

Assessment of orthographical processing in Spanish children with dyslexia: The role of lexical and sublexical units

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Abstract

Introduction. The aim of this study was to examine the role of multiletter units, such as the morpheme and whole word, in accessing the lexicon, in Spanish children with dyslexia.

Method. A sample of 60 participants were selected and organised in three different groups: 1) an experimental group of 18 reading-disabled children, (2) a control group of 27 normal readers matched in age with the reading disabled group, and (3) a control group of 15 younger children at the same reading level as the reading disabled group. Homophones and morphological root comprehension tasks were used.

Results. The results were analysed using measures of accuracy and latency for the morphological comprehension task and accuracy for the homophone task. These showed that there was a lexical processing deficit in children with reading disabilities compared to younger children with the same reading level. Nevertheless, when we analysed the latency of the morphological comprehension task, results showed that this latency decreased during presentation, independently of the groups, although the performance of normal readers matched in age with the reading disabled children was significantly better than the two other groups.

Keywords: Reading disabilities, dyslexia, lexical processing, morphological processing.

Introduction

Word recognition is an important link in reading development and constitutes one of the main deficits in children with reading disabilities (Perrfetti, 1986, 1989; Siegel, 1986). Numerous studies suggest that students with reading disabilities (RD) have deficits in the sublexical and lexical processes (e.g., Beech & Awaida, 1992; Ehri & Wilce, 1983; Manis, 1985; Perfetti, 1985). Other studies have demonstrated that students with RD are slower in lexical access than good readers (e.g., Cirrin, 1984; Ellis, 1981; Johnston & Thompsom, 1989; Laxon, Coltheart & Keaping, 1988; Rayner, 1988; Seymour, 1987; Seymour & Porpodas, 1980).

The Spanish language is an alphabetically transparent system (orthography is mapped onto phonological structure), in which spelling-sound rules are fairly simple and have few exceptions because there is a direct correspondence between written symbols and phonemes. There are several studies in Spanish that demonstrate that reading is carried out through phonological processing (De Vega, Carreiras, Gutiérrez Calvo & Alonso Quecuty, 1990). However, lexical processing has functional value in word recognition in a transparent language because studies with Spanish adults (e.g., Domínguez & Cuetos, 1992; Domínguez, Cuetos & De Vega, 1993) and children (Jiménez & Rodrigo, 1994; Rodrigo & Jiménez, 1999; Rodrigo & Jiménez, 2000; Valle, 1989) have shown that variables such as the lexicality and familiarity of words have an influence similar to that in opaque systems. This means that the Spanish reader uses the lexical or orthographic route to identify the most frequent words.

Most recent studies propose that problems in word recognition are basically phonological route problems (Rack, Snowling & Olson, 1992; Siegel & Ryan, 1988; Stanovich, 1988; Wagner & Torgesen, 1987). Treiman (1992) suggested that correspondence between print and speech are not restricted to the level of whole words or the level of single phonemes. She pointed out that multiletter units that correspond to onset and rimes are more important than other multiletter units in the processing of the printed words, in children and adults. Print representing speech might be more easily understood, especially by children with poor phonological skills, if it were introduced by reference to a larger, more accessible unit of sound. Álvarez, Carreiras and Taft (2001) studied three types of multiletter units in word recognition in adult participants in Spanish: the basic orthographic syllabic structure (BOSS); the root morpheme and the syllable. A null effect of BOSS was found, except when the BOSS was the same frequency as the root morpheme. Previous studies have failed to find any support for the BOSS as being functional in Spanish (Sánchez-Casas, 1996). With regard to morphological unit, root

frequency produces a facilitating effect in word recognition. There is considerable evidence that the syllable is an important processing unit in Spanish. Words with high-frequency first syllables are harder to recognise than words with low-frequency first syllables. These results are consistent with those of previous studies in Spanish which showed that syllable frequency produces an inhibitory effect in expert readers (Álvarez, de Vega & Carreiras, 1998; Jiménez & Rodrigo, 1994; Rodrigo & Jiménez, 2000). Nevertheless, reliable effects of syllable frequency were found in children who are learning to read (Jiménez, Guzmán & Artiles, 1997).

Since Treiman's proposal, a great deal of research has been carried out with regard to the role of multiletter units in children with RD in word recognition. In Spanish, Jiménez (1997) analysed phoneme awareness within the context of a reading-level match, and results demonstrated that there were no differences in intrasyllabic awareness between the RD group and younger control group, but there were differences in phonemic task (e.g., phoneme segmentation and reversal) because the RD group performed more poorly than the younger control group. This difference suggests that a precursor to the phonological coding difficulty appears to be a deficit in segmental language skills. More recently, Jiménez, Álvarez, Estévez and Hernández-Valle (2000), indicated that there were no differences between Spanish children with RD and normal readers in using correspondences that are based on higher-level units such as onsets and rimes. Consequently, as Bryant and Goswami (1986) have suggested, if no differences are found between groups with RD and their age-matched controls, despite the fact that one group is reading at a much lower level, then it is most unlikely that the variable in question plays a role in causing reading difficulties. These results suggest that onset-rime units are not relevant in the Spanish language in word recognition because there is a direct correspondence between grapheme and phoneme.

With regard to the syllable, another multiletter unit in lexical access, Jiménez and Rodrigo (1994) found that there were no interactions between syllable frequency in the words and reading level. That implies that the failure of the group with RD lay in the procedure of letter by letter grapheme-phoneme conversion, not at the level of syllable by syllable. These empirical results suggest that it is unlikely that the syllable unit plays any role in causing reading difficulties.

Another multiletter unit in lexical access is the morpheme. Morphemes are the smallest unit of written language that carries meaning. Words are morphologically articulated and structured. Research on morphological processing began with Taft and Forster's (1976) paper in

which it was proposed that prefixed words are analysed into their constituent morpheme before lexical access occurs. Spanish is a language with a very productive inflectional system, with suffixes of gender and number for nouns and adjectives and a high degree of inflectional articulation in verbs, although there is little research that has studied the role of the morpheme in word recognition. Domínguez, Cuetos and Seguí (2000) studied lexical access in order to find out if the meanings of words are indirectly reached through their morphemes (full parsing) or, conversely, attained by a direct procedure such as that performed when we use a dictionary, that is, by accessing their representation in memory (full listing). These authors concluded that the best option for morphologically irregular words would be to store all the forms separately in lexicon. Conversely, morphological regular words could be recognised after a process of affixation by rules. In the same way, Domínguez, Seguí and Cuetos (2002) have attempted to dissociate the sources of processing for orthographic, morphological and semantic relations between words with the priming paradigm. The facilitation obtained for morphologically related words in all experiments could be interpreted as a specific way of lexical access. Furthermore, morphologically related words (the root morpheme) cannot be interpreted as different lexical items with different meanings and different syntactic properties. They cannot be considered competitive candidates (Alvarez, Carreiras & Taft, 2001). Most of these studies have been carried out with adult Spanish participants, not with children with RD.

Nevertheless, there are studies with children, such as that of Tornéus (1987), which found that the morphological awareness of kindergarten pupils predicted their reading ability in the second grade. In another study on the reading strategy of dyslexics and younger reading/level matched controls, Elbro and Petersen (1993) found that adolescents with dyslexia read practically as well in the morpheme condition as in the whole word condition and these participants were more supported by the morpheme condition than were the younger normal readers. Elbro and Arnbak (1996) suggest that adolescents with RD use recognition of the root morpheme as a compensatory strategy in reading both single words and coherent text. The same authors suggest that it may be possible to improve the awareness of morphology independently of phoneme awareness, and that such training may have positive effects on the reading of coherent text and on the accurate spelling of morphologically complex words. All this evidence supports the view that training in morpheme recognition could function as a compensatory strategy for poor readers. Good morphological skills may help readers who have phonological problems to be more fluent (Elbro & Arnbak, 1996). However, these studies have not been carried out in a transparent language like Spanish which is entirely predictable on the basis of

phonemes, but in orthographies that are governed not only by phonology but also by morphology. Therefore, the following questions remain to be answered: Does morpheme recognition contribute to reading in Spanish children with dyslexia and is this contribution different in dyslexia than in normal reading in Spanish?

Finally, the other unit of lexical access that we have investigated here is the whole word. Although reading in Spanish is carried out through phonological processing because it is a transparent system, lexical processing has functional value in word recognition. From a developmental perspective, the stage-based models of learning to read distinguish between an early reading phase, during which grapheme-phoneme correspondences are learned (usually referred to as the alphabetic stage), and a later one during which the processing unit is the whole word and orthographic or lexical representations are acquired (the orthographic stage) (Frith, 1985; Seymour & McGregor, 1984). When children access the orthographic stage, they are expert readers because they are able to read fluently. Normal readers, in their first steps to reading, could recognise frequent and non frequent words using the word-to-sound information. Later, these normal readers could use a lexical strategy to recognise familiar words (Backman, Bruck, Herbert & Seidenberg, 1984). Coltheart (1987) specifies that phonological processing precedes orthographical processing when children are learning to read. In the same way, Share and Stanovich (1995) found that phonological decoding facilitates the establishment of lexical representations. Therefore, Alegría (1985) suggested that the building of the lexicon depends on the phonological route in Spanish. Nevertheless, children with RD have problems in the processing of letter-to-sound relationships. These kind of problems determine the poor experience with reading of children with RD, and, consequently, their lexical representation in the mental lexicon will be low in comparison to normal readers of the same age (Stanovich, 1986). However, Rodrigo and Jiménez (1999), in the analysis of word naming errors, found evidence that Spanish children with RD were using an orthographic strategy to compensate the phonological deficit, but performance in this strategy was lower than that of good readers.

Based on this empirical evidence, the aim of this study was to test whether morpheme recognition and whole word contribute to reading in Spanish children with dyslexia, and whether this contribution is different in children with RD and in normal readers. A morphological comprehension task and a homophone selection task were used to assess morphological and lexical processing. Our prediction is that the reading disability group would have more need to use larger units like the morpheme in visual word recognition; however, the control

groups would not need multiletter units because their phonemic awareness can be helpful in word decoding in a transparent orthography. Nevertheless, we expected that the performance of children with RD would be lower than the other groups in the use of lexical strategies because they have problems with phonological strategies and the lexicon is built on phonological skills.

Method

Participants

A sample of 60 children was selected (30 male, 30 female) with an age range of 7 to 12 years ($M=111.05$; $SD=11.64$). The children were classified into three groups: (1) An experimental group of 18 reading-disabled children (age, $M=117.16$; $SD=5.3$), RD; (2) A control group of 27 normal readers matched in age with the reading disabled (age, $M=117.11$; $SD=5.0$), CA; and (3) A control group of 15 younger children at the same reading level as the reading disabled (age, $M=92.8$; $SD=3.7$), RL. Children with reading difficulties were defined as those who had a percentile score of < 25 on the Pseudoword test. There were no significant differences in the distribution of the participants as a function of gender $X(2)=1.28$, $p=.525$. and there were no differences between groups in IQ, $F(2,57)=1.0$, $p=.98$. But we did find significant differences in verbal working memory, $F(2,58)=3.8$, $p=.05$. Post hoc comparisons of these means showed that reading disabled children had significantly lower scores than normal readers matched in age ($t=-.64$, $p<.05$) and younger normal readers ($t=-.69$, $p<.001$). Children were excluded who had sensory, acquired neurological, and other problems traditionally used as exclusionary criteria for LD. The children came from urban area schools and from average socio-economic backgrounds.

Table 1. Means and Standard Deviations on the IQ, age and working memory measures. RL = Reading age; CA = Chronological age.

	Groups					
	Reading Disabled		RL controls		CA controls	
	M	SD	M	SD	M	SD
IQ	109.8	13.7	110.3	13.1	109.8	13.3
Age	117.16	5.36	92.8	3.72	117.11	5.00
Working Memory	2.61	0.6	3.26	0.9	3.06	0.7

Design

Two experimental designs were carried out:

(1). A three-group reading level design was used (dyslexics, good readers and younger normal readers) and for the analysis, a between-participants (reading level) factor and a within-participant factor (task differences), were used. The results were analysed using the correct responses for the morphological comprehension task and for the homophone task and using latency for the morphological comprehension task.

(2). A three-group reading level design (dyslexics, good readers and younger normal readers) and a within-participant factor (number of presentation, 1-4, in morphological comprehension task) were used. We analysed as dependent variables the latency times of correct responses. We controlled the longitude effect dividing the latency times of the correct responses by the number of letters of every word.

Materials

In order to select the sample for this study we used three tests:

Standardised Reading Skills (PROLEC, Cuetos, Rodríguez, & Ruano, 1996). This test includes different reading subtests. We administered only the Pseudoword Reading subtests because speed and accuracy in naming pseudowords discriminates between good readers and poor readers both in a deep orthography (Perfetti & Hogaboam, 1975; Siegel & Ryan, 1988; Siegel & Faux, 1989), and in Spanish (Domínguez & Cuetos, 1992; Jiménez & Rodrigo, 1994). These subtests require

the correct identification of pseudowords with different linguistic structures. This subtest measure the accuracy of the responses.

Verbal Working Memory. To assess the children's working memory, we administered the task used by Siegel and Ryan (1989). This task was modelled on the procedure developed by Daneman and Carpenter (1980). The children heard sentences that had the final word missing. The task was to supply the missing word and then to repeat all the missing words from the set. There were three trials at each level or set size (2, 3, 4, and 5 words). Task administration was stopped when the child failed all the trials at one level.

Culture Fair (or Free) Intelligence Test. Also known as a measure of G, (Scale 1 and 2, Form A; Cattell & Cattell, 1950/1989), this test allows a measurement of the g factor without interference from cultural bias.

To assess lexical and morphological processing in our sample we administered the morphological and lexical task included in the SICOLE software program (A knowledge based system in assessing and remedial education of reading disabilities in the Spanish language, Jiménez et al., 2002). SICOLE consists of different serially connected components. The construction of the first component resulted in an interface displaying a choice-dependent sequence of menus that leads to the selection of a preliminary set of language and reading task situations (e.g., speech perception, syllabic awareness, intrasyllabic awareness, phoneme awareness, word reading, sentence processing, morpheme and lexical processing, and reading comprehension). The morphological and lexical test includes two tasks: (1) homophone selection task and (2) morphological root comprehension task.

In the homophone selection task (homophones are words which are spelled differently but which have the same pronunciation), participants are presented with a picture, two homophone words and a spoken question (e.g. what is an animal?). The children have to choose one of the written words. The correct response is the word which matches with the picture and the question. There are 9 items in the homophone selection task (Reliability: Alpha .97).

In the root morphological comprehension task, participants are presented with a written word and two pictures. One of these corresponds to the written word. The participant had to read aloud the writing word and then point to the correct picture. Five different root morphemes were used. Each one included the same root during four presentations, with the suffixes changed. Twenty items were administered. (Reliability: Alpha.90).

Procedure

Six experienced psychologists carried out the administration of the reading test and the lexical and morphological awareness assessment using the SICOLE software program. Both assessments were carried out individually during four sessions per participant in a school room providing appropriate conditions. The tasks were presented randomly, each preceded by two examples to ensure that the children understood the instructions.

Results

Morphological and lexical processing and reading disabilities. The comparison between reading disabled children and normal readers matched in age, and younger normal readers was compromised somewhat by the fact that the reading disabled group had a lower verbal working memory (VWM) mean than the control groups. To control for this difference, two one-way analyses of covariance (ANCOVAs) were conducted across the groups for the homophone and morpheme root task in which Verbal Working Memory served as the covariant. The Bonferroni correction was used for each of these ANCOVAs to reduce the likelihood of making a Type I error. We used hierarchical regression analyses to test the homogeneity of regression assumption. This assumption was met, then the ANCOVA was used. Results revealed a significant effect of VWM on homophones task [$F(1,59)=7.47, p<.01$]. The same significant effect was found on the morphological comprehension task, [$F(1,59)=18.77, p<.001$] (accuracy), [$F(1,34)=3.59, p<.001$] (latency). Because of the effects of VWM on our tasks, this variable was partialled out in the subsequent analyses. Accuracy scores on verbal working memory were used as the covariant for these analyses.

Task differences

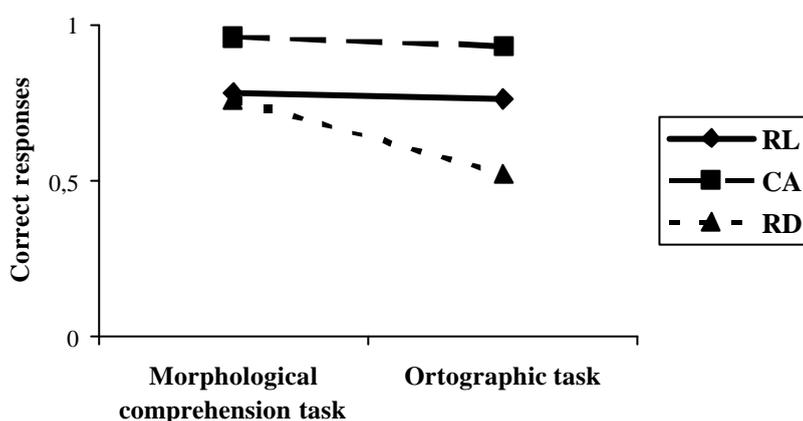
A (3x2) Group (reading disabled vs. normal readers matched in age vs. younger normal readers) x Task Differences (homophones task vs. morphological root comprehension task) mixed analysis of covariance (ANCOVA) was performed on the number of correct responses as a dependent variable, and it was calculated separately across participants (F1) and items (F2). Table 2 contains means and standard deviations for the three groups in each of the Morphological and lexical tasks.

Table 2. Mean and Standard Deviation correct responses (SDs) in each of the orthographic and morphological awareness tasks as a function of different groups.

RL = Reading age; CA = Chronological age.

Tasks	Groups					
	Reading Disabled		RL controls		CA controls	
	M	SD	M	SD	M	SD
Homophones	.52	.20	.76	.14	.93	.08
Morphological Comprehension	.76	.18	.78	.16	.96	.04

Figure 1. Interaction between Group and Task differences on correct responses:
RL = Reading age; CA = Chronological age; RD = Reading disabled.



This analysis yielded a main effect of Group [$F(2,48)=36,72$, $p<.001$], $\zeta^2 = .62$ [$F(2,34)=23,002$, $p<.001$], and also a main effect of Task Differences [$F(1,56)=10,42$, $p<.001$], $\zeta^2 = .11$ [$F(1,34)=17,16$, $p<.001$], but was subsumed under a significant interaction Group x Task Differences [$F(2,57)=3,39$, $p<.01$], $\zeta^2 = .24$ [$F(2,34)=5$, $p<.010$]. Tests of simple main effect confirmed that RL scored significantly higher than RD on the homophone task [$F(1,48)=17,27$, $p<.001$]. However, there were no differences between these groups in the morphological comprehension task.

Results indicated that the CA group had better achievement on the responses than the RL group on homophones [$F(1,48)=9,27$, $p<.001$] and on the morphological comprehension task [$F(1,48)=14,50$, $p<.001$]. The same significant differences were found between CA and

RL on homophones [$F(1,48)=71,33$, $p<.001$] and on the morphological task [$F(1,48)=19,48$, $p<.001$].

Latency differences

We analysed the differences within groups on the latency of the morphological task across presentations (four presentations per morpheme). An analysis of covariance (ANCOVA) was performed on the latency of the correct responses as a dependent variable and was calculated separately across participants and items. This analysis yielded a main effect of Group [$F(2,34)=3.53$, $p<.01$], and a main effect of presentation [$F(3,32)= 51.52$, $p<.001$], Good readers were significantly faster than the reading disabled group [$F(1,34)=5.34$, $p<.05$], and than younger readers [$F(1,34)=4.34$, $p<.05$].

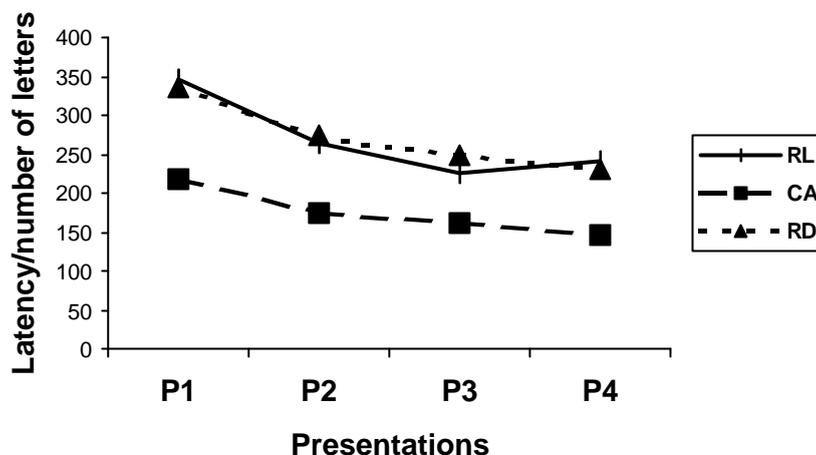
Comparisons of the presentations among groups

T-test pairs comparisons were used to determinate differences among the presentations per group. The difference between the first and the second presentation was significant in all groups, $t=61,67$, $p<.001$. The same differences were found when we compared the first and the third presentation, $t=9,26$, $p<.001$. Also the differences between the first and the fourth were significant, $t=94,10$, $p<.001$. Finally, the differences appeared again when we compared the second with the fourth $t=32,41$, $p<.01$.

Table 3. Means and Standard Deviations (SDs) of latency/number of letters in the morphological comprehension tasks along presentation as a function of different groups. RL = Reading age; CA = Chronological age.

<i>Presentations</i>	Groups					
	Reading Disabled		RL controls		CA controls	
	M	SD	M	SD	M	SD
1	334.97	128.46	347.05	110.83	219.42	92.10
2	277.55	106.88	265.21	44.60	175.34	31.64
3	249.70	104.57	226.85	64.49	161.64	64.33
4	230.62	79.20	241.82	88.88	146.40	68.26

Figure 2. Morphological comprehension task latency/ number of letters along presentations in msec: RL = Reading age; CA = Chronological age; RD = Reading disabled.



Discussion

The aim of this study was to investigate the role of multiletter units, such as the morpheme and the whole word, in word recognition in Spanish children with dyslexia. Results showed that there was a lexical processing deficit in children with reading disabilities compared to younger children with the same reading level, and we did not find deficits in morphological processing. Nevertheless, when we analysed the latency of the morphological comprehension task, results showed that this latency decreased during the presentation, independently of the groups, although the performance of normal readers matched in age with the reading disabled children was significantly better than the two other groups.

With regard to the role of the morphological unit (root morpheme) to access the lexicon in children with RD, we had hypothesised that the reading disability group would have more need to use larger units like the morpheme in visual word recognition because they have problems with phonemic awareness. Nevertheless, we found that there were no differences between Spanish children with RD and the other control groups in using correspondences that are based on higher level units, such as the morpheme, in a transparent orthography. Consequently, if no differences are found between the group with RD and both their age-matched controls and the reading level control groups, then it is most unlikely that the variable in question (morpheme) plays any role in causing reading difficulties (Bryant & Goswami, 1986). These findings are consistent with research in Spanish which has investigated the role of multiletters units in word recognition. Jiménez, González, Estévez and Hernández-Valle (2000) found that there were no

differences between children with reading disabilities and normal readers in using correspondences that are based on higher-level units such as onset-rime, and the findings of Jiménez and Rodrigo (1994) showed that there was no interaction between syllable and reading level. This implies that there were no differences between normal readers and readers with disabilities in using the syllable unit. This empirical result suggested that the syllable unit plays a role in causing reading difficulties. Nevertheless, some orthographies, unlike Spanish, are not entirely predictable on the basis of the phonemes, i.e. are not transparent systems. This is true for notoriously “irregular” orthographies like English and to some extent Danish and French. These languages are governed not only by phonology, but also by morphology. For instance, Elbro and Arnbak (1996) carried out one study on morphological analysis as a strategy in word decoding in Danish teenagers with dyslexia. They found that the teenagers with dyslexia, as a group, showed a dependency on morphological word structure. The interactions indicate that this group was significantly more affected by morphological word structure than the normal reading-level matched controls. The semantic analysis of the word was a significant help for the dyslexics, whereas the normal controls did not use and maybe did not even need such a semantically transparent structure to decode the words. These results show that the recognition morpheme may be a compensatory strategy in word decoding in dyslexia.

In summary, our findings allow us to answer the two questions presented above. Morpheme recognition contributes to reading in Spanish in children with and without reading problems and this contribution is not different in children with reading disability as compared to normal reading children.

Nevertheless, when we analysed the latency of the morphological comprehension task, results show that this latency decreases during the presentation, independently of the groups, although the performance of normal readers matched in age with the reading disabled children is significantly better than the younger children at the same reading level and the reading disabled groups. This result must be interpreted in terms of delay, not deficit, in the reading disabled group because the performance of this group is similar to the reading level group. Possibly, this result may be due to both groups having less experience with the written language, which in turn provides the opportunity to become aware of morphological analogies between words.

Although it is obvious that with the results of the present research we cannot resolve the conflictive field of morphology, this is the first step to clarifying the role of the morpheme unit

in word recognition in Spanish children with dyslexia. It will now be necessary to carry out further studies about the different types of morphemes.

In this research we also looked at the role of the whole word in visual word recognition in Spanish children with dyslexia. Our results show that there was lexical deficit in children with reading disabilities compared to the younger children with the same reading level. The deficit that we found in lexical processing could be explained by taking into account that our sample of reading disability children was selected by pseudoword accuracy reading, so we assume that they have problems in phonological decoding. Coltheart (1987) specifies that phonological processing precedes lexical processing when children are learning to read. Bruck (1993a). Share and Stanovich (1995) suggest that phonological decoding facilitates the establishment of lexical representations. Also, Alegría (1985) affirms that the building of the lexicon depends on the phonological route in Spanish language. Therefore, normal readers, in their first steps to reading, could recognise frequent and non-frequent words using the word-to-sound information. Later, these normal readers could use a lexical strategy to recognise the familiar words (Backman, Bruck, Herbert & Seidenberg, 1984). However, children with reading disabilities have problems in the processing of letter-to-sound relationships. This kind of problem determines the poor experience with reading of children with reading disabilities (Stanovich, 1986). Consequently, lexical representations are less in the reading disability group than in the other two groups because they have problems in phonological processing.

In conclusion, the research findings of this study have provided some evidence that the morpheme unit does not seem to be as relevant as the whole word unit in Spanish children with dyslexia, and lexical processing seems to be more affected than morphological processing in the reading disability group.

The present results have implications for educational practice. They suggest that while it is necessary to train children with dyslexia in the lexical strategy, as they show a deficit in this processing skill, when it comes to the role of the morphological unit (root morpheme) in accessing the lexicon, in a transparent orthographic system like Spanish it is not necessary to train children with RD in morphological strategy. Experience with the written language in itself will provide these children with the opportunity to become aware of the morphological analogies between words.

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