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Do Spanish Children Use the Syllable in Visual Word Recognition in Learning to Read?

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The purpose of this study was to investigate whether Spanish children that are learning to read use the syllable unit in word reading. We used a visual version of the syllable monitoring technique (Mehler, Dommerges, Freavenfelder & Seguí, 1981). For Experiment I, we selected first grade readers at the end of the first year of reading instruction. In the Experiment II we selected second grade readers at the middle of the second year of reading instruction. Participants responded whenever the structure of the target string (e.g., bal) appeared at the beginning of a subsequently presented printed word (e.g., bala). The target was either a consonant-vowel (CV) or consonant-vowel-consonant (CVC) structure and either did or did not correspond to the initial syllable of the target-bearing word. At the end of the first year of reading instruction, children showed significant effects of syllable compatibility (faster detection times when the targets correspond to the initial syllable of target-bearing words than when they did not). When we tested children of the second year of reading instruction, they also showed a syllable compatibility effect. These results suggest that Spanish children use syllabic units at the beginning of reading instruction in the visual word recognition.
Keywords: learning to read, visual word recognition, syllabic units, reading instruction, beginning readers, Spanish language.

El principal objetivo de este estudio fue analizar si los niños españoles que aprenden a leer se apoyan en la sílaba para el reconocimiento visual de palabras. Usamos una versión visual de la técnica de monitorización de sílaba (Mehler, Dommerges, Freavenfelder y Seguí, 1981). En un primer experimento seleccionamos a niños que estaban finalizando el primer año de instrucción lectora, y en un segundo experimento seleccionamos a niños que estaban en el segundo año de instrucción lectora. Los niños tenían que responder si la sílaba que se presentaba como target (v.gr., bal) aparecía al principio de una palabra que se presentaba posteriormente en la pantalla del ordenador (v.gr., bala). La sílaba target era una sílaba con estructura consonante-vocal (CV) o con estructura consonante-vocal-consonante (CVC) que podía corresponder o no con la sílaba inicial de la palabra que se presentaba. Al final del primer año de instrucción lectora, se encontró un efecto significativo de compatibilidad silábica (i.e., los tiempos de reacción fueron más rápidos cuando la estructura de la sílaba target correspondía a la estructura de la sílaba inicial de la palabra presentada). Cuando analizamos las respuestas de los niños en el segundo año de instrucción de la lectura, se encontró también un efecto significativo de compatibilidad silábica. Estos resultados sugieren que los niños españoles que aprenden a leer se apoyan en la sílaba para el reconocimiento visual de las palabras.
Palabras clave: aprendizaje de la lectura, reconocimiento visual de palabras, sílaba, enseñanza de la lectura, lectores principiantes, lengua española.

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The main purpose of this study is to test whether children that are learning to read in Spanish use syllables as linguistic units in visual word recognition. Spanish is a language with consistent grapheme-phoneme correspondences: syllables are well defined, pronunciation depends on syllabic context, and syllable boundaries are always clear. In fact, it is empirically demonstrated that syllables are computed during the processing of Spanish printed words in adults (Álvarez, de Vega, & Carreiras, 1998; Dominguez, de Vega, & Cuetos, 1997). In addition, Carreiras, Álvarez, and de Vega (1993) provided evidence that syllable effects are independent of the presence or absence of bigram troughs. Moreover, they demonstrated that syllable would be then a represented mentally unit, participating in visual word recognition activating lexical units. Also, previous research in adults (Álvarez, Carreiras, & de Vega, 2000; Álvarez et al., 1998) suggests that the initial syllable takes on the main role in activating lexical candidates, a conclusion that has also been assumed by others when focusing on the manipulation of syllable frequency (e.g., Perea & Carreiras, 1998). Nevertheless, all of these studies have been conducted with adults but not with children.

The role of syllable unit in visual word recognition has been studied in Spanish children that received computer-assisted instruction (Jiménez et al., 2007). Jiménez, et al. conducted a study to assess the effects of four reading-training procedures for children with reading disabilities (RD), with the aim of examining the effects of different spelling-to-sound units (i.e., syllables, phonemes, onset-rimes, whole-word) in computer speech-based reading. The onset-rime condition was not as effective as phoneme and syllable conditions on phonological decoding. This finding is not surprising because this type of unit does not seem to be as relevant in a language where a direct correspondence between graphemes and phonemes exists, and where the syllable boundaries are well defined. The observation of this result is congruous with the findings of Jiménez, Álvarez, Estévez, and Hernández-Valle (2000), which focused on the effects of (sub-syllabic) intrasyllabic units on lexical decision performance in normally achieving readers and children with RD in a transparent orthography. They found that neither Spanish normally achieving readers nor children with RD seem to use mappings that involve intra-syllabic units in lexical access, relying instead more on the phonemic level. Thus, they suggested that in a transparent orthography such as Spanish, remedial education may be more successful if it concentrates on the phoneme level rather than on onset-rime units, in contrast to what has been suggested by Treiman (1992) in the English language. In fact, a finding in the study conducted by Jiménez, et al. (2000) supporting the idea above mentioned is that onset-rime group began with the highest rate of requests of speech feedback among the four groups. It was also found that syllable condition contribute to improving phonological decoding.

Nevertheless, these studies did not provide any empirical evidence about the role of syllable when normally achieving readers are starting the learning-to-read process. One piece of evidence for the existence of syllabic processing in Spanish children that are learning to read has been obtained by manipulating the positional syllable frequency (PSF). For instance, Jiménez, Guzmán, and Artiles (1997) analyzed the effects of PSF (i.e., the number of times that a syllable appears in a particular position in a word), on visual word recognition in the context of learning to read. Reliable effects of PSF were found both in reaction times and latency responses, and also on misreading in pseudo words. However, Jiménez et al. (1997) used a lexical decision and naming task and we do not know if the syllable effect is consistent across different tasks when children are learning to read. In the present study, we used a visual version of the syllable monitoring technique (Mehler et al., 1981). Participants responded whenever the structure of the target string (e.g., bal) appeared at the beginning of a subsequently presented printed word (e.g., bala). The target was either a consonant-vowel (CV) or consonant-vowel-consonant (CVC) structure and either did or did not correspond to the initial syllable of the target-bearing word. Some authors suggested that frequency of occurrence determines the strength of the corresponding representation in memory and subsequently the ease with which such a representation can be retrieved to perform a task such as syllable detection (Colé, Magnan, & Grainger, 1999). We also analyze the possible role of syllabic units in a silent reading task involving disyllabic and trisyllabic words. Trisyllabic words are more representative of the word length in Spanish and we know that syllable is a processing unit also in long stimuli (Álvarez et al.,1998). In sum, several methodological choices were made for the present study for different reasons. First, the majority of studies on reading acquisition have used monosyllabic words, which are likely to induce reliance on intra-syllabic units; the use of disyllabic and trisyllabic items allows us to examine reliance on syllabic units. Second, a large number of studies on reading acquisition have employed reading aloud tasks, which are likely to encourage children to focus on phonological information. A silent reading task allows us to examine the use of phonological structure, when such structures are not actually required to perform the task.

The main purpose of this study is to test whether Spanish children discern the perceptive units corresponding to oral syllables in word recognition. Our specific hypothesis is that the passage from grapho-phonemic units to syllabic units must operate very quickly when Spanish children are learning to read. As a consequence, we predict that the syllabic congruency effect should be observed at the first year of reading instruction. In addition, we expect that at the second year of reading instruction syllable should continue being a fundamental processing unit in visual word recognition. Therefore, a second experiment with children that are learning at the second year of reading instruction would be interesting to replicate the results obtained in the first experiment.

Experiment I

The purpose of this experiment was first to test whether Spanish beginning readers begin to show the effects of syllable compatibility when they are learning to read in the first year of reading instruction. We examine the possible role of syllabic units in a silent reading task involving disyllabic and trisyllabic words.

Method

Participants

A sample of 60 Spanish beginners readers (31 Male, 29 Female) was selected ranging in age from 6 years 5 months and 7 years 6 months (age months, M = 83.2; SD = 2.85) in the first grade of an urban elementary school participated in this experiment. All were native speakers of Spanish. Children with neurological disorders or sensory deficits were excluded. These children learned to read by code-oriented instruction, and every grapheme-phoneme correspondence was explicitly taught in first grade. Reading instruction starts with simple (e.g., *m, p,* and *t*) and moves to more complex correspondences (e.g., *c, g,* and *r*). This is the most common approach to reading instruction in Spanish schools. Table 1 shows the means and standard deviations in age, IQ, letter knowledge, word and pseudo word reading.

Materials and design

Standardized Reading Skills Test PROLEC. This Spanish standardized reading test includes different reading subtests (Cuetos, Rodríguez, & Ruano, 1996). We just administered the Letter Knowledge, Word Reading, and Pseudo word Reading subtests. All subtests measure response accuracy. The authors reported an alpha coefficient of .92, using as validity criteria the teacher's ratings of reading ability.

Raven's Progressive Matrices Test (Seisdedos, De la Cruz, Cordero, & González, 1991*)*. This test was designed to measure a person's ability to form perceptual relations and to reason by analogy independent of language and formal schooling, and may be used with persons ranging in age from 6 years to adult. We only administered the Coloured Progressive Matrices (CPM).

Stimuli. The stimuli included target letter strings whose structure was either CV or CVC and words that had the same first three letters. The words in each pair differed in terms of the structure of the first syllable, which was either CV or CVC. High-frequency words used in the study were selected on the basis of ratings generated from a normative study conducted by Guzmán and Jiménez (2001), which employed a sample of 3,000 words obtained from different texts of children's literature. Word familiarity was measured using these authors' procedure of frequency estimation, which involved the separation of the 3,000 words into different sets which were printed. For each set, different groups of 30 children were asked to rate each word on a 5-point scale, ranging from *least frequent* (1) to *most frequent* (5). The estimated frequency was calculated for each word by averaging the rating across all 30 judges. On the basis of these ratings, we used the indexes of this dictionary to select high-frequency words.

Procedure

The stimuli were presented in the centre of the visual display screen of a Pentium 150MHz, 16 Mb EDO RAM, hard disk 1.2Gb, Graphics card S3·64V+ and colour monitor. The duration of each session was twenty minutes. After a fixation point had appeared for 1 second, the target remained on the screen for 1 second; this was replaced by the test word, which remained on the screen until the participant responded. The next sequence followed after a 500 ms delay. Stimulus presentation was randomized with a different order for each participant. The participants were instructed to decide as quickly and as accurately as

Table 1
Means and standard deviations of Spanish first graders in age, IQ, letter knowledge, word reading, and pseudo word reading

	Minimum	Maximum	Range	Mean	*SD*
Age (months)	78	92	14	83.2	2.8
IQ	76	135	59	100.7	14.7
Letters	5	20	15	17.4	2.6
Word reading	7	30	23	27.9	4.9
Pseudo word reading	4	30	26	26.4	6.2

possible whether the target occurred at the beginning of the test word. They were told to press one the mouse button if the target and test word corresponded and another one if they did not. The buttons of the mouse were identified with different colours. The button with red colour should be pressed when the target was not included in the test word, and the button with green colour should be pressed if they did. Participants responded whenever the structure of the target string (e.g., CA) appeared at the beginning of a subsequently presented printed word or pseudo word (e.g., CARA CARTI). The target was either a consonant-vowel (CV) or consonant-vowel-consonant (CVC) structure, corresponding (or not) to the initial syllable of the target-bearing word (or pseudo word). The first three letters of the test words had regular spelling-sound correspondences and were very familiar CV and CVC structures. Words and pseudo words might be disyllabic or trisyllabic. For disyllabic stimuli, participants could find that: (1) the letter strings whose structure was either CV or CVC did or did not correspond to the initial syllable of the target-bearing word (e.g., pa palo, pal palco) (2) the letter strings whose structure CV or CVC belongs to the word but it did not correspond to he initial syllable of the target-bearing word (v. gr. pa palco, pal palo) or (3) the letter strings whose structure was either CV or CVC did not appear in the word (control item).

The same procedure was applied for trisyllabic words but the letter strings whose structure was either CV or CVC could be in initial o medial position. Faster detection times when targets correspond exactly to the structure of the initial syllable of target-bearing words (or pseudo words) than when they do not (e.g. syllabic congruency effect), are interpreted as an effect indicating the use of syllabic structures in reading. Each child was administered eight different lists of words and pseudo words: 1) The list A included 25 disyllabic words (10 experimental and 15 control), 2) The list B included 25 disyllabic pseudo words (10 experimental and 15 control), 3) The list C included 25 disyllabic words (10 experimental and 15 control), 4) The list D included 25 disyllabic pseudo words (10 experimental and 15 control), 5) The list E included 45 trisyllabic words (20 experimental and 25 control), 6) The list F included 45 trisyllabic pseudo words (20 experimental and 25 control), 7) The list G included 45 trisyllabic words (20 experimental and 25 control), 8) The list H included 45 trisyllabic pseudo words (20 experimental and 25 control).

If an experimental stimulus was preceded by CV target in the List A (e.g., ca – cala) then CVC target was presented in the List C (e.g., cal – cala), and vice versa. The same procedure was used for the following pair of lists B-D, E-G, and F-H. The experimental stimuli were the same for each pair of lists. The presentations were randomized for each participant. All experimental stimuli are shown in Appendix.

Results

Mean response times for correct responses and errors means are shown in Table 2.

A repeated measures ANOVA was performed on the data using participants (F1) and items (F2) as random variables. All response times were included in this analysis except those greater than 10.000 ms that were deleted.

Disyllabic words and pseudo words

A (2 x 2 x 2) Lexicality (word vs pseudo word) x Target Structure (CV-CVC) x Word Type (CV-CVC) mixed analysis of variance revealed a significant interaction between Target Structure x Word Type, $F1$ (1,51) = 15,09; $p < .001$, $\eta^2 = .23$; $F2$ (1,32) = 6.47, $p < .05$. Planned contrasts confirmed that CV targets were detected faster in words with CV structure than words with CVC structure $F1$ (1, 51) = 15.6, $p < .001$, $F2$ (1, 37) = 5.99; $p < .05$ and also confirmed that CVC targets were detected faster in words with CVC structure than words with CV structure $F1$ (1, 51) = 4.94, $p < .05$, but it was not significant in the analysis by items $F2$ (1,37) = 1.45; $p = .24$ (see Figure 1).

A repeated measures ANOVA performed on the error data showed a main effect of Target Structure, $F1$ (1, 59) = 7.67, $p < .01$, $\eta^2 = .11$; $F2$ (1, 32) = 21.9, $p < .001$, but it was subsumed under a significant interaction Target Structure x Word Type, $F1$ (1, 59) = 10.5, $p < .01$, $\eta^2 = .15$; $F2$ (1, 37) = 136.89, $p < .001$. Planned contrasts revealed that detecting a CVC target in a word with CVC structure produced significantly less errors than detecting CV target in a word with CVC structure $F1$ (1, 59) = 10.6, $p < .001$; $F2$ (1,37) = 132.66, $p < .001$.

Trisyllabic words

A (2 x 2 x 2) Target Structure (CV-CVC) x Word Type (CV-CVC) x Target Position (initial-medial) repeated measures ANOVA revealed a main effect of Target Position $F1$ (1, 45) = 15.4, $p < .001$, $\eta^2 = .26$; $F2$ (1, 32) = 22.52, $p < .001$. Targets in initial position were detected more rapidly than targets in medial position. A repeated measures ANOVA performed on the error data showed a main effect of Target Position $F1$ (1, 59) = 14.8, $p < .001$, $\eta^2 = .20$; $F2$ (1, 39) = 112.84, $p < .001$; and a significant interaction Target Structure x Word Type $F1$ (1, 59) = 8.88; $p < .01$, $\eta^2 = .13$; $F2$ (1, 37) = 46.5, $p < .001$. Planned contrasts revealed that detecting a CV target in a word with CV structure produced significantly less errors than it did in a CVC word $F1$ (1, 59) = 6.78, $p < .05$; $F2$ (1,37) = 4.56, $p < .05$, likewise CVC target was detected with less errors in a word with CVC structure in comparison with a word with CV structure $F1$ (1, 59) = 8.07, $p < .01$; $F2$ (1,37) = 7.28, $p < .01$.

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Table 2
Mean detection times and errors for words and pseudo words and standard deviations of Spanish first graders as a function of target structure, word type, and target position

	Measures			
	Response times		Errors	
	M	*SD*	*M*	*SD*
Disyllabic Words				
CV target				
CVw	2160.34	929.22	.45	.90
CVCw	2151.25	900.44	1.00	1.65
CVC target				
CVw	2433.49	988.29	.70	1.30
CVCw	2143.83	876.37	.35	.80
Trisyllabic Words				
CV initial target				
CVw	2781.15	1301.44	.40	.85
CVCw	2847.64	1231.10	.95	1.65
CVC initial target				
CVw	2846.24	1111.82	.85	1.55
CVCw	2724.68	1129.72	.35	.80
CV medial target				
CVw	3011.79	1235.35	1.10	1.60
CVCw	3226.62	1534.03	1.60	1.95
CVC medial target				
CV	3367.68	1231.08	1.45	1.90
CVC	3321.59	1497.39	1.15	1.65
Disyllabic Pseudo words				
CV target				
CVpw	2105.93	782.22	.45	1.00
CVCpw	2300.71	804.91	1.10	1.75
CVC target				
CVpw	2277.93	857.05	.75	1.50
CVCpw	2143.87	824.28	.35	.85
Trisyllabic Pseudo words				
CV initial target				
CVpw	2718.22	1148.11	.40	.90
CVCpw	2636.48	992.38	1.00	1.65
CVC initial target				
CVpw	3016.25	1476.40	.90	1.50
CVCpw	2555.30	1027.02	.40	.85
CV medial target				
CVpw	3220.26	1224.94	1.30	1.45
CVCpw	3048.60	1131.24	1.55	1.85
CVC medial target				
CVpw	3475.30	1509.43	1.65	1.80
CVCpw	3349.64	1216.48	.90	1.45

Note. CVw = consonant-vowel word; CVCw = consonant-vowel-consonant word; CVpw = consonant- vowel pseudo word; CVCpw = consonant-vowel-consonant pseudo word.

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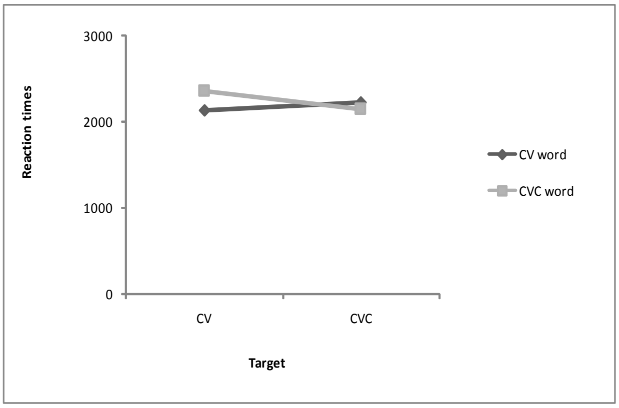

Figure 1. Mean target detection times (in milliseconds) as a function of target structure and word type in first grade readers.

Trisyllabic pseudo words

A repeated measures ANOVA performed on the response time data for trisyllabic pseudo words revealed a main effect of Target Position (initial-medial) $F1$ $(1, 48) = 35.6, p < .001, \eta^2 = .42$; $F2\ (1, 32) = 34.9$; $p < .001$. Moreover, there was a main effect of Target Structure $F1$ $(1, 48) = 4.84, p < .05, \eta^2 = .09$ and a significant interaction Target Position x Target Structure $F1\ (1, 48) = 4.99$, $p < .05$, $\eta^2 = .09$, but only when participants were treated as a random factor.

A repeated measures ANOVA performed on the error data showed a main effect of Target Position $F1\ (1, 59) = 16.6$, $p < .001$, $\eta^2 = .22$; $F2\ (1, 32) = 85.4$, $p < .001$, but it was subsumed by a significant interaction between Target Position x Word Type $F1\ (1, 59) = 7.2, p < .01, \eta^2 = .11$; $F2\ (1, 32) = 5.2$, $p < .05$. Planned contrasts revealed that detecting a target in medial position in a CV pseudo word produced significantly less errors than in a CVC pseudo word $F1\ (1, 59) = 6.87$; $p < .05$; $F2\ (1, 37) = 6.52, p < .05$.

Moreover, there was a significant interaction between Target Structure x Word Type $F1\ (1, 59) = 12.6$, $p < .001$, $\eta^2 = .17$; $F2\ (1, 39) = 57.2$, $p < .001$. Planned contrasts confirmed that detecting a CV target in a CV pseudo word produced significantly less errors than it did in a CVC pseudo word $F1\ (1,59) = 9.46$, $p < .01$; $F2\ (1,39) = 5.7$, $p < .05$. Also, detecting CVC target in pseudo words with CVC structure produced less errors that in pseudo words with CV structure $F1\ (1,59) = 11.8$, $p < .001$; $F2\ (1,39) = 11.6$, $p < .05$.

Discussion

The purpose of this first experiment was to test whether Spanish beginners readers begin to show the effects of syllable compatibility when they are learning to read in the first year of reading instruction. A main finding was that Spanish children showed significant effects of syllable compatibility (faster detection times when the targets correspond to the initial syllable of target-bearing words than when they did not). This effect was subsumed by the influence of syllable structure because participants detected faster syllables in CV words than CVC words. These results suggest that reading instruction in Spanish rapidly allows syllable-sized units to be accessed from print. We only selected high frequency words where it is generally the whole-word orthographic codes that win the race (Colé, Magnam, & Grainer, 1999). However, our results suggest that syllabic structure is used to detect the presence of the target. Our prediction is that this type of coding continues to influence how future Spanish readers process words, therefore we designed a second experiment including second grade readers. Experiment 2 used the same visual syllable detection paradigm as Experiment 1 except that the participants were older. The children were tested in the second year of reading instruction. Any effect of syllable compatibility would indicate that they continue using syllable-sized units in their processing of printed stimuli.

Experiment II

The purpose of this second experiment is to test whether Spanish readers show the same effects of syllable compatibility across different syllable structures when they have more experience with reading instruction.

Table 3

Means and standard deviations of Spanish second graders in age, IQ, letter knowledge, word reading, and pseudo word reading

	Minimum	Maximum	Range	Mean	*SD*
Age (months)	82	94	12	87.3	3.31
IQ	81	116	35	100.6	8.35
Letter knowledge	24	20	6	18.6	1.48
Word reading	12	30	18	27.5	3.40
Pseudo word reading	14	30	16	25.8	3.93

Table 4

Mean detection times and errors for words and pseudo words and standard deviations of Spanish second graders as a function of target structure, type word, and target position

	Measures			
	Response times		Errors	
	M	*SD*	*M*	*SD*
Disyllabic Words				
CV target				
CVw	1785.45	643.99	.49	.83
CVCw	2082.74	854.07	1.37	1.51
CVC target				
CVw	2320.94	1009.51	.63	.87
CVCw	1979.62	847.75	.19	.43
Trisyllabic Words				
CV target				
CVw	2355.85	1130.78	.54	.83
CVCw	2373.31	1053.06	.83	1.37
CVC initial target				
CVw	2466.23	1174.72	.59	1.02
CVCw	2394.68	1047.18	.39	.73
CV medial target				
CVw	2922.36	1357.91	1.66	2.00
CVCw	2735.03	1266.38	2.10	1.85
CVC medial target				
CVw	2894.58	1467.47	1.95	1.81
CVCw	3124.49	1422.08	1.71	1.81
Disyllabic Pseudo words				
CV target				
CVpw	1812.91	652.85	.24	.73
CVCpw	1968.07	886.57	1.17	1.37
CVC target				
CVpw	2075.36	881.28	.88	1.02
CVCpw	2048.08	740.95	.39	.63
Trisyllabic Pseudo words				
CV initial target				
CVpw	2398.11	1032.32	.44	.73
CVCpw	2515.31	1217.98	.88	1.42
CVC initial target				
CVpw	2528.41	1222.48	.63	1.02
CVCpw	2353.42	1160.74	.39	.68
CV medial target				
CVpw	2633.51	1266.10	1.56	1.95
CVCpw	2762.70	1269.60	2.15	1.85
CVC medial target				
CVpw	2912.60	1540.32	1.85	1.90
CVCpw	2761.43	990.31	1.46	1.71

Note. CVw = consonant-vowel word; CVCw = consonant-vowel-consonant word; CVpw = consonant- vowel pseudo word; CVCpw = consonant-vowel-consonant pseudo word.

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Method

Participants

A sample of 48 Spanish beginner readers (20 Male, 28 Female) was selected ranging in age from 6 years 9 months and 7 years 9 months (age, $M = 87.3$; $SD = 3.31$) in the second grade of an urban elementary school participated in this experiment. All were native speakers of Spanish. Children with neurological disorders or sensory deficits were excluded. These children learned to read by code-oriented instruction, and every grapheme-phoneme correspondence was explicitly taught in first grade. Table 3 shows the means and standard deviations in age, IQ, letter knowledge, word and pseudo word reading.

Materials

The experimenter used the same materials as in Experiment 1.

Procedure

The experimenter used the same procedure as in Experiment 1.

Results

Mean responses times for correct responses and errors means are shown in Table 4.

Lexicality

A (2 x 2 x 2) Lexicality (word vs pseudo word) x Target Structure (CV-CVC) x Word Type (CV-CVC) mixed analysis of variance revealed a main effect of Target Structure $F1$ (1, 39) = 17.4, $p < .001$, $\eta^2 = .30$; $F2$ (1, 32) = 10.6, $p < .01$, but it was subsumed by a significant interaction Word Type x Target Structure $F1$ (1, 39) = 14.8; $p < .001$, $\eta^2 = .27$; $F2$ (1,32) = 6.86, $p < .05$. Planned contrasts revealed that CV targets were detected faster in words with CV structure than words with CVC structure $F1$ (1, 39) = 22.5, $p < .001$, $F2$ (1, 37) = 22.08, $p < .001$, however, there were no significant differences for CVC target as a function of word type $F1$ (1, 39) = .64, $p = .42$, $F2$ (1, 37) = .16, $p = .69$ (see Figure 2).

A repeated measures ANOVA performed on the error data showed a main effect of Target Structure, $F1$ (1,47) = 7.47, $p < .01$, $\eta^2 = .14$; F2 (1, 32) = 13.2, $p < .001$ and Word Type $F1$ (1, 47) = 8.7, $p < .01$, $\eta^2 = .15$; $F2$ (1,32) = 6.21, $p < .05$, but it was subsumed under a significant interaction Target Structure x Word Type, $F1$ (1, 47) = 32.3, $p < .001$, $\eta^2 = .40$; $F2$ (1,32) = 57.2, $p < .001$. Planned contrasts revealed that detecting a CV target in a CV word produced significantly less errors than it did in a CVC word, $F1$ (1, 47) = 7.2, $p < .01$; F2 (1,37) = 6.5, $p < .05$, and detecting a CVC target in a CVC word produced significantly less errors than it did in a CV word, $F1$ (1, 47) = 27.5, $p < .01$; $F2$ (1,37) = 52.9, $p < .001$.

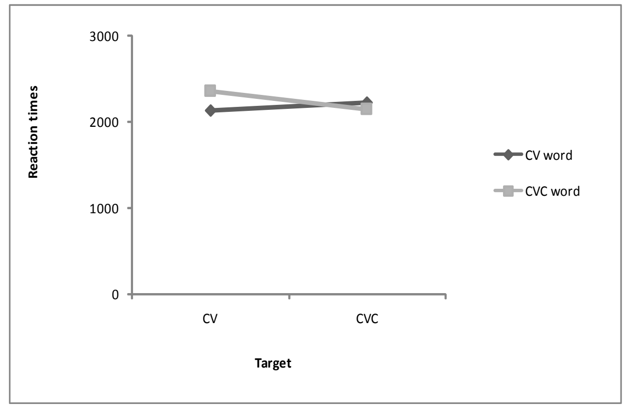

Figure 2. Mean target detection times (in milliseconds) as a function of target structure and word type in second grade readers.

Trisyllabic words

A (2 x 2 x 2) Target Structure (CV-CVC) x Word Type (CV-CVC) x Target Position (initial-medial) ANOVA revealed a main effect of Target Position $F1$ (1, 33) = 14.9, $p < .001$, $\eta^2 = .31$; $F2$ (1, 32) = 31.2, $p < .05$ that means that target in initial position was detected faster than target in medium position. A repeated measures ANOVA performed on the error data showed a main effect of Target Position $F1$ (1, 47) = 27.8, $p < .001$, $\eta^2 = .37$ but only when participants were treated as a random factor. Moreover, there was a significant interaction Target Structure x Word Type $F1$ (1, 47) = 9.49, $p < .01$, $\eta^2 = .16$; $F2$ (1, 32) = 9.19, $p < .01$. Planned contrasts revealed that detecting a CVC target in a CVC word produced significantly less errors than it did in a CV word $F1$ (1,47) = 9.84, $p < .01$, but it was not confirmed in the analysis by items F2 (1,37) = 1,93, $p = .17$

Trisyllabic pseudo words

A repeated measures ANOVA performed on the response time data for trisyllabic pseudo words revealed a main effect of Target Position $F1$ (1, 30) = 14.7; $p < .001$, $\eta^2 = .32$; $F2$ (1, 32) = 14.4; $p < .001$. That means that target in initial position was detected faster than target in medium position. Moreover, there was an interaction Word Type x Target Structure $F1$ (1, 30) = 5.36, $p < .05$, $\eta^2 = .15$ but it was not confirmed in the analysis by items.

A repeated measures ANOVA performed on the error data showed a main effect of Target Position $F1$

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(1, 47) = 26.5, $p < .001$, $\eta^2 = .36$, *F2* (1, 32) = 81.9, $p < .001$. The target in initial position was detected with fewer errors than the target in medium position. Moreover, there was a significant interaction Word Type x Target Structure *F1* (1, 47) = 18.5, $p < .001$, $\eta^2 = .29$; *F2* (1, 32) = 14.9, $p < .001$. Planned contrasts confirmed that detecting a CV target in a CV pseudo word produced significantly less errors than it did in a CVC pseudo word, *F1* (1,47) = 5.6, $p < .05$ but it was not confirmed in the analysis by items. Also, detecting a CVC target in a CVC pseudo word produced significantly less errors than it did in a CV pseudo word, *F1* (1,47) = 5.6, $p < .05$ but it was not confirmed by item analysis.

Discussion

This second experiment was designed to test whether this type of coding, that is, children conduct a segmentation of groups of letters corresponding to oral syllables in task of reading of words. Our findings suggest that second grade readers also showed a syllable compatibility effect. Again, Spanish children showed significant effects of syllable compatibility, and this effect was subsumed by the influence of syllable structure because participants detected faster syllables in CV words than CVC words.

General Discussion

The aim of this study was to test whether Spanish children discern the perceptive units corresponding to oral syllables in word recognition. First of all, we conducted an experiment selecting first grade readers of the first year of reading instruction. For a second experiment, we selected second grade readers at the middle of the second year of reading instruction. In both experiments, Spanish children showed significant effects of syllable compatibility (faster detection times when the targets correspond to the initial syllable of target-bearing words than when they did not). And, this effect was subsumed by the influence of syllable structure because participants detected faster syllables in CV words than CVC words. Some authors suggested that frequency of occurrence determines the strength of the corresponding representation in memory and subsequently the ease with which such a representation can be retrieved to perform a task such as syllable detection (Colé et al, 1999). So, for instance, previous studies have also found a different pattern of results for CV and CVC words (e.g., in Spanish, Álvarez, Carreiras, & Perea, 2004; Marín & Carreiras, 2002; in French, Peretz, Lussier, & Beland, 1998). Álvarez, et al. (2004) provided a tentative explanation of this pattern of results suggesting that the CVC structure is a much less frequent pattern in Spanish. In fact, Sebastián, Martí, Carreiras and Cuetos (2000) demonstrated that CVC syllables are three times less frequent than CV syllables in Spanish.

Nevertheless, all of these studies have been conducted with adults but not with children that are learning to read. Another tentative explanation would be that at the beginning of reading instruction programming of linguistic units used by teachers would have an influence for the superiority effect of CV structure. At the beginning teachers use words with CV, VC or CCV syllables more frequently than CVC structures. This programming is included in many reading instruction books in Spain (Jiménez & Ortiz, 2000).

Alternatively, Seidenberg (1987) suggested that the effects of syllable structure can be understood as deriving from the frequency of co-occurrence of letter patterns. He also pointed out that the bigram provides cues for segmentation rather the syllable structure per se. However, there is evidence in Spanish that syllable effects are independent of the presence or absence of bigrams through (Carreiras et al, 1993; Domínguez et al, 1997).

Evidence for syllable or syllable-type units in learning to read has also been studied for other languages. In French language, studies have found contradictory results. For instance, Colé, et al. (1999) used the same visual version of the syllable monitoring technique that we used for this study. After six months of schooling, beginner readers were not syllabically recoding printed words. These readers were not sensitive to the syllable compatibility of the targets and the first part of test words or to the estimated frequency with which they had encountered these words in print. Most recent, Doignon and Zagar (2006) conducted a similar study to the study presented here selecting children from the first year (6-7 to years old) to the second year (8-9 years old) during French reading instruction. Results showed that children perceive syllables in letter sequences as soon as the end of the first year of the learning-to-read process.

In contrast with English, Spanish is a transparent orthography with a very close grapheme-to-phoneme correspondence: Perhaps, more importantly, it has very regular syllabic structure with clearly defined syllable boundaries that are resistant to stress movement (Harris, 1983) and there is almost no ambisyllabicity. It has been shown that syllable frequency influences reading times for words embedded in texts (de Vega, Carreiras, Gutierrez, & Alonso-Quecuty, 1990), and lexical-decision times (Álvarez et al., 1998; Álvarez et al, 2004; Carreiras et al, 1993; Domínguez, Cuetos, & de Vega, 1993; Perea & Carreiras, 1998).

So, the evidence appears to be strong that the syllable is an important unit in the recognition of Spanish words. On the other hand, the interaction between structure of the target string (CV or CVC) and the syllable structure of the target-bearing word (CV or CVC syllable) was not explained by the position of target in trisyllabic words in children that are learning to read. We just found that

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targets in initial position were detected more rapidly than targets in medial position.

We also examined the role of syllable-sized units in polysyllabic words, because the majority of studies on reading acquisition to date have used monosyllabic words. Presenting monosyllabic words is more likely to induce participants to use intrasyllabic units, whereas with polysyllabic words full syllable structures may dominate processing. We only selected high-frequency words because it has been demonstrated that high-frequency words will be less affected by the frequency of the syllabic neighbours than will low-frequency words. However, we did not find that children showed significant effects of syllable compatibility in trisyllabic words, that is, faster detection times when the targets correspond to the initial syllable of target-bearing words than when they did not. Trisyllabic words are more representative of the word length in Spanish, and this effect has been found in adults. For instance, Álvarez, et al. (1998) conducted three experiments using a lexical decision task and a temporal separation technique. The data showed that the syllable is a processing unit, also in long stimuli.

According to our findings, Spanish children use the syllable unit in word reading at an early age and, in view of the results obtained in the present study, older reading children seem to continue doing this despite the fact that they do not succeed in rendering the phonological reading procedure automatic. The absence of an interaction between lexicality and syllable compatibility effects suggests that after two year of schooling, children developed an efficient letter-sound-meaning route but had not yet developed an efficient whole-word orthographic route to meaning.

In sum, our findings demonstrate how reading instruction in Spanish rapidly allows letter strings are mapped onto syllable-sized units. Spanish children do not seem that they are using the letter identities to perform the target matching task, or they could be generating a string of phonemes and using these to perform the task. Both strategies would produce the observed target size effects. Consequently, we concluded that syllable could then be a pertinent unit in the learning-to-read process.

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APPENDIX

LIST OF EXPERIMENTAL STIMULI

Word Type	Target Structure	Target	Disyllabic Word	Disyllabic pseudo word	Trisyllabic word (initial)	Trisyllabic pseudo word (initial)	Trisyllabic word (medial)	Trysillabic pseudo word (medial)
	CV	ca	cala	Cali	caliente	calomi	encalo	encali
CV			2.82		3.71		2.65	
	CVC	cal	cala	Cali	caliente	calomi	encalo	encali
			2.82		3.71		2.65	
	CV	ca	cara	Caru	careta	carote	sacara	racaro
CV			3.86		3.63		3.77	
	CVC	car	cara	Caru	careta	carote	sacara	racaro
			3.86		3.63		3.77	
	CV	pa	panes	Pano	panera	panori	campana	bampane
CV			3.76		2.28		3.57	
	CVC	pan	panes	pano	panera	panori	campana	bampane
			3.76		2.28		3.57	
	CV	pa	paro	paru	parado	paruda	repara	daparo
CV			3.53		3.53		3.16	
	CVC	par	paro	paru	parado	paruda	repara	daparo
			3.53		3.53		3.16	
	CV	ve	vera	veru	verano	verilo	polvera	toveri
CV			3.76		3.74		3.52	
	CVC	ver	vera	veru	verano	verilo	polvera	toveri
			3.76		3.74		3.52	
	CV	ca	calma	calpo	caldero	calpote	descalzo	descaldi
CVC			3.55		3.72		3.76	
	CVC	cal	calma	calpo	caldero	calpote	descalzo	descaldi
			3.55		3.72		3.76	
	CV	ca	carne	carbe	carnada	carpado	encargo	racarto
CVC			3.64		2.31		3.59	
	CVC	car	carne	carbe	carnada	carpado	encargo	racarto
			3.64		2.31		3.59	
	CV	pa	panza	panto	pandero	pantilo	comparsa	espandi
CVC			2.63		3.43		3.53	
	CVC	pan	panza	panto	pandero	pantilo	comparsa	espandi
			2.63		3.43		3.53	
	CV	pa	pardo	parti	pardela	pardile	espanto	comparti
CVC			2.68		2.80		3.28	
	CVC	par	pardo	parti	pardela	pardile	espanto	comparti
			2.68		2.80		3.28	
	CV	ve	verbo	verpa	vergüenza	verbino	caverna	maverno
CVC			2.66		3.20		2.82	
	CVC	ver	verbo	verpa	vergüenza	verbino	caverna	maverno
			2.66		3.20		2.82	

The numbers under words are frequency measures

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