Stressed		Unstressed		Prepausal	
		S1	S3	S1	S3	S1	S3
CVC	Voiced fricative	165	170	112	125	160	180
	Voiceless stop	186	264	161	205	250	340
CCV	Voiced fricative	156	153	124	135	181	206
	Voiceless stop	240	220	163	140		235
CVVC	Voiced fricative	170	236	150	185		
	Voiceless stop	235	275	193	230		
CVV	Voiced fricative		168				
	Voiceless stop		244		150		

word in the sentence, type of word and, in unstressed syllables, pre- or postonic position was also observed. The ratios of stressed non-prepausal to unstressed non-prepausal syllables ranges from 1.13 to 1.57.

Inter-stress interval duration

For the analysis of the data obtained from the measurement of inter-stress intervals the following criteria were adopted:

(a) the sentences which presented only one interval were excluded.

(b) the sentences which presented two or more intervals with a difference in duration between them not greater than 100 ms were sorted into a group of "similar intervals".

(c) the sentences which presented one or more intervals differing from the average of them in more than 100 ms, were sorted into a group of "different intervals".

The value of 100 ms for the interval durational differences analysis was chosen as a reference since it has been shown that an increment or decrement of about 100 ms is not perceived (Lehiste, 1977).

Table VI Duration (ms) os similar intervals. The figure between brackets below each interval indicates the number of syllables of that interval

S1	
(1) 350–400	(6) 580–500
(3) (4)	(5) (4)
(2) 480–480–400	(7) 250–300
(5) (4) (3)	(3) (2)
(3) 310–400–410–350–380	(8) 450–480
(3) (4) (4) (2) (4)	(5) (5)
(4) 330–350–400	(9) 430–420
(3) (3) (3)	(3) (4)
(5) 355–320–390	(10) 465–350–440
(3) (3) (4)	(4) (2) (3)
S3	
(11) 610–630	(20) 515–495
(3) (3)	(3) (3)
(12) 470–450–450	(21) 540–520
(3) (2) (4)	(3) (4)
(13) 440–420	(22) 420–400
(3) (3)	(3) (3)
(14) 310–350	(23) 420–510
(4) (3)	(4) (4)
(15) 470–465	(24) 500–580
(4) (4)	(3) (4)
(16) 490–500	(25) 430–360
(5) (5)	(4) (3)
(17) 440–420	(26) 470–410
(4) (4)	(3) (3)
(18) 470–480–460	(27) 520–580
(4) (4) (4)	(3) (4)
(19) 705–750	
(4) (6)	

Results from "similar interval" sentences are shown in Table VI. The duration of inter-stress intervals is given in ms with the number of syllables between brackets below each.

In 13 sentences, the intervals contain the same number of syllables. In 6 of the cases (although the difference in duration is very slight) the shortest interval contains more syllables than the longest one. A careful inspection of these sentences shows a decrement in duration of some syllables, effect by which similar intervals are attained despite containing different number of syllables.

In the sentence [ai↓toroh de↓miura en el↓feudo] for instance the syllable [miu] with three segments has the same duration (200 ms) as the following three [ra en el] with six segments. Comparing some segments of the first interval with others in the second one, post-stressed [o] with post-stressed [a], prestressed [e] from [de] with prestressed [e] from [el], a reduction in duration of about 50% is found.

In some cases the intervals are identical in duration but differ in the number of syllables. In others, the intervals are slightly different but contain the same number of syllables. In general, the longer intervals contain a greater number of syllables than the shorter ones. Nevertheless, the increment in duration does not seem to be proportional to the increment in syllables. Thus, for instance, in sentence 17 the longer interval (390 ms, 4 syllables) would last 473 ms in relation with the first and second intervals respectively. The average

Table VII Duration (ms) of interstress different intervals. The figure between brackets below each interval indicates the number of syllables of that interval

S1	S1	S3
(1) 555–320–560	(11) 585–410–500	(20) 430–600
(4) (3) (3)	(4) (2) (3)	(3) (3)
(2) 605–430	(12) 220–340–235	(21) 260–460–410
(5) (4)	(2) (2) (1)	(2) (3) (2)
(3) 360–650–540	(13) 525–300	(22) 380–520
(4) (6) (4)	(4) (3)	(3) (4)
(4) 800–400–435	(14) 400–300	(23) 600–720
(5) (2) (3)	(3) (2)	(4) (4)
(5) 595–460–430	(15) 220–570	(24) 590–300
(4) (3) (3)	(2) (3)	(4) (3)
(6) 720–580	(16) 670–400	(25) 650–360
(5) (4)	(3) (3)	(5) (2)
(7) 545–700	(17) 280–540	(26) 460–350
(4) (5)	(2) (4)	(4) (3)
(8) 520–360–535	(18) 410–255–385	(27) 400–520
(3) (2) (4)	(2) (2) (3)	(4) (4)
(9) 430–280–590	(19) 260–430	
(3) (3) (5)	(4) (4)	
(10) 795–510–460		
(6) (2) (3)		

inter-stress interval for all speakers was 447 ms with a standard deviation of 92.9. Table VII shows data on different intervals for S1 and S3. The duration of inter-stress intervals is presented in msec with the number of syllables between brackets below each.

As it can be observed, where there are three intervals, two are similar in duration and one differs. A close inspection of different interval sentences shows that there are various syntactic and semantic factors which may account for the differences among the intervals. These are:

(1) *Non-temporal rhythm*: in the case of sentence 9, it is perceived as rhythmical may be because of the repetition of the coordinating conjunction "o": *O la casa está allá, o mi padre se equivocó*.

(2) *Embedded constructions*: in sentences 1, 4, 5, 10, the presence of certain constructions between the subject nucleus and the verb seems to disrupt the similarity among the intervals: *La casa, por ser fea, está en la colina*.

(3) *Boundaries*: in sentences 3, 11, 14, 20, 21, 22, 23, 25, 26, the presence of boundaries is cued by pauses, segmental lengthening and/or pitch changes: *Esta es la casa, cuyo arquitecto desconozco*.

(4) *Word prominence*: in sentences 2, 6, 8, 13, 15, 19, 24, the speaker's intention to highlight certain words in each of them, alters the relation among stresses: *Leo muchas poesías*.

(5) *Speaker's attitude change*: in sentences 12, 17, there is a clear division between both parts of the sentences cued by a different rate of speaking in each of them: *Dame el libro, por favor*.

The average inter-stress interval across all speakers was 467 ms with a standard deviation of 142.2. This average value is quite similar to the value in the "similar intervals" group of sentences, the standard deviation being greater than in that group.

Discussion

Even though the data obtained in the present paper are preliminary since the detailed analysis of some conditions that influence segment duration has not been undertaken, they provide with some evidence about the temporal organization of Spanish.

From the present results it is apparent that segment duration is affected by several factors like manner of articulation in consonants, position of the segment in relation to stress and pause, type of word and rate of speaking. The comparison between average ratios of stressed to unstressed, prepausal to non-prepausal in consonants and vowels shows that vowels are more affected by stress and prepausal position than consonants. Furthermore, a change in the rate of speaking has a greater effect on vowels than on consonants.

Our results about syllable structure are in agreement with those of Gili y Gaya (1940), namely that the more complex the syllable structure, the greater the duration of that syllable is likely to be. It is also worth noting that the average ratio of stressed, non-prepausal open syllables to unstressed non-prepausal open ones, 1.4, is in close agreement with the ratio obtained by Gili y Gaya (1940) for Peninsular Spanish, 1.43, and in contrast with the one reported by Delattre (1966), 1.11. A similar average ratio, 1.3, was obtained when comparing stressed with unstressed syllables of more complex structure. Delattre's values have often been presented as evidence of a syllable-timed rhythm in Spanish (Major, 1981).

In summary, contrary to what was postulated for Spanish, syllable duration varies due to several intrinsic and extrinsic factors, results that are in agreement with previous observations made by Navarro Tomás and Gili y Gaya for Peninsular Spanish. These data do not give support to the claims that Spanish is "isosyllabic". The fact that in Spanish certain syllabic type, CV, is so frequent, 55.9%, offers one plausible explanation for the impression of Spanish "isosyllabicity".

Before considering other evidences against that assumption, it is necessary to review the phonetic status of "stress" in Spanish since this feature seems to be a central one in the discussion of rhythm.

Bolinger (1961) considered that stress in Spanish, like in English, is associated with pitch variations. In recent experiments (Manrique *et al.*, 1982; Massone, 1982; Manrique, 1982) it was determined that in Argentine Spanish, stressed syllables were higher in pitch, longer and sometimes louder than unstressed ones, except at the end of the phrase where the main acoustic correlate of stress seemed to be an extra elongation of the stressed vowel.

Allen (1975) considers that when stress is associated with higher pitch and loudness, the stressed syllables seem to "lead the group" in which they occur. Thus we may assume that in Spanish the stressed syllable is the rhythmic focus of the accented group.

Another aspect to be taken into account in relation to stress is vowel reduction. As it was shown, unstressed vowels are shorter than stressed ones in Spanish. Furthermore the acoustic data obtained in a recent paper (Manrique *et al.*, 1982) has demonstrated that unstressed vowel areas shift toward the area of [a] which occupies a central position with high F1 in a F1–F2 plot. Thus, although vowel reduction in Spanish does not present the same characteristics than in English (a shift toward schwa) it implies a change in quality and in duration. In some cases it was observed that this reduction may be associated with a rhythmic tendency to shorten inter-stress intervals.

With respect to inter-stress intervals our results showed that although they vary in duration to a greater or lesser degree, they cluster around an average value. Furthermore there are inter-stress interval differences in production that are not relevant in perception as Lehiste (1977) demonstrated in a series of experiments. On the other hand there are interval differences that are perceptually relevant and which may be assumed to convey some type

of linguistic information by means of a deviation from an expected pattern. This assumption rests on the consideration that the expected pattern is the occurrence of stresses at regular intervals, that is, stress alternation. Allen (1975) postulated this alternation tendency to be almost universal since stress in order to be perceived must alternate with non-stress.

Results from this paper give support to Allen's assumption since that tendency is observed even in Spanish and French, (Wenk & Wioland, 1982) languages previously considered as syllable-timed. Our data do not give support to a syllable-timed rhythm in Spanish. Thus it is worth making a comparative revision of some factors that are associated with a stress-timed rhythm.

Allen (1975) remarked that inter-stress intervals ranging from 0.2 to 0.8 seconds might be expected for languages with stress-timed rhythm. Our measurements fall within this range. On his part Major (1981) considered that Portuguese had a tendency toward stress-timing because a series of reasons such as the shortening process of unstressed syllables, the fact that inter-stress durations are not directly proportional to the number of syllables and that many differences in inter-stress duration are not perceptible. These rhythmic effects are also observed in Spanish.

Lehiste (1977) pointed to the fact that a deviation from the rhythmic pattern could be used to signal anything, such as a syntactic boundary. As reported above, we have observed differences in intervals large enough to be perceived, that seem to be due to syntactic and semantic factors. In summary, the analysis of Spanish shows a series of temporal aspects that closely resemble those of stress-timed languages.

It is apparent that there are some aspects of Spanish that may explain the assumption that it is syllable-timed. The high occurrence of the syllabic type CV and the different manner of reduction of unstressed vowels make the syllables perceptually more clear cut than in other languages.

As Allen (1975) remarked, there are temporal effects due to rhythmic performance universals which have been incorporated to the phonology of each language, sometimes in different ways. Therefore, if all the observations made about Spanish rhythm are considered within Allen's framework, it may be assumed that the syllabic relevance in Spanish reveals how the phonology of this language has incorporated those rhythmic universals.

In brief, it may be concluded that Spanish has a tendency toward stress-timed rhythm with differenciating characteristics in the way in which this is manifested.

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