

RHYTHMICAL PATTERNS AND SYLLABIC FEATURES OF THE SPANISH SENSE-GROUP

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This report offers an example of the linguistic information which can be obtained in applying the techniques of spectrographic segmentation and computer sorting to a large corpus of language material. In the present study these objective techniques are directed to one aspect of one language, that of rhythm in Spanish.

Rhythm, which is felt as a recurring beat in language as well as in music, is described here mainly in terms of stressed and unstressed syllables as they occur in the Spanish sense-group. The corpus used as a typical sample of cultivated Spanish is one-half hour of extemporaneous speech by the noted Mexican artist, Diego Rivera.

To begin the analysis, spectrograms were made of the entire corpus. After segmentation was accomplished, a first analysis revealed some 1,455 sense-groups, 7,005 syllables, and 16,421 individual sounds. In order to handle efficiently this volume of material, an IBM 7094 digital computer was used to make concordances and frequency lists. The wealth of information to result from our study can be summarized in four major categories: the general frequency characteristics of rhythmical patterns, their sound sequences, their structural sequences, and their length sequences.

1. GENERAL FREQUENCY CHARACTERISTICS

An initial count of the number of different rhythmical patterns shows that the 1,455 sense-groups of our corpus yield 139 different pattern types. These patterns are found in decreasing order of frequency in Table 1 where dots represent unstressed syllables and dashes represent stressed syllables.

An interpretation of the data from Table 1 reveals five specific tendencies.

1. All patterns considered together in decreasing order of frequency show the Zipf constant of frequency-to-rank (Zipf 1932). As frequency decreases, rank increases. There is only one pattern with a frequency of 172; there are nine patterns with a frequency of 5; and there are 53 patterns with a frequency of one. This progression is nearly logarithmic.

TABLE 1

The 139 different rhythmical patterns found in 1,455 sense-groups are arranged in order of decreasing frequency. Dots represent unstressed syllables and dashes represent stressed syllables.

...-	172	..-.-.	5	..-.-.-.-	1
..-	149	..-.-.-.	5	..-.-.-	1
...-.	100	..-.-.-	5	..-.-.-.-.	1
..-.	61	..-.-.	5	..-.-.-	1
-	48	..-.-.-	5	..-.-.-	1
-.	46	..-.-.	4	..-.-.-.	1
...-	45	..-	4	..-.-.-	1
...-.	45	..-.-.-	4	..-.-.-.-	1
..-.	43	..-.-.-.	4	..-.-.-.-.	1
..-	42	..-.-	3	..-.-.-.-	1
..-.	39	..-.-.-.	3	..-.-.-	1
..-.-.	38	..-.-.-.	3	..-.-.-	1
...-	35	..-.-.	3	..-.-.-	1
..-.	23	..-.-.	3	..-.-.-	1
..-.-.	22	..-.-.-.	3	..-.-.-.-	1
..-.-.-.	22	..-.-.-.-.	3	..-.-.-.-.-	1
..-.-.-.	21	..-.-.-.-	3	..-.-.-.-	1
..-.-.-.	20	..-.-.-.-	3	..-.-.-.-.	1
..-.-.-.	19	..-.-.-.-	3	..-.-.-.-	1
..-.-.-	18	..-.-.-.-.	3	..-.-.-.-.-	1
..-.-.-	17	..-.-.-.-.	3	..-.-.-.-	1
-	16	..-.-.	2	..-.-.-.-.	1
..-	16	..-.-.	2	..-.-.-.-	1
..-.	16	..-.-.-	2	..-.-.-.-.	1
..-.-.	16	..-.-.-.-	2	..-.-.-.-.-	1
..-.	15	..-.-.-.-.	2	..-.-.-.-	1
..-.-.	14	..-.-.-.-	2	..-.-.-.-	1
..-.-.-	14	..-.-.-.-	2	..-.-.-.-.-	1
..-.-.-.	13	..-.-.-.-.	2	..-.-.-.-.-	1
..-	11	..-.-.-.-.	2	..-.-.-.-.	1
..-.-.	11	..-.-.-.-.	2	..-.-.-.-.-	1
..-.-.-	11	..-.-.-.-.	2	..-.-.-.-	1
..-.-.-.-.	11	..-.-.-.-	2	..-.-.-.-.-	1
..-.-.-.-.	10	..-.-.-.-	2	..-.-.-.-	1
..-.-.	10	..-.-.-.	2	..-.-.-.-	1
..-.-.-.	10	..-.-.-.-.	2	..-.-.-.-	1
..-.-.-.-.	9	..-.-.-.-.-	2	..-.-.-.-.-	1
..-.-.-.-.	8	..-.-.-.-	2	..-.-.-.-	1
..-.-.	8	..-.-.-.-.	2	..-.-.-.-.-	1
..-.-.-.	7	..-.-.	1	..-.-.-.-.	1
..-	6	..-.-.-.-	1	..-.-.-.-	1
..-.-.-.-.	6	..-.-.-.-.	1	..-.-.-.-.-	1
..-.-.-.-.	6	..-.-.-.-	1	..-.-.-.-	1
..-	5	..-.-.-.	1	..-.-.-.-.-	1
..-.-.-.	5	..-.-.-.-.	1	..-.-.-.-	1
..-.-.-.	5	..-.-.-.-	1	..-.-.-.-.-	1
..-.-.-.-	5	..-.-.-.-.	1	..-.-.-.-	1

2. From the point of view of length, patterns of four and five syllables are preferred where both combined contain 45 percent of the occurrences.

3. With respect to the number of stressed syllables in the pattern, those containing one and two stressed syllables are the most frequent and constitute together 91 percent of the total occurrences.

4. The ratio of stressed syllables to unstressed syllables is approximately 1:3 in patterns with one stress; 1:2 in patterns with two stresses, and 1:1+ in patterns with three stresses. The prevailing tendency is: as the number of stressed syllables increases, the number of unstressed syllables decreases in a ratio of approximately one to one.

5. The place of stress in rhythmical patterns is typically in syllable positions 2, 4, and 6 or 7 counting from right to left. Stressed and unstressed syllables tend to alternate with stress taking the even-numbered positions.

In retrospect, it can be seen that the most frequent pattern, [...-], with 172 occurrences is also one of the most typical. This pattern has a length of four syllables, contains one stressed syllable in penultimate position, and the ratio of stressed syllables to unstressed syllables is 1 to 3. Representative examples of this pattern from the text follow. Stressed syllables are indicated by capital letters.

por lo MENos
de las COsas
el deREcho
para VERlo

2. SOUND SEQUENCES

Preferences in sound distribution within the rhythmical pattern also show marked tendencies. It was found that pattern position (initial, medial, final) and syllable weight (stressed, unstressed) correlate with certain types of consonant and vowel combinations.

For the three syllable positions, initial position tends toward voiceless, oral stops /p,t,k/ and the mid-front vowel /e/; medial position tends toward nasals /m,n,ɲ/ and the high-front vowel /i/; and final position tends toward voiceless, oral continuants /f,s,x/ and the low-central vowel /a/. The following sense-groups taken from the text show these preferences when combined. The stressed syllables are indicated again by capital letters.

treMENda
que RIgen
de la VIda
que PINte

For the two degrees of syllable weight, stressed syllables prefer nasals /m,n,ɲ/ and unstressed syllables prefer voiceless stops /p,t,k/. Neither stressed nor unstressed

syllables show a marked vocalic preference in our corpus. The following sense-groups taken from the text show the consonantal tendencies correlated with syllable weight. Stressed syllables are indicated again by capital letters.

eleMENTos
actualMENTe
que teNEmos
de la GENte

3. STRUCTURE SEQUENCES

Structural shapes in terms of Consonant-Vowel canonical forms were also studied. Results show that certain types of structural strings are clearly preferred in the Spanish sense-group, and that syllable weight is correlated with syllable structure.

The first most frequent type of structural string is composed of CV syllabic sequences only. Many examples from our corpus show this tendency.

de su paso
CV CV CV CV
de manera que
CV CV CV CV CV
que se come
CV CV CV CV
la música
CV CV CV CV

The second most frequent type of structural string combines CV with CVC structures. When the closed syllable CVC appears in the string, it is found more toward the end of the pattern than toward the beginning. Examples from the text are frequent.

para conocer
CV CV CV CV CVC
no llegan
CV CV CVC
que caminaron
CV CV CV CV CVC
que depende
CV CV CVC CV

Degree of stress viewed in the light of syllabic structure is especially revealing. Our corpus shows stressed syllables to be in general more closed, end more frequently in a consonant, than unstressed syllables—stressed syllables are 44% closed and unstressed syllables are only 26% closed. This tendency is present in all positions of the pattern: initial, medial, and final. But in final position it is especially marked

where stressed syllables are 89% closed and unstressed syllables are only 30% closed.

A further analysis of stress shows that syllable length by number of phonemes is longer for stressed than for unstressed syllables. Stressed syllables were found to be on the average 2.56 phonemes in length while unstressed syllables were 2.25 phonemes in length. This difference in the actual number of segments for stressed and unstressed syllables has an interesting correlation with the measurement of overall syllable duration.

4. LENGTH SEQUENCES

By precise measurements on spectrograms, the duration of all syllables was recorded in number of centiseconds. The major factors of length conditioning were found to be syllable weight (stressed, unstressed), syllable position in the sense-group (non-final, final), and syllable type (closed, open). Table 2 gives average syllable lengths for these three conditioning factors.

TABLE 2

Average syllable length in number of centiseconds for three conditioning factors: syllable weight (stressed, unstressed), syllable position (final, non-final), and syllable type (closed, open).

Stressed	Final	Closed	31.44
		Open	26.47
	Non-Final	Closed	23.92
		Open	17.77
Unstressed	Final	Closed	23.60
		Open	17.16
	Non-Final	Closed	18.97
		Open	13.67

After viewing the data of Table 2, it can be seen that the two stronger factors of length conditioning are position and weight. Final syllables and non-final syllables have a ratio of 1.35 to 1; stressed syllables and unstressed syllables have a ratio of 1.32 to 1. For the weaker factor of syllable type, closed and open syllables reveal a ratio of 1.27 to 1.

When factors are combined, syllable duration is longest in stressed, final, closed syllables which have an average length of 31.44 centiseconds. When factors are opposed, syllable duration is shortest in unstressed, non-final, open syllables which show an average length of 13.67 centiseconds. Syllable length varies between the two limits of longest and shortest durations when factors are in various intervening degrees of opposition and combination.

It is interesting to note that non-final stressed syllables and final unstressed syllables have approximately the same average durations with non-final stressed being slightly longer. In this combination, syllable position and weight are almost counterbalanced.

In conclusion, some of the most important points which have been discovered here can be summarized. Table 3 shows one pattern, somewhat abstract, which is representative of our corpus by its rhythmical contour, its structures, its lengths, and its sound combinations.

TABLE 3

One representative rhythmical pattern which contains the tendencies of our corpus with respect to syllable structure, syllable length, and syllable sound combinations.

CV 14	CV 14	CV 18	CV 17
$\begin{bmatrix} p \\ t \\ k \end{bmatrix} + /e/$	$\begin{bmatrix} m \\ n \\ \eta \end{bmatrix} + /i/$		$\begin{bmatrix} f \\ s \\ x \end{bmatrix} + /a/$

The contour containing four syllables with stress in penultimate position is by far the most frequent in the text and should best represent the language here. Structurally this pattern should be composed of a series of CV shapes—the type of string which is preferred in our corpus. These structures should show length preferences by which the non-final stressed syllable and the final unstressed syllable are of approximately the same length, while the non-final unstressed syllables are somewhat shorter. (The lengths given in centiseconds are those actually calculated for this pattern.) Finally, with respect to sound sequences, the initial syllable should show a combination of voiceless stops and the vowel /e/; the medial unstressed and stressed syllables should prefer the nasal consonants and the vowel /i/; and the final unstressed syllable should combine the voiceless fricatives and the vowel /a/.

Since Table 3 is the result of frequency calculations, sense-groups with its exact dimensions are somewhat difficult to find. Nevertheless, there are many approximations. Groups which readily come to mind are: *tu camisa* and *de mi hija*.

The various tendencies which have been observed here reveal rhythm to be a complex but objectively definable factor of the Spanish sense-group. It was found that rhythm relates in this language not only to sequences of stressed and unstressed syllables with their length characteristics but is also closely allied with certain elements of syllable structure and syllable sound combinations.

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DISCUSSION

BREND (Ann Arbor, Mich.)

1. I believe your study has thus far been limited to rather small units — such as noun phrases, and the like. But, I wonder if you have given any thought to a rhythmic pattern of the larger sentences which may be superimposed on these smaller units when they combine?

2. Could you comment on the (to me) rather simplistic statement that English has stressed-time rhythm while Spanish is syllable-timed? Your study seems to prove that Spanish syllables are NOT absolutely equal length as the above statement would imply.

OLSEN

1. So far, I have limited my study to units no larger than the sense-group because of the difficulty in delimiting larger groups such as the sentence and the paragraph.

2. The terms syllable-timed and stress-timed are relative terms. I believe Spanish can be called 'syllable-timed' even though it has covering patterns of rhythm based on sequences of stressed and unstressed syllables. Spanish syllables are much more equal than English syllables with respect to their length, their retaining of vowel quality, etc.

LEAL (Montréal)

D'après votre exposé, il est possible d'avoir plusieurs syllabes toniques (ou plusieurs syllabes atones) contiguës dans le discours. Certains spécialistes, tel Gili Gaya, nient cette possibilité, AU NIVEAU DE LA PAROLE, par le développement d'un accent (ou d'une désaccentuation) rythmique. Que pensez-vous de cela?

OLSEN

The question referred to the number of stressed and unstressed syllables which can follow in succession. I found that as many as four or five stressed or unstressed syllables can easily appear in succession in the sense-group.