

Frequency of Occurrence of Phonemes in American Spanish

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Volume 19, numéro 2, 1990

La phonétique

URI : <https://id.erudit.org/iderudit/602680ar>

DOI : <https://doi.org/10.7202/602680ar>

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Éditeur(s)

Université du Québec à Montréal

ISSN

0710-0167 (imprimé)

1705-4591 (numérique)

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Citer cet article

Guirao, M. & García Jurado, M. A. (1990). Frequency of Occurrence of Phonemes in American Spanish. *Revue québécoise de linguistique*, 19(2), 135-149.
<https://doi.org/10.7202/602680ar>

Résumé de l'article

On a fait un inventaire des phonèmes de l'espagnol américain en faisant une statistique informatisée de leurs fréquences et leurs distributions. Le corpus a été relevé dans cinq pièces du théâtre contemporain, et il comprend 74 460 syllabes dont 163 861 phonèmes et 43 306 mots. En premier lieu, les sons ont été traités séparément. Les phonèmes /e a o s n r i/ ont obtenu 67,5 % de l'occurrence totale. Il a également été calculé la distribution relative des phonèmes dans les syllabes les plus fréquentes. Les plus hauts pourcentages correspondent à /a e o/ et /s n d t k/. De plus, ils se distribuent en tenant compte de leur position initiale et finale, tant dans les syllabes que dans les mots.

La forte incidence des voyelles, ainsi que celle des consonnes neutralisées en position finale des segments syllabiques, met en évidence le caractère vocalique de la langue espagnole.

FREQUENCY OF OCCURRENCE OF PHONEMES IN AMERICAN SPANISH*

Miguelina Guirao and María A. García Jurado

This work is part of a more extensive computer-aided statistical analysis of Spanish phonological units now in progress.

The main purpose of this paper was to enlarge our knowledge in the frequency and distribution of Spanish phonemes counted in isolation as well as in syllable and word position. Our interest was also centered on the distribution of phonemes according to their articulatory configurations.

Another purpose was to provide a basic phoneme inventory to researchers working in the field of Automatic Speech Recognition Systems. The material could also be useful for cross-language phonological comparisons and for the teaching of the Spanish language.

In particular we examined five different statistics of phoneme frequency distribution: 1) single phonemes, 2) distribution in the most frequent syllables, 3) in syllables of initial and final positions, 4) distribution according to articulatory classes, 5) distribution according to the occurrences of manner of articulation as well as whether in initial or final word position.

Most of the statistical work presented in the past is based in the Peninsular Spanish phonological system. It is known that in the Latin American, as well as in other non-Castilian pronunciations, the sounds of /θ/ (spelled *z*) and /s/ (spelled *s* and *c*) do not have a phonological distinction. The same is true with the pair /x/ spelled *ll* and *y*, that have only one phoneme /ɣ/ for both type of words. For this reason, and because we counted two different vowels per each diphthong, our

* We are particularly indebted to Carlos R. Luis and Guillermo A. Toledo for their collaboration in the phonetic transcription of the speech material, and to Jorge L. Brischetto for his technical assistance with the computer programs.

system consisted of 22 phonemes (17 consonants and 5 vowels). Alarcos Llorach (1961) adopted 24 phonemes (19 consonants and 5 vowels), transcribed by 25 informal letters. He also counted the five archiphonemes /N/, /R/, /B/, /D/ and /G/ separately.

In the classic work of Navarro Tomás (1946) 42 elements are listed, including 14 diphthongs and 4 triphthongs, that he considered monophonemes. In turn, a sample of 5000 Spanish sounds previously transcribed by Navarro Tomás (1926) was used by Zipf and Roger (1939), who compared phoneme frequencies in four Romance Languages and Classic Latin. A similar work was performed by Delattre (1965), who examined phoneme frequencies in four languages. He selected small oral samples (the number of items is not specified) that were expressed in casual and colloquial style. An extensive corpus of 70755 words used by Lloyd and Schnitzer (1967) is not included in our comparison because their text was taken from dictionaries. Quilis and Esgueva (1980) adopted the same transcription used by Alarcos Llorach to count 160000 phonemes. They tape recorded conversational speech of 16 talkers, half men and half women, between the ages of 18 and 65 years, spanning four generations.

A few other surveys provide quantitative data on American Spanish phoneme statistics. Tato et al. (1949) presented an inventory of 45952 elements counted from 10000 words. Since they adopted 23 symbols and did not use a phonetic transcription, their data could only be approximately compared with ours. A comparison is also difficult with the results of Saporta (1955) who worked with a single Mexican informant and adopted a peninsular Spanish transcription. Guirao and Borzone de Manrique (1972) analysed, with computer assistance, a total of 62980 phonemes distributed in 14577 words. In their inventory frequencies of syllables, syllabic types and words were also calculated. Samples were taken from tape recorded informal TV dialogues, newspaper notes and passages of modern plays. In the present study, since we added distributional aspects of phoneme statistics, the size was 2.6 bigger than in the 1972 paper.

Speech material

Our corpus was drawn from five modern plays written by contemporary authors: Roberto Cossa "Por siempre alegre", Ricardo Taleisnik "La fiaca", Carlos Gorostiza "El puente", "El pan de la locura" and "Los prójimos". Because of their

everyday life conversational style and the spontaneity of expression the material was considered sufficiently representative of the average Spanish American talker. The total transcribed phonemic units altogether summated 163861 phonemes, 74460 syllables and 43306 words. Specific computer programs were devised to be used for the analysis.

Since Spanish orthography is largely phonetic, a relatively simple phonemic transcription was adopted so that we could use the minimum number of symbols without introducing ambiguity in the identification of each one of the sounds. As seen in Table 1, all but four phonemes /ɣ/ (spelled *y* and *ll*), /tʃ/ (*ch*) /x/ (*j*) and /ɲ/ (*ñ*) are represented with orthographic symbols. Allophonic variants are described by Guirao and Borzone de Manrique (1972). Three trained phoneticians were in charge of the phonemic transcription. They also marked in the text the boundaries between phonological syllables and between words according to the norms of the language.

Distribution of phonemes

Our first count of single phonemes with the rank order, the number of occurrences and the percent distribution are shown in Table 1. We see in this table that vowels and consonants nearly equally divide the whole percentage to 48.4% and 51.6% respectively.

Table 1. Distribution of phonemes

Total number of phonemes in corpus: 163861

Vowels: 79265 (48.4%) Consonants: 84576 (51.6%)

Rank	Phoneme	Occurrences	Percent
1	/e/	24561	15.0
2	/a/	21741	13.3
3	/o/	17621	10.7
4	/s/	15384	9.4
5	/n/	11699	7.1
6	/i/	10791	6.6
7	/r/	8855	5.4
8	/t/	7347	4.5
9	/k/	7064	4.3
10	/d/	6550	4.0
11	/l/	6354	3.9
12	/m/	5188	3.2
13	/b/	5044	3.1
14	/u/	4571	2.8

15	/p/	4392	2.7
16	/g/	1814	1.1
17	/ʒ/	1183	0.7
18	/x/	1150	0.7
19	/f/	871	0.5
20	/tʃ/	650	0.4
21	/rr/	632	0.4
22	/ɲ/	399	0.2

For the sake of simplicity we divided the sample into four groups by steps of 5% intervals. Group 1 contains the three top vowels /e a o/ each with a percentage of between 14.9 and 10.0. This group alone accounts for 39.0% of all occurrences. In Group 2 we find the three more frequent consonants /s n r/ plus vowels /i/ with scores between 9.9 to 5.0%. Note that the sum of these two groups gives a 67.5% of the total occurrences. Group 3 contains nine phonemes /t k d l m b u p g/ which scored between 4.9 and 1.0%. Finally in Group 4 are the remaining six consonants /ʒ x f tʃ rr ɲ/ with percents lower than 1.0. This group represents only a 7.9% of the total.

The reliability of our counts was examined by calculating the radius (K) of the confidence interval for each phoneme. We looked for the 99% level of confidence using to that effect the formula

$$K = 2.57 (p q/n)^{1/2}$$

where p is percent of occurrence by fraction q is equal to 100-p, and n is equal to 163861 which is the total number of phonemes in the sample. The factor 2.57 correspond to the 99% level of confidence interval. With this factor the values of occurrence given in table 1 should fall between the limits of $\pm 0.3\%$. The confidence intervals (k) obtained gave values between 0.22 and 0.19 for the phonemes of Group 1, 0.18 to 0.14 for Group 2, 0.13 to 0.06 for Group 3 and 0.05 to 0.03% for Group 4. Thus, the values obtained can be considered to reflect the true distributions in the corpus.

Comparison with other studies

In Table 2a and 2b our results are compared with those obtained by the above mentioned authors. In all cases vowels and consonants are almost equally. We observe that in general a notable agreement exists not only in the percent figures but also in the rank order for each

Table 2a. Comparison with other studies.

Distribution of vowels

	Present study	Quilis and Esgueva	Guirao and Borzone	Delattre	Alcaros Llorach	Navarro Tomas	Zipf and Rogers
Total	48.4	47.6	47.2	42.5	47.3	43.5	43.6
/e/	15.0	14.7	14.5	14.0	12.6	11.8	12.2
/a/	13.3	12.2	12.5	13.0	13.7	13.0	14.1
/o/	10.8	10.0	9.9	9.2	10.3	8.9	9.3
/i/	6.6	7.4	7.3	4.5	8.6	4.8	4.2
/u/	2.8	3.3	3.1	1.8	2.1	1.9	1.8

Table 2b. Comparison with other studies.

Distribution of vowels.

	Present study	Quilis and Esgueva	Guirao and Borzone	Delattre	Alcaros Llorach	Navarro Tomas	Zipf and Rogers
Total	51.6	52.4	52.8	57.3	52.7	56.5	56.4
/s/	9.4	8.3	9.7	8.4	8.0	8.5	8.1
/n/	7.1	2.8	7.7	7.0	2.7	6.9	5.9
/r/	5.4	3.3	5.6	6.2	2.5	5.9	5.9
/l/	4.5	4.5	4.9	4.8	4.6	4.8	4.5
/k/	4.3	4.0	4.4	4.7	3.8	4.2	3.8
/d/	4.0	4.2	4.2	5.2	4.0	5.0	5.1
/l/	3.9	4.2	4.3	3.9	4.7	5.5	5.2
/m/	3.2	3.1	3.0	3.7	2.5	3.1	3.0
/b/	3.1	2.4	2.5	2.9	2.5	2.5	3.3
/p/	2.7	2.8	2.8	2.3	2.1	3.1	2.9
/g/	1.1	0.9	0.9	0.7	1.0	1.0	1.0
/ʒ/	0.7	0.4	0.6	3.0	0.4	0.4	2.4
/x/	0.7	0.6	0.7	0.4	0.7	0.5	0.6
/f/	0.5	0.6	0.7	0.5	1.0	0.7	0.7
/tʃ/	0.4	0.4	0.3	0.3	0.4	0.3	0.3
/rɾ/	0.4	0.4	0.5	-	0.6	0.8	1.0
/ɲ/	0.2	0.3	0.3	0.3	0.2	0.4	0.4

phoneme. Some deviations are obviously due to differences in the phonological system. For instance Navarro Tomas and Zipf and Roger considered diphthongs as single phonemes and for this reason their values of /i/ and /u/ are lower than ours. Similarly Alarcos Llorach and Quilis and Esgueva present lower numbers for /n/ and /r/ in part because they counted archiphonemes as separate elements. Delattre obtained a higher score for /r/ because he treated both vibrants /r/ and /rɾ/ as one single phoneme.

In the same way the peninsular Spanish phonemes /θ/ should be discounted from our percent for /s/ and /ʎ/ from our /z/. The figures obtained by the various authors were Navarro Tomas 0.60 and 2.23 for /θ/ and /ʎ/ respectively, Zipf and Roger 1.74 and 0.60, Alarcos Llorach 1.70 and 0.50, Delattre 1.42 and 0.47 and Quilis and Esgueva 1.45 and 0.38%.

We note in Table 2a a slight discrepancy in the vowel /a/ and /e/ which Quilis and Esgueva attributed to differences between written and oral language. However we found a systematic predominance of vowel /e/ in our text as well as in the oral samples selected by Quilis and Esgueva and Delattre. Vowel /e/ is also the first phoneme in the count of Guirao and Borzone where both styles were combined.

As for the size of the corpus it seems that the samples could still be considerably decreased before we notice a substantial modification in the results. See for instance that the quantity of peninsular Spanish speech material collected by the various authors was wedely different. The agreement is still very close with the Spanish American count by Guirao and Borzone in spite of the fact that the sample was much smaller than ours.

On the other hand, as reported by Quilis and Esgueva, significant differences were not found neither between talkers of different generations nor between men and women.

Finally, it must be noted that these high correlations were obtained in spite of the difference in literary and conversational styles with the consequent variations in vocabulary. Given the consistency of these findings, we have reason to believe that the frequency of occurrence of phonemes seems to be a fonction of the internal structure of the Spanish language.

Distribution of phonemes in syllables

An interesting point was to examine to what extent the predominance of certain phonemes could result from a small number of syllables which also have a high incidence (Guirao and García Jurado, 1987). In this instance we calculated the percent frequency of the phonemes that occurred in the first 27 different syllables, the list is presented in Table 3a and the results in Table 3b.

Table 3a. Percent distribution of the first twenty seven syllables (with asterisk are also words).

/a/*	5.5	/do/*	1.7	/pa/	1.3
/ke/*	3.9	/ta/	1.6	/e/*	1.2
/no/*	3.8	/to/	1.6	/ba/*	1.2
/de/*	2.5	/la/*	1.5	/lo/*	1.2
/se/*	2.5	/me/*	1.5	/da/*	1.1
/es/*	2.4	/ra/	1.4	/ka/	1.1
/i/*	2.1	/sa/	1.4	/o/*	1.1
/te/*	2.0	/ko/	1.3	/el/*	1.0
/si/*	1.8	/na/	1.3	/ro/	1.0

The sample covers 67391 phonemes which is close to the 40% of the total number in the corpus. Notice that this sample represents only 0.05% of the 74460 syllables counted in the text and 50% of the total number of syllabic occurrences. Phonemes that are missing in the table exhibited less than 1.0% or never appeared.

Table 3b. Relative distribution of phonemes in the most frequent syllables
Sample size: 67391 phonemes in 27 syllables

Rank	Phoneme	Percent
1	/a/	19.4
2	/e/	19.0
3	/o/	13.0
4	/s/	8.9
5	/k/	7.0
6	/d/	5.9
7	/t/	5.8
8	/n/	5.7
9	/i/	4.3
10	/l/	4.2
11	/r/	2.8
12	/m/	1.6
13	/p/	1.4
14	/b/	1.3

We observe in Table 3b that although some of the sounds changed in rank order, in general, phonemes of high incidence are also encountered in the most recurrent syllables. The three vowels of Group 1 predominate with a percentage of 47.9%. This time /a/ ranks first followed by /e/ and /o/. Of the other two vowels, /u/ never appeared and /i/ was displaced to a lower rank. Among consonant of Group 2 the sound /s/ was next to the top vowels as before, but /n/ and /r/ shifted to ranks lower than /d t k/ of Group 3. The other consonants of this Group /l m b

p/ kept in a similar ranking order as in table 1. The sound /g/ and consonants of Group 4 are not registered as components of the most frequent syllables.

Our next step was to look into the distribution of phonemes on the basis of their initial and final position in the syllable. For this purpose we used all the phonemic items in the corpus. Notice that one single phoneme syllables, like the vowels, are excluded in both positions. Their percentage in isolation is /a/ 2.13, /i/ 1.24, /e/ 0.89, /o/ 0.70 and /u/ 0.27%

Results are shown in Table 3c and Table 3d for the initial and final positions, respectively. As it is known in Spanish all phonemes are used to start a syllable but practically about a half of them are admitted in the final position. Also, as was expected, consonants concentrate more heavily in the first position and vowels in the second.

Table 3c. Relative frequency distribution of phonemes in syllable-initial position

Total number of phonemes: 163861

Total number of syllables: 74460

Rank	Phoneme	Percent	Rank	Phoneme	Percent
1	/t/	9.9	12	/r/	4.2
2	/s/	9.8	13	/i/	2.5
3	/k/	9.4	14	/g/	2.4
4	/d/	8.3	15	/u/	1.8
5	/n/	7.5	16	/ʒ/	1.6
6	/a/	6.8	17	/x/	1.5
7	/b/	6.7	18	/o/	1.3
8	/m/	6.0	19	/f/	1.2
9	/p/	5.9	20	/tʃ/	0.9
10	/e/	5.8	21	/rr/	0.8
11	/l/	5.1	22	/ɲ/	0.5

As indicated in Table 3c phonemes are distributed in gradually decreasing number corresponding the higher scores to /t s k/. The next more probable phonemes to start a syllable are /n d/. These five consonants made up 50.7% and together with the second set /a b m p e l/ summated 87.1% of all phonemes initiating a syllable.

Table 3d. Relative frequency distribution of phonemes in syllable-final position

Total number of phonemes: 163861

Total number of syllables: 74460

Rank	Phoneme	Percent
1	/a/	21.7
2	/e/	21.3
3	/o/	17.2
4	/s/	10.9
5	/i/	9.2
6	/n/	8.2
7	/r/	5.0
8	/l/	2.6
9	/u/	2.3
10	/m/	1.0
11	/d/	0.5
12	/k/	0.1

As shown in table 3d among the items terminating syllables 71.8% are vowels. This marked predominance for open syllables was pointed out by Delattre and Olsen (1969) who obtained the same percentage using a sample of 2000 Spanish syllables. The three vowels of Group 1 /a e o/ alone account for the 60.3% of all phonemes in final syllable position. If we add vowel /i/ and the three consonants of Group 2 /s n r/ we found that only seven sounds are responsible for the 93.3% of all phonemes terminating a syllable. Three other sounds /l u m/ together approximate a 6.0. Sounds like /d/ as in "usted" and /k/ as in "acto" are seldom pronounced in syllable final position. The rest of the consonants with percents lower than 0.02 are not included in the table. Examples are: /g/ in "digno", /p/ as in "apto", "f" as in "afgano" and /b/ as in "absoluto".

Articulatory classes

Table 4 gives the same data presented in Table 1 but regrouped according to conventional articulatory classes. One feature to be noted is that the sum of vowels and voiced phonemes, a percentage of 77.5%, holds for more than three-fourths of the total occurrences.

The three more frequent vowels are produced at different points of the vocal tract: central /a/, frontal /e/ and back /o/. The first is open, and the other two are half closed.

Table 4. Percent distribution of phonemes according to articulatory classes
Total vowels: 79285 (48.4%) Total consonants: 84576 (51.6%)

VOWELS			CONSONANTS	
Front	Close /i/	6.6	Voicing	
	Half close /e/	15.0	Voiced	
			/l r r r m n ɲ d g b ʒ/	29.1
Central	Open /a/	13.3	Unvoiced	
Back	Close /u/	2.8	/p t k s f x tʃ/	22.5
	Half close /o/	10.8		

CONSONANTS			
Manner of articulation		Point of articulation	
Liquids	/l r rr/	9.7	Dental /n l r rr t d s/ 34.7
Nasals	/m n ɲ/	10.5	Labial /b p m f/ 9.5
Stops			
Voiced	/b d g/	8.2	Velar /x k g/ 6.1
Unvoiced	/p t k/	11.5	
Fricatives			Palatal /ɲ ʒ tʃ/ 1.4
Voiced	/ʒ/	0.7	
Unvoiced	/s f x tʃ/	11.0	

In the same Table, the three consonantal sets of sounds described by manner of articulation present subcategories that, with the exception of /ʒ/, are fairly evenly distributed. Each group of liquids and nasals average about 10.0%. Voiced and unvoiced stops and unvoiced fricatives scored between 8 and 11% per group. When the criterion is place of articulation dentals play a prominent part in the consonantal system. This group with a percent of 34.7%, has an incidence of almost four times more than the labials, 9.5%, and about six times more than velars, 6.1%. Palatals have a low occurrence, 1.4%.

Phonemes in words

Table 5 presents a list of phonemes distributed in initial and final word position. In the same table each phoneme is differentiated according to its articulatory specification.

Table 5. Percent distribution of each phoneme by articulatory configurations and by word position

Total phonemes: 163861 Total words: 43306

Phoneme classes		Position in the word	
		Initial	Final
VOWELS			
Front close	/i/	3.7	7.2
Front half close	/e/	9.9	21.7
Central open	/a/	9.9	19.8
Back close	/u/	3.0	0.3
Back half close	/o/	1.4	21.5
CONSONANTS			
Liquids	/l/	7.0	3.0
	/r/		6.1
	/rr/	0.9	
Nasals	/m/	6.1	
	/n/	6.7	6.6
	/ɲ/	0.1	
Voiced stops	/b/	6.0	
	/d/	6.2	0.8
	/g/	1.0	
Unvoiced stops	/p/	7.4	
	/t/	5.8	
	/k/	12.6	
Voiced fricatives	/z/	1.8	
	/s/	8.0	13.0
	/ʃ/	1.4	
Unvoiced fricatives	/x/	0.7	
	/tʃ/	0.5	

In examining this table it should be kept in mind that figures represent subtotals of the grand total which include internal occurrences. Also, the five vowels, which in isolation form words by themselves, are excluded from this list.

As it was expected, in general consonants have a high predominance at the onset of the words while vowels have the opposite tendency. Exceptions are /u/ and /s/. Vowel /u/ seldom appears as a final word sound. The fricative /s/, which makes most of the plural Spanish words, gives the higher score at the final position. Still it appears in both margins with a relatively high rank. In fact, as

a first component with 8.0%, it is next to the unvoiced stop /k/, which in turn with a percent of 12.6%, is the most probable phoneme for starting a word. This figure duplicates the incidence of the other two unvoiced stops /t/ and /p/. Both are articulated in the initial position as often as their voiced counterparts /d/ and /b/. Likewise, nasals /m n/ and the liquid lateral /l/ averaged between 6.0 and 7.0%. Of the other two liquids /r/ is quite infrequent (0.9%) and single vibrant /r/ never takes the initial position. Fricatives /ʒ f x tʃ/ appeared with very low incidence, between 0.5% and 1.8%, and the unvoiced stop /g/ ranked only around 1.0%.

In words starting with vowels, central open /a/ and frontal half closed /e/, each with an average of 10.0%, are three times more frequent than front closed /i/ and back closed /u/. Back half closed /o/ (14.0%) is the least numerous in an initial position. Instead this vowel had an average of 21.0% in the final position, the same as /a/ and /e/ which together cover 62.0% of all phonemes located at the end of words. Vowel /i/ follows with 7.0% while /u/ seldom is produced to terminate words.

As for consonantal sounds in a final position, due to the phonological rules of the system, only four phonemes have a significant number of occurrences. The fricative sound /s/ close to 13.0% outnumbers the vibrant /r/ and nasal /n/ in a proportion of almost 2 to 1. The same proportion holds between these two sounds and lateral /l/. Voiced stop /d/ seldom appears in this position though it occurs in carefully pronounced words as in "alud". Phonemes with scores lower than 0.03% are not included in this table. Example of those cases are nasal /m/ as in "album"; the fricatives /f/ and /x/ as in the interjections "uf" and "puaj"; and the stops /k b t/ which appear in names as in "Isaac", or in borrowed words as in "club" from the English and "complot" from the French language.

In comparing the data in Table 3c and 3d with those in Table 5, we first observe that results are consistent with our phonological expectations. It is clear that there is less uncertainty about the termination of a syllable, or word, than about its onset. In fact, the end of both segmental units is marked by vowels 70.0%, voiced consonants /r l n/ 16.0% and fricative /s/ nearly 12.0%. These phonemes maintain approximately the same rank order whether syllables are counted as a part or outside of the words.

The situation is different when items are marking the onset of segmental units. A phoneme may score quite differently whether or not the syllable is

initiating a word. For example in syllables that start words vowel /a/ ranked second and /e/ third but when syllabic segments were counted alone the same vowels scored tenth and sixth respectively (Table c). Conversely the stop /t/, the most probable phoneme to initiate a syllable, changed to rank order number 11 when the syllable is initiating a word. Voiced stops /b/ /d/ /g/ are more likely to start a syllable than to start a word while the reverse is true with unvoiced stops /p/ and /k/. In Table 3c we see that /l/ and /r/ are almost equally probable to initiate a syllable though lateral /l/ is practically the only one to initiate a word since vibrant /rr/ is rather infrequent and /r/ is never placed in that position.

Only two sounds /s/ and /n/ are encountered with equal probability at any of the two margins of the syllables counted alone or in initial and final word position, though their articulatory features vary to a great extent from one position to the other. This is generally true for all sounds that mark boundaries at any of the two borders of syllables. Consonants located at the onset of phonological segments are relatively more strongly articulated and more resistant to effacement. On the contrary, sounds produced in closed syllables as apico-alveolars /l/ /r/ and nasal /n/ are in general weakly articulated, and as a consequence these phonemes are neutralized. Similarly, fricative /s/ when closing a syllable is articulated as an aspirate [h] as in [lo^h mi^h mo^h] written "los mismos". In all four cases the effect is a more open articulation of the preceding vowel with the corresponding increment in its duration.

Also, the fact that 7 out of the 10 phonemes encountered in this position are vowels reflects the strong tendency of the Spanish language for the open syllables (Guirao and García Jurado, 1989). Hence the phonetic vocalic character of this language could be attributed, in part, to the enhancement of vowels when placed at the boundaries between syllables.

Concluding remarks

The present inventory shows that voicing is an important dimension of the Spanish language. In fact, vowels and voiced consonants cover more than three quarters of all phoneme occurrences.

Front half closed vowel /e/, the most frequent of all items, plus open central /a/ and back half closed /o/ account for 40.0% of all phoneme occurrences.

Fricative /s/, the first of all consonants, together with nasal /n/ liquids /r/ and /l/ and stops /t k d/, amounts to approximately another 40.0%. The same set of three vowels, four dentals /s d n t/ and one velar /k/ predominate in the more used syllables.

The onset of syllables is marked by stops /t k d/ ranging between 8.0 and 10.0%, fricative /s/ close to 10.0%, stops /p b/, nasals /n m/ and vowels /a e/ all of which average about 6.4%. Next are liquids /l r/ ranging between 5.0 and 4.0%. The same phonemes, with exception of /r/, together with the two vowels, are preferred for starting words. Order of rank presents some variations. Stop /k/ is the first 12.7%, followed by /a e/ and fricative /s/ each close to 10%, stops /p d b t/, lateral /l/ and nasals /m n/ each with values between approximately 6.0 and 7.5%.

The final portion of syllables and words is delimited mainly by vowels /e a o/. These sounds are distributed more or less evenly between 20.0 and 22.0% at the release of the syllable and between 17.0 and 22.0% at the end of words. Fricative /s/ follows with an average of 13.0% in word and of 11.0% in syllable final positions. Vowel /i/ is produced at the end of both segments with an average of 7% in words and 9.0% in syllables. Nasal /n/ and liquids /r l/ ranged between 3.0 and 7.0% terminating words and between 2.5 and 9.0% at the offset of syllables.

The high incidence of vowels 70.0% and neutralized consonants (15.0%) at the terminal limits of syllables, either in isolation or in words, accentuate the vocalic quality of the Spanish language.

Comparison with other studies based on Peninsular Spanish pronunciation shows minor differences which have a small effect on the overall phonemic correspondence.

The frequency of occurrence of phonemes seems to be associated to the inherent structure of the Spanish language.

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