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The initial development of spelling in Spanish: From global to analytical

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Abstract. During a school year, samples of words written by three groups of children of successive ages were collected. Two groups of children were in first and second year of Kindergarten (4 and 5 years of age), when alphabetic rules were not taught in a systematic way. The third group was in first year of Primary School (6 years of age), and was being taught to read and spell in a systematic way. After classifying the words written by the children, seven categories of spelling were obtained, which may represent different stages in their learning process. Their analysis showed that they are related to different types of knowledge and processes, mainly phonological ones. The results show that the development of spelling in Spanish does not qualitatively differ from that of children who learn to spell in opaque writing systems. The differences mainly involve the time it takes to learn, and the rate of acquisition.

Key words: Phoneme–grapheme correspondence rules, Phonologica1 skills, Spelling

The developmental models of spelling acquisition that have been put forward over the last two decades (Ehri, 1986; Frith, 1985; Gentry, 1982, 1987; Henderson & Beers, 1980; Morris, 1983; Treiman, 1994) share three main features: (i) they are suprime, especially based on the analysis of the errors children make when trying to spell new words, (ii) they are theories that describe the stages of the spelling development and (iii) they mainly focus on the phonological skills of children, although they admit the importance of orthographic knowledge (Ellis, 1994).

These models and the empirical work derived from them have given rise to the acceptance of three major stages that children progressively go through when they are learning how to spell. The first stage is basically pre-communicative. The children represent words based on their visual features (a logographic procedure), and still do not relate sounds and letters in words. After this stage, the process of acquiring the alphabetic principle begins. The children learn the phoneme–grapheme correspondence rules (PGCs from now on). Finally, once the code is mastered, the children reach the last stage, where their spelling is orthographically

correct, since they have stored the orthographic patterns of many words in their mental lexicon.

The second stage, which is critical for mastering spelling in alphabetic orthographic systems, has been in turn subdivided into three substages: 'semiphonetic', 'phonetic' and 'transitional' (Ellis, 1994). In the 'semiphonetic' substage, the children start to show a certain knowledge about the relation between spelling and the sound of words, but it is still incomplete. The letters used to represent words provide a partial but not total mapping of the phonetic representation of the word being spelled. In the 'phonetic' substage, the children show a remarkable ability to segment words, and their spelling shows a representation of all the sounds. However, letters are assigned strictly on the basis of sound without regard conventions of the orthography. Finally, in the 'transitional' substage, the children follow certain spelling conventions but still do not reach full orthographic knowledge, which requires a broad experience with the written language and will take place later on, and that are necessary knowledge for spelling irregular or exceptional words (in English, the language in which most of these studies have been undertaken) or of which have inconsistent graphonemes[1] in the case of Spanish.

We must bear in mind that most of the research mainly refer to alphabetic systems such as that of the English language, which is far from being transparent, since the PGCs are highly unpredictable and their acquisition requires a long learning process. Spanish, however, is very different, since its orthographic system is totally transparent in reading and is only slightly unpredictable in spelling, due to the existence of certain phonemes which can be transcribed with more than one grapheme, namely inconsistent graphonemes (Marín, Carrillo, & Alegría, 1999). For example, /b/ that could be spell as b or v; /x/ that could be spell j or g with vowels e and i; or /θ/ that it is spell c with e and i, and z with a, o u. Finally, the case of letter h that have no sound. It is necessary to specifically know how these graphonemes are spelt in each of the words that contain them. The English language also has more complex phonetics, with a greater number of vowel sounds than Spanish, which only has five vowel sounds (and only six vowel graphonemes, /a/↔a, /e/↔e, /o/↔o, /u/↔u, /i/↔i, /i/→y). The same applies to consonant sounds and their clusters, many of which are very similar.

Some studies have proven that the features of any alphabetic system, mainly its degree of transparency, affect the development of its acquisition. These studies show that such features have a major influence in the time needed to acquire the code (Cossu, 1999; Wimmer, Landerl, & Frith, 1999) and on the type of orthographic unit (phonemes, intrasyllabic

units) relevant for such acquisition (Share & Levin, 1999). The latter is shown by the different units in which words tend to be segmented when they are spelled, depending on the language one learns to write (Tolchinsky & Teberobsky, 1997).

A question that immediately arises is whether the development of spelling in an almost transparent system such as Spanish is qualitatively different from the development of spelling in a non-transparent language such as English or whether the differences are quantitative instead. In other words, are there different stages in learning to spell? Are the stages similar and do they differ only in the difficulty of their acquisition? Or do the spelling ability follow a continuum development? If qualitative differences were found between the developments of spelling in both languages, it would prove the inadequacy of extrapolating the findings of research in the English language to explain spelling acquisition in another alphabetic system, such as Spanish. If such differences were not found, it would show the powerful common mechanism underlying the learning of spelling in alphabetic languages, despite their superficial differences.

Our premise was that it should be much easier to master the correct spelling of words, both phonetically and orthographically, in Spanish than in English. This should originate qualitatively different models of spelling development, with fewer stages and substages. Even though there are studies in Spanish that support the existence of similarities with English between the mechanisms involved in the learning of reading and spelling, once these skills start to be formally taught (Cuetos, 1993; Valle-Arroyo, 1989), none of them have undertaken a longitudinal analysis ranging from the pre-writing stage of children to the formal learning period.

Therefore, we carried out a longitudinal study in the classroom, and monitored three groups of 4- and 5-year-old children (first and second year of Kindergarten), and 6-year-old-children (first year of Primary School) during the school year. The participation of both children who had not begun to learn to spell in Spanish and children who were beginning to learn was aimed at allowing us to check the presence or absence of the three commonly accepted major stages (pre-communicative, alphabetic and orthographic) as well as the substages. More specifically, we wanted to observe the children's behavior when spelling new words (for the kindergarten children it was presented as a task of invented spelling), the development of their phonological and orthographic knowledge during the school year, and analyze the errors they made when spelling.

Method

Participants

One hundred and one Spanish children from three age groups participated (see the features of the sample in Table 1), belonging to 1st and 2nd year of Kindergarten (K1 and K2, respectively) and Primary School (PS). All children came from a medium SES context, and have no sensory or intellectual deficit.

In the classroom, both Kindergarten children K1 and K2, performed pre-writing tasks (mainly orientation of their stroke and motor functions); K2 children were taught some PGCs in a non-systematic way. They learnt only the vowels and few consonants. Thus, the Kindergarten group of 4-year-olds (K1) had a weak knowledge of the alphabet, whereas the Kindergarten group of 5-year-olds (K2) was somewhat familiar with it at the end of the school year. The PS group was systematically taught the alphabet and the PGCs. These children learned the alphabet by means of 'reading-spelling units', in each of which a new letter and its matching sound were learnt. The words that appeared in each new unit included the new letter as well as letters from the previous units.

Procedure

Sixteen tests were prepared, with 16 different consonants, to observe the development of the phonological and orthographic knowledge during the school year. They involved spelling words dictated to the children (see Appendix 1). To avoid effects due to fatigue, we chose only six words per test. Most of them were two-syllable words, which are very common in Spanish, and they were assigned depending on the letters learned by the children at any given point.

Table 1. Sample characteristics.

Level	Mean Age	Boys	Girls	Total
1st year Kindergarten	4 years; 8 months	6	10	16
2nd year Kindergarten	5 years; 4 months	16	17	33
1st grade Primary School	6 years; 3 months	22	30	52
Total		44	57	101

Previous research (Defior & Martín-Martín, 2001) had shown that children have trouble writing diphthongs, and tend to represent them with only one of their vowels. They also tend to confuse consonant phonemes that are phonetically very similar to each other. These errors have also been found by other authors (Henderson & Beers, 1980; Lombardino, Bedford, Fortier, Carter, & Brandi, 1997; Read, 1986; Treiman, Broderick, Tincoff, &Rodriguez, 1998).

For this reason, out of the six words, two had a diphthong, two included the latest grapheme taught in the classroom and the other two included a consonant phoneme that shared two articulatory features[2] with the phoneme that matched the latest grapheme learnt and was therefore very similar to it. To offset the possible effect of the position of the target grapheme in the word, one of these words included it in its first syllable, whereas the other one included it in its second syllable. The partial aim of these conditions was to find out when the children start to be able to clearly distinguish the vowels in a diphthong and spell them, and also when the children are able to clearly distinguish very similar consonant phonemes.

In the K1 and K2 groups, where most of the children did not know any consonants or hardly any, but knew the vowels, the children were told that it was a game where they were supposed to pretend they knew how to spell and that they should perform the task as well as possible.

The tests were assigned depending on the process followed in each group to teach children to spell. The PS children, who were learning more letters collectively, performed all the tests (several in one month). The K1 children only performed three different tests, and repeated the same tests from one month to the next in many cases. The K2 children performed an intermediary number of tests. In the two Kindergarten groups, the tests were assigned individually, following the procedure used by the teachers of these groups. The children were never given feedback about their performance. We tried to obtain at least one test per child every month, to be able to follow the children's monthly development.

Apart from the dictation tests, all the children performed a composition task in April. The Kindergarten children 'wrote' about their recent Easter holidays and the PS group wrote about their favorite animal. These compositions allowed us to assess (i) what kinds of errors the children made; (ii) whether the number and the kind of errors in spontaneous writing were similar to those found in dictation tests and (iii) whether younger children used writing as a means of expression or preferred other means such as drawing.

Results

The children's spelling was classified depending on the kind of errors they made when writing, which gave rise to different spelling categories. Certain common errors in Spanish such as 'yeísmo',[3] 'seseo',[4] and 'ceceo'[5] were excluded, as they were interpreted as a pronunciation problem and not as a spelling error.

The number of children making each kind of error was computed every month, and percentages were calculated. Phonological omission and substitution errors were analyzed, because they provided more accurate information about the phonemic analysis of words by the children. A statistical analysis was carried out by using the chi-square test, comparing the distribution of the spelling categories between the different groups and within each group to study the learning process. The results of the composition task are also presented briefly.

Spelling categories. Seven spelling categories (see examples in Appendix 2) were found:

- Linear scribbles. Continuous upward and downward strokes that imitate the appearance of a written line.
- Random letters. Letters randomly written, which bear no relation at all with the dictated word.
- Partial spelling. There is some relation between what is spelt and the target word, but not all its phonemes are represented. Two subtypes can be distinguished: vowel partial spelling, formed only by vowels, and consonant–vowel partial spelling, with consonants and vowels, though not all the ones in the word appear.
- General substitutive spelling. The children try to represent all the phonemes of the word, and there is one grapheme per phoneme. However, some letters are replaced by others with which they have no phonological or orthographic relation.
- Specific substitutive spelling. As in the previous category, the children try to represent all the sounds of the word, and some letters are replaced by others. Yet, the letters which are replaced correspond to very similar phonemes which share two articulatory features with them.
- Non-orthographic spelling. Sounds are transcribed correctly from the phonological point of view, but incorrectly with respect to orthographic rules. This error happens when certain sounds may be represented with more than one grapheme and there is no rule that establishes which is the correct one (inconsistent

graphonemes) or, if there is a rule which determines it, when it is a complex rule (complex consistent graphonemes).

- Conventional spelling. Children were considered to have reached the level of conventional writing when they spelled the 6 words in the test correctly.

Distribution of the spelling categories over time. Table 2 shows the monthly distribution of the percentage of children in each category; only data from testing periods including the three groups are presented. The review of these percentages reveals that children tend to have a different behavior depending on which group they are in. For example, in the case of K1 children, after the initial scribbles, they mainly produce categories of random letters or partial spelling; K2 children use random letters, partial spelling and some kinds of substitutions, whereas PS children use substitutions at the beginning, and quickly evolve to 'non-orthographic' spelling, until they finally reach conventional spelling.

Analysis of phonological errors. Table 3 shows the overall percentage of errors (omission and substitution) in each group of children, in the categories partial spelling, general substitutions and specific substitutions. The incomplete or erroneous transcription of the phonemes of a word was considered a phonological error.

Table 3 shows that omission errors, typical of partial spelling, are widespread in the K1 group, whereas substitutions prevail in the K2 and PS groups. Regarding substitution errors, in the K1 group, more than half of errors involve general substitutions, and there is a less percentage of specific substitutions. The same trend continues in the K2 group, though the differences are more marked (79% versus 21%); the proportion is the opposite in the PS group, where specific substitutions are much more abundant.

Therefore, even though the percentage of errors decreases as the process of alphabetic learning evolves (see Table 2), the kinds of prevailing error differ between the groups: omissions (partial spelling) in K1, substitutions, mainly general ones, in K2 and substitutions, mainly specific ones, in PS. This suggests a change in the strategy used by children.

Specific substitution errors might be due to chance. Since there are 24 phonemes in Spanish, 19 of which are consonant and 5 of which are vowel sounds (Lázaro, 1989), the probability of obtaining a specific consonant substitution by chance was calculated. It is 0.152 (25/342) or 15.2% (see Appendix 3). As shown by Table 3, the percentage of specific substitutions was always above chance.

Table 2. Monthly distribution of the percentage of children in each spelling category as a function group.

Percentage	December			January			February			April			June		
Group:	K1	K2	PS	K1	K2	PS	K1	K2	PS	K1	K2	PS	K1	K2	PS
Scribble	35.7	11.6	0	0	0	0	0	0	0	0	0	0	0	0	0
Letters by chance	57.1	44.2	0	30.8	28.3	0	44.4	19.2	0	21.7	12.2	0	0	0	0
Partial S.	7.2	32.5	28.9	69.2	50.9	16.1	22.2	36.5	3.5	43.4	47	0	27.3	24.5	0
General S.	0	4.6	5.2	0	1.8	12.9	22.2	25	4.7	26.1	14.3	0	27.3	18.4	0
Specific S.	0	4.6	44.7	0	11.3	30.6	11.2	7.68	30.6	4.4	12.2	7.2	27.3	24.5	0
Non-orthographic	0	2.5	15.8	0	7.7	35.5	0	3.85	30.6	0	4.1	30.9	9.05	16.3	13.3
Conventional	0	0	5.4	0	0	4.9	0	7.68	30.6	4.4	10.2	61.9	9.05	16.3	86.7

Table 3. Global percentage of phonological errors in each group.

Error type	Group K1	K2	PS
Omission (Partial S.)	80.7%	44.4%	30.6%
Substitution:	19.3%	55.6%	69.4%
" General	56.4%	79%	32.9%
" Specific	43.6%	21%	67.1%

A deeper analysis of partial spelling revealed that the use of vowel partial spelling prevails in K1 children (58%), whereas K2 children, and especially PS children, mainly used consonant–vowel partial spelling (64 and 80%, respectively). An interpretation of this may be that children are aware of vowel sounds before consonant ones, and given the simplicity of their representation in the Spanish orthographic code, they are able to write them very early on. In the PS group, this type of spelling is discarded after a few months of schooling, though it persists until the end of the school year in the pre-school groups.

With respect to the spelling of diphthongs, their spelling improved as the age of the children and their alphabetic knowledge increased (see Table 4). K1 children tended to represent diphthongs with only one of the letters that formed them. This phenomenon appeared much less frequently in K2 children and disappeared after a few months at school in PS children.

Development of spelling acquisition. Table 5 shows the number of different spelling categories in each group and month. The chi-square test was used to analyze the development of the distribution of the spelling

Table 4. Percentage of diphthong represented by one vowel, as a function of group and month.

Month	K1	K2	PS
December	50%	20%	10%
January	42%	7%	9%
February	71%	10%	4.5%
March	–	–	2%
April	31%	5%	0%
May	14%	4%	–
June	28%	2%	0%

categories in the different groups and within each group on three Test points – January, April and June (see Table 5).

The results show that the distribution of the categories is not significantly different between the children of the pre-school groups, but the pattern of categories of the children in first year of PS is different from that of the Kindergarten children. On the other hand, this distribution varies between the months of January and April in the PS group, but not in the K1 or K2 groups. There are also differences in the distribution of categories between the months of April and June in both K2 and PS, but not in K1 (see Table 5).

Composition task. Even though it was only used as a means of observation complementary to the dictation, the results show that most Kindergarten children used drawing as a means of expression, and drew scenes they had experienced in their Easter holidays. Among those who used writing, the same categories were found as in the dictation tests, with the exception of the linear scribbles and the general substitutions, which did not appear. The PS group used writing as a means of expression, with no exceptions. Apart from the errors already explained, two new kinds of errors appeared: (a) the incorrect linking of syllables (segmentation error), mainly due to the presence of synalepha, defined by the junction of two vowels from two adjacent syllables in one syllable (e.g. 'MIA BUELA' instead of 'mi abuela', which means 'my grandmother'), which

Table 5. Chi-square values of comparison as a function of group and month.

Groups/month	Categories	d.f.	Chi-Square
K1—K2/January	5	4	10.316
K1—K2/April	6	5	5.467
K1—K2/June	6	4	1.786
K2—PS/January	6	5	50.092**
K2—PS/April	6	5	69.841**
K2—PS/June	5	4	64.874**
Months/group			
January—April/K1	5	4	5.82
April—June/K1	6	5	11.888
January—April/K2	6	5	14.201
April—June/K2	6	5	44.104**
January—April/PS	5	4	64.4**
April—June/PS	3	2	9.21*

*$p < 0.01$, **$p < 0.01$

were very frequent in PS; (b) incorrect separation of syllables, as if they were separate words (e.g, 'PRO CE SIO NES' instead of 'procesiones').

Discussion

Our findings show the presence of different categories of spelling which are similar to the categories and errors found by other authors in the English language (Henderson & Beers, 1980; Lombardino et al., 1997; Read, 1971, 1975, 1986; Treiman & Cassar, 1997; Treiman et al., 1998). This entails, at least, similarities in the mechanisms used when learning to spell in both languages, as well as an indication of the existence of similarities in the strategies used by the children who speak either language when they face the task of alphabetic spelling. Therefore, the answer to the question raised at the beginning of this paper about the possible existence of qualitative differences in the learning of spelling is negative. This convergence of results suggests the presence of general processes in the acquisition of spelling, as well as in the approach to learning it, which seem to be common in alphabetic languages, in spite of the fact that the differences between their codes may cause variations in this process, as it was pointed out in the introduction.

We believe the different spelling categories reflect differences in the children's knowledge about three interesting points: what spelling is, the phonological structure of words, and the spelling code of Spanish. This knowledge develops throughout the process of learning how to spell. Thus, the use of *linear scribbles* may be interpreted as the first attempt by the children to produce something similar to writing (Treiman, 1997). This type of writing indicates the beginning of the distinction between written language and other means of expression such as drawing.

The fact that the children use chains of letters, though completely unrelated to the target word *(random letters)* means one step further in this distinction. It shows the children already know that writing is made up of letters and not of other kinds of graphic symbols, though they still do not relate them to oral language. This category of spelling has also been found by other authors who studied pre-writing in Spanish-speaking children (Bozorne & Signorini, 1998).

We believe *partial spelling* means a crucial step in knowledge of spelling, since it marks the beginning of the relation between written and spoken language. Yet, as the ability of the children to analyze the sounds of the words is still limited, we share the idea suggested by other authors (Ferreiro & Teberosky, 1982; Gombert, 1996) that

although the children only write vowels, they are in fact segmenting syllables in a implicit way.

General substitutions seem to suggest that the children are already sensitive to all the sounds of the word and that they have reached the level of phoneme segmentation. However, given that their alphabetic knowledge is still limited and that they do not know the graphemes that correspond to some phonemes, they use the letters they know even if they do not bear any relation with the sound. General substitutions always affect consonant sounds and not vowel sounds, whose correspondence seems easier to master, unlike what happens in opaque languages such as English.

We consider that the existence of *specific substitutions* supports the connection between the development of spelling and that of phonological skills. Indeed, this error shows that the children are able to carry out very accurate phonemic analysis, and get confused only when the distinctions are of a very high level and involve very similar sounds that are only differentiated by only one articulatory feature.

The fact that children reach a high phonological knowledge and are able to represent the phonology of words does not imply they have managed to master orthography, as *non-orthographic spelling* shows. The development and improvement of both phonemic awareness and knowledge of the PGCs are not enough to guarantee correct spelling. Children need to learn contextual PGCs and accumulate lexical knowledge to be able to spell words with inconsistent graphonemes correctly (Defior, Martos, & Herrera, 2000). Phonology alone is not enough to spell them well.

Conventional spelling involves mastering phonemics and reaching a high level in orthographic knowledge. Obviously, the latter will never cease to be developed and will benefit from semantic and morphosyntactic knowledge, among others, as shown by recent research in the field (Bryant, Nunes, & Aidinis, 1999; Fayol, Thevenin, Jarousse, & Totereau, 1999; Titos, Defior, Alegría, & Martos, 2003).

The development of spelling in Spanish

Our results show that the developmental patterns of the children in first and second year of Kindergarten are not significantly different from each other, but that they are different from the children in first year of PS. The most plausible explanation seems to be that the children in both years of Kindergarten are not systematically being taught to spell,

and therefore, their production reflects a lack of consistent knowledge of the alphabetic principle.

The development of each group as the months go by shows that the K1 children do not undergo significant changes in their spelling categories and remain to have a very rudimentary performance. Again, we consider it is because they have a weak knowledge of the alphabet and their phonological awareness is hardly developed. In contrast, K2 children show significant changes at the end of the school year, which may reflect the effect of having started the partial study of the alphabet, though they still do not reach the levels of the children of first year of PS in the most evolved categories. The differences between the spelling strategies used by the children of first year of PS in January and in April were extremely obvious. During these months, they learned the alphabet completely, and showed progress in the phonological procedure. There were also differences, although less significant, between April and June, probably because that was when they consolidated the knowledge they already had. With respect to our starting hypothesis, the fast rate at which the children acquire the alphabetic principle, which is already present at the end of April, seems to be due to the transparency of the Spanish orthographic system. It is known that English and French children, whose spelling systems are more opaque, need one or two more years to reach the same level as Spanish-speaking children (Marín et al., 1999; Wimmer & Landerl, 1997).

Considering these results, contrary to our starting hypotheses, we believe that the development of spelling in Spanish does not qualitatively differ from that of more opaque languages. However, the differences involve the early age of acquisition and the shorter time needed to learn to spell, which matches the findings of Marín et al. (1999), who found that Spanish-speaking children reach a high percentage of success before French-speaking ones.

This work also shows that an almost transparent code such as Spanish allows learners to reach a high level of command in spelling the same year as they start to learn, which does not happen in opaque systems. We believe this acquisition speed is related to the phonological nature of the Spanish orthographic system and to the use of the phonetic method in the early teaching of reading and spelling.

With respect to the idea that the stages take place in a linear sequence, we feel that the coexistence of different kinds of spelling within each group, and even in the same child, does not allow us to strictly talk about stages as something that can only be reached after mastering the previous stage (Frith, 1985). Children seem to follow different procedures which overlap, and which they use to a greater or

lesser degree depending on the knowledge they build up. Therefore, the development of spelling seems better described in terms of phases where a given strategy prevails, rather than as a sequence of obliged steps, each one of which is characterized by a kind of strategy (Bozorne & Signorini, 1998; Rieben & Saada-Robert, 1997; Treiman & Cassar, 1997).

Even though spelling will continue to improve with the knowledge of more complex PGCs and with an increased orthographic, morphosyntactic and semantic knowledge, it should be underlined that, in order to establish the orthographic procedure, there has to be a minimum teaching of the phonological domain (Share, 1995). The quality leap in the PS group takes place between April and June; that is to say, the rudimentary strategies disappear when there is a good stock of phonological knowledge and that is when it is possible to build up orthographic knowledge.

To conclude, let us briefly point out the implications of these findings for the teaching of spelling. They can be summarized as follows: (a) the importance of teaching PGCs and developing phonological skills simultaneously, making the elements that make up the words explicit, (b) in the early stages, learners should carefully be taught to distinguish very similar phonemes that only have one different trait and (c) children should be made aware that learning to write certain words correctly requires specific (lexical) knowledge and that this learning is a life-long task.

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Notes

1. Phonemes that can be transcribed into more than one grapheme, with no rule to determine which one is correct.
2. The three articulatory features of a phoneme: articulation placement, articulation mode and voicing.
3. 'Yeismo' refers to the case in which the palatal, fricative, voiced consonant is pronounced like the palatal, lateral, voiced one, e.g. llave'' (key) is said ļabe/ instead of /yabe/.
4. 'Seseo' refers to the case in which the interdental, fricative, voiceless consonant is pronounced like the alveolar, fricative, voiceless one, e.g. pozo'' (well) is said /poso/ instead of /poθo/.

5. 'Ceceo' refers to the case in which the alveolar, fricative, voiceless consonant is pronounced like the interdental, fricative, voiceless one, e.g. "masa" (mass) is said /maθa/ instead of /masa/.

Appendix 1

Dictation Tasks List					
To whom know m			To whom know j (/x/)		
Mapa	muela	mono	Cojo	juego	cazo
Cama	mueve	pana	Jota	viejo	zona
To whom know n			To whom know c or z (/θ/)		
Nena	nuevo	mano	Taza	zueco	foca
Rana	bueno	masa	Zape	sucio	café
To whom know p			To whom know f		
Peso	puede	bote	Fase	mafia	zeta
Cora	poeta	bola	Gafas	fuego	pozo
To whom know b			To whom know l		
Beso	bueno	pelo	Luna	luego	llave
Cabe	biela	sopa	Pelo	suelo	calle
To whom know d			To whom know ll		
Dado	rueda	taco	Llora	lluvia	leche
Nido	duelo	bote	Calle	cuello	chino
To whom know g			To whom know s		
Gato	agua	casa	Sopa	suelo	pozo
Pega	guasa	roca	Casa	paseo	ceja
To whom know t			To whom know rr		
Tema	tiene	duna	Rosa	correa	bola
Coto	nieta	toda	Cerro	rueda	losa
To whom know c (/k/)			To whom know y		
Casa	cueva	gata	Yema	leche	
Paco	vacuo	toga	Mayo	coche	

Appendix 2

Spelling Categories

1. EO = pEIO", AO = gAtO", A = Azul, UA = sUAve".
2. ATO = gATO", IEO = cIElO", ALO = AzuL", ELO = pELO", OTA = suAve, EA = nEnA".
3. LELO = pelo", UALE = suave", LELA = nena". p", v" y n" were sustituted by 1".

4. SUADE = suave''. v'' (/b/), stop, bilabial, voiced was sustituted by d'' (/d/), stop, dental, voiced.
5. MUEBE = mueve''
6. SOPA, SUELO, POZO, CASA, PASEO, CEJA.

Appendix 3

Possible combinations of consonants sharing two articulation features (place, manner, voicing, indistintively). Only an example of the all possible combination is shown. Stop and voiceless: /p/, /t/, /k/. 6 possible combinations

(p-t, p-k, t-k, t-p, k-p, y k-t.)

Stop and voiced: /b/, /d/, /g/. 6 possible combinations

Fricative: /f /, /s/, /θ/, /x/. 12 possible combinations

Nasal: /m/, /n/, /ɲ/. 6 possible combinations

Velar and voiceless: /k/, /x/. 2 possible combinations

Lateral and voiced: /l/, /ʝ/: 2 possible combinations

Palatal and voiced: /y/, /ĉ/: 2 possible combinations

Alveolar and voiced: /n/, /r/, /l/: 6 possible combinations

Bilabial and voiced: /b/, /m/, 2 possible combinations

Stop and bilabial: /b/, /p/: 2 possible combinations

Stop and dental: /d/, /t/: 2 possible combinations

Stop and velar: /g/, /k/, 2 possible combinations

Affricate and Palatal: /ĉ/, /y/ 2 possible combinations

The probability to obtain a specific consonant substitution by chance is:

Suitable cases = 52 (combination of two consonant sharing two articulation features)

Possible cases = 342 (combination of two consonant whatever).

Probability is 52/342 = 0.152 or 15.2%.

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