The Spanish Journal of Psychology
2002, Vol. 5, No. 1, 3-19

1138-7416

Identifying Subtypes of Reading Disability in the Spanish Language

Juan E. Jiménez González and Gustavo Ramírez Santana
University of La Laguna

This study was designed to examine the dyslexic subtypes in a transparent orthography (i.e., Spanish language). The subtyping procedure used comparison with chronological-age-matched and reading-level controls on reaction times (RTs) to high frequency words and to pseudowords. Using regression-based procedures, the authors identified 20 phonological and 48 surface dyslexics from a sample of 89 dyslexic third-grade children by comparing them to chronological-age-matched controls on RTs to high frequency and pseudoword reading. However, when the dyslexic subtypes were defined by reference to reading-level controls, the same 20 phonological dyslexics were defined, but only 19 surface dyslexics were identified. Nevertheless, the results of the phonological awareness tasks and error analysis do not validate the division of the dyslexic sample into these subgroups.
Key words: developmental dyslexia, dyslexic subtypes, phonological awareness, learning disabilities, reading-level match, regression method

Esta investigación analiza los subtipos disléxicos en una ortografía transparente (i.e., lengua española). El procedimiento utilizado para la identificación de subtipos disléxicos consistió en la comparación de los tiempos de latencia (TL) entre palabras familiares y pseudopalabras, en una tarea de denominación. Se tomó como referencia un grupo control de lectores normales igualado en edad cronológica y un grupo control de lectores normales más jóvenes igualado en nivel lector con el grupo experimental de disléxicos. Mediante la técnica de regresión estadística, y como resultado de comparar los TL en palabras familiares y pseudopalabras de la muestra de disléxicos con los obtenidos en el grupo control de igual edad cronológica, se identificaron un total de 20 disléxicos fonológicos y 48 disléxicos de superficie de una muestra de 89 disléxicos de tercer curso de Primaria. Cuando los subtipos disléxicos fueron definidos con referencia al grupo control igualado en nivel lector, se identificaron a los mismos disléxicos fonológicos, pero solamente fueron identificados un total de 19 disléxicos de superficie. Sin embargo, los resultados obtenidos en las tareas de validación demuestran que ambos subtipos disléxicos comparten los mismos problemas fonológicos. Se concluye que la existencia de subtipos disléxicos podría estar reflejando las diferencias existentes entre los sistemas ortográficos.
Palabras clave: dislexia evolutiva, subtipos disléxicos, conciencia fonológica, dificultades de aprendizaje, diseño de nivel de lectura, regresión estadística

This research was supported by a grant from DGICYT (Dirección General de Investigación Científica y Técnica, number PB94-0587, Ministerio de Educación y Ciencia).

Correspondence concerning this article should be addressed to Juan E. Jiménez González, Departamento de Psicología Evolutiva y de la Educación. Universidad de La Laguna. Campus de Guajara. 38200 Islas Canarias (Spain). E-mail: ejimenez@ull.es

In recent years, a body of subtyping work has been published around the study of acquired dyslexia and the attempt to conceptualize it within the framework of theories of adult word recognition (Stanovich, Siegel, & Gottardo, 1997a). Acquired dyslexia is thought to be deviant because it results from damage to the normal reading system and because it produces patterns that are not seen in skilled adult readers (Manis, Seidenberg, Doi, McBride-Chang, & Petersen, 1996). Developmental or congenital dyslexia has been characterized by the developmental inability to read despite adequate opportunity, intellectual ability, and motivation (Hynd & Hynd, 1984). In this context, the question emerges of whether developmental dyslexics form a homogeneous population, with a unique underlying impairment, or whether they form distinct subgroups. Some research conducted with an English language focus has described dyslexic children with differing degrees of deficiency in reading pseudowords and irregular words, leading to the conclusion that there are developmental analogues of the acquired forms of dyslexia (Castles & Coltheart, 1993; Manis et al., 1996; Stanovich, Siegel, & Gottardo, 1997b). These cases of developmental dyslexia were interpreted within the functional cognitive architecture assumed by the dual-route theory, which contemplates a phonological dyslexia profile with impaired phonological skills and fairly well-preserved orthographic skills, and a surface dyslexia profile characterized by impaired orthographic skills and fairly well-preserved phonological skills (Stanovich, et al., 1997b). The primary purpose of the study reported here was to investigate the dyslexic subtypes in a transparent orthography (i.e., Spanish language). The advantage of using a transparent orthography lies in its characteristics, which include a much higher degree of consistency in the grapheme-phoneme correspondences than the English language because there is no alternative to sounding out graphemes. There are some exceptions with a few letters (i.e., c, g, and r) but they can be predicted from context dependent grapheme-phoneme correspondences rules.

The existence of subtypes of developmental dyslexics has been questioned because some authors have suggested that all the cases of developmental dyslexia can be explained in terms of weaknesses in phonological processing (e.g., Felton & Wood, 1992; Stanovich & Siegel, 1994; Wilding, 1989). For example, Wilding has argued that none of the cases of developmental dyslexia so far reported has shown a clear dissociation on the critical error categories of irregular word reading (e.g., *island*) and pseudoword reading (e.g., *mulp*). Therefore, Castles and Coltheart (1993) suggested that research involving larger samples, instead of individual case studies, is needed to resolve this issue and to determine the theoretical and clinical value of this methodology to developmental reading disorders. In fact, they showed that their dual-route subtypes could be defined by reference to the performance of normal controls. In addition, Bryant and Impey (1986) suggested that extrapolating from the reading patterns of children at a higher reading level is an inappropriate way of defining abnormal patterns of processing skills at a lower reading level. One major criticism of the case study method is that, when looking for extreme profiles, mixed profiles that might represent a significant proportion of the dyslexic population are not taken into account. Another problem is that the performance of the cases studied is not compared with that of average readers of the same age and the same reading level. Lacking such controls, there is a potential risk of wrongly assuming that behavior also found in children who read quite normally for their age is specific to dyslexia.

Therefore, Bryant and Impey (1986) suggested the need to examine the subtypes within the context of a reading-level match. In fact, a reanalysis of the Castles and Coltheart (1993) data conducted by Stanovich et al. (1997b) confirmed such suggestions. In addition, Stanovich et al. (1997b) conducted a subtype analysis of the Castles type on a sample of children who were considerably younger than those studied by Manis et al. (1996) and than those in the post hoc analysis of the Castles and Coltheart (1993) study. They examined whether the results generalize to earlier reading levels and how early the subtypes can be reliably identified. They concluded that there is reasonably convergent evidence for the subtypes identified by regression-based procedures, but they offered a different interpretation of the two subtypes: "Surface dyslexia may arise from a milder form of phonological deficit than that of the phonological dyslexic, but one conjoined with exceptionally inadequate reading experience" (Stanovich et al., 1997b, p. 123).

Overall, the research reviewed by Stanovich et al. (1997b) has been conducted in an opaque orthography using a reading-level match design. However, there is great variability in alphabetic systems, that is, the relation between written forms and the phonology found across languages. If we consider a continuum in the predictability of grapheme-phoneme relationships, at one extreme are the languages with a much higher degree of orthographic transparency where the mapping between graphemes and phonemes is largely consistent (e.g., Serbo-Croatian, Spanish, and Finnish, to name a few), whereas at the other extreme of continuum are languages with an opaque orthography where there are many ways of sounding out graphemes and many of the correspondences cannot be predicted from context-dependent graphophonological rules (e.g., English).

Many authors have suggested that differences in the depth of alphabetic codes imply different ways of processing written languages (Baluch & Besner, 1991; Frost, Katz, & Bentin, 1987; Seidenberg, 1985). In the case of languages with an opaque orthography, skilled readers are normally assumed to recognize words through the orthographic-graphemic code, whereas in transparent orthographies, readers are assumed to rely on the phonemic prelexical code. Nevertheless, there is empirical evidence for the use of orthographic and phonemic cues in printed-word recognition in English (e.g., Perfetti, Bell, & Delaney, 1988). In the Spanish language, there is a higher probability that lexical access may be influenced to a greater extent by a phonological recoding. As has been suggested by Frost et al. (1987) in transparent orthographies, phonology is activated directly from print.

Some research was conducted with Spanish speakers to determine to what extent the dual-route models are functional in Spanish (e.g., Defior, Justicia, & Martos, 1996; de Vega & Carreiras, 1989; de Vega, Carreiras, Gutiérrez, & Alonso-Quecuty, 1990; García-Albea, Sánchez-Casas, & Viso, 1982; Valle-Arroyo, 1996). Overall, the pattern of results in these studies suggests no difference between the processes involved in the acquisition of reading Spanish and those implicated in opaque orthographies such as English. In addition, some Spanish studies reported individual cases of phonological dyslexia in which there was a dissociation of reading words versus nonwords similar to what has been found for opaque orthographies (e.g., Cuetos, Valle-Arroyo, & Suárez, 1996; Iribarren, Jarema, & Lecours, 1999). Consequently, if reading mechanisms are the same for different alphabetic writing systems, then the pattern of results found in the subtyping work in English should be expected in Spanish as well.

However, because phonological decoding is easier in Spanish, we would expect more surface dyslexics in a highly regular orthography. For instance, Genard et al. (1998) found that developmental phonological dyslexia was less common in French than in English due to the greater transparency of the French orthography. Recently, Frith (1999) has also argued that phonological dyslexia will be just as common across language communities but that phonological dyslexics will be harder to detect in regular orthographies.

The procedure used by Castles and Coltheart (1993) for identifying dyslexic subtypes is based on pseudoword and irregular word reading in the English language. However, there are no irregular words in a transparent orthography such as Spanish because pronunciations can always be derived and obtained by the strict application of grapheme-phoneme correspondences rules. Therefore, alternative means must be used. Grompone (1975) adapted the diagnostic screening procedure developed by Boder (1973) to Spanish and administered it to a group of Spanish-speaking Uruguayan children diagnosed as dyslexics. The children were able to read all of the words. The main difference between the groups was in speed and reading style: the dyslexics sounded out syllables or letters and took longer to do so. Also, Martínez (1995) using a regression procedure, found that Spanish surface dyslexics were only identified when using reaction times (RTs) in combination with errors such as reading by syllables. Nevertheless, studies conducted in a transparent language such as German (Wimmer, 1996) also suggest that dyslexics do not differ from normal readers in pseudoword reading accuracy but rather in speed of processing. On the contrary, in opaque orthographies, this reading accuracy measure is sufficient to distinguish subtypes of dyslexic children (Castles & Coltheart, 1993; Manis et al., 1996; Stanovich et al., 1997b).

In an examination of other methods, Ruíz, Ansaldo, and Lecours (1994) recorded the RTs to both words and pseudowords and found in a patient (identified as DC) that RTs were significantly higher than those of control participants, mainly for words. It was on this basis, and following Coltheart's (1978) assertion that lexical reading is faster and more efficient than non-lexical reading, that Ruiz et al. (1994) maintained that RTs can be used as another way of detecting surface dyslexia in Spanish speakers.

In the present study, using voice onset time to differentiate dyslexic subtypes, the purpose was to examine the prevalence of subtypes in a transparent orthography within the context of a reading-level match. The transparent orthographic system was examined with respect to any possible influence it may have on the incidence of dyslexic subtypes.

It was hypothesized that children who have greater RTs for familiar words with regard to RTs for pseudowords will have difficulties in using a lexical procedure. On the other hand, it was hypothesized that children who show longer latencies for pseudoword reading as compared to familiar word reading will have more difficulties in using a phonological route.

Method

Participants

The initial group was obtained from the local population, in which the teachers nominated normal readers and children who were reading disabled. We studied only those children who were either normal readers or reading disabled according to their performance in the different subtests of the Spanish "Test de Análisis de Lectoescritura" (TALE, [Standardized Literacy Skills Test]; Toro & Cervera, 1980). The children were classified into three groups: (1) The reading-disabled group (dyslexic) was made up of 89 third-grade children (age in months, M = 104.6, SD = 7.87) who achieved a performance below the Grade 3 norms (i.e., 2 years) on each of the subtests of TALE individually; (2) The first control group was made up of 37 normal readers matched in age with the reading-disabled group (age in months, M = 106.8, SD = 5.18); (3) A second control group was made up of 39 younger children of the same reading level as the reading-disabled group (age in months, M = 82.2, SD = 4.45). Both reading disabled and younger normal readers were matched on each of the TALE subtests individually (i.e., letter, syllable, and word reading) based on Grade 1 norms. Normal readers matched in age achieved a performance according to Grade 3 norms. The grade-level means by group are presented in Table 1. These children had learned to read by phonic instruction, and grapheme-phoneme correspondences were explicitly taught in first grade. This method moves children gradually from simple to complex correspondences and is the most common approach to reading instruction in Spanish schools. Excluded from the study were those children who had sensory, acquired neurological, or other problems traditionally used as exclusionary criteria for learning disabilities.

Tasks

"TALE" ([The Standardized Literacy Skills Test], Toro & Cervera, 1980), which has various reading subtests, was used. Letter, Syllable, and Word subtests were administered. In the Letter subtest the participants read all the letters in the Spanish alphabet presented in upper and lower case letters. The Syllable subtest included a list of syllables with different structures (i.e., CV, VC, CVC). The Word subtest required correct identification of ordinary words. The subtests of the TALE are based on the accuracy of the responses.

Naming task. The two reading disability subtypes were defined by their performance on a set of experimental words and pseudowords. The naming task consisted of reading aloud each of the verbal stimuli that appeared one by one on a computer screen. The child had to read the item as quickly as possible. The RT of each stimulus was registered from the moment when the word or pseudoword appeared on the screen until the subject pronounced the first reading sound. The sound was recorded by the voice key, which stopped the computer's chronometer. The participants were presented either with the block of words followed by the pseudowords, or vice versa, so that they would not use a specific strategy. It is known that when words and pseudowords are used in the same block, the most efficient strategy for performing the task is to use only the phonological route, as Álvarez, Carreiras, & de Vega, (1992), Domínguez, Cuetos, and de Vega (1993), and Tabossi (1989) have suggested.

Table 1
Mean and Standard Deviations of the Three Groups in Each TALE Subtest

	Group	*M*	*SD*
Letters	RL	1.48	0.77
	A	3.61	0.48
	DG	1.46	0.59
Syllables	RL	1.41	0.81
	A	3.73	0.55
	DG	1.38	0.71
Words	RL	1.48	0.81
	A	3.82	0.38
	DG	1.44	0.59

Note. RL = Reading-level-matched controls; A = Age-matched controls; DG = Dyslexic group. These scores are grade level.

A reliability analysis was used on the different blocks of stimuli for the sample of reading-disabled children. In both the words and the pseudowords, reliability was .97. To conduct this experiment, the program UNICEN was designed and used together with a device that detected the sounds within the broad band of the human voice but was not affected by the fairly high percentage of background noise (Escribano, 1991).

The experiment started with a few practice items to train the participants. During this phase, the RT was not registered. Then, the first stimulus appeared, setting in motion the chronometer, which stopped as soon as the participant emitted any vocal sound; after registering the RT, the second item appeared on the screen. The sequencing in the administration of the stimuli was as follows: blank screen on the computer (200 ms), fixation point in the center of the screen (400 ms), stimulus word or pseudoword. In total, the time between items was 2,000 ms. The experiment was conducted in a single session. The order of presentation of words and pseudowords was counterbalanced. Items were presented in random order within each set. In total, there were 32 words and 48 pseudowords. A complete list of stimuli used in this research appears in the Appendix. High-frequency words used in the experiment were selected on the basis of ratings generated from a normative study conducted by Guzmán and Jiménez (2001), who 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 and, 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, high-frequency words were selected. Pseudowords were extracted from research by de Vega et al. (1990).

While the children were performing the naming task, recordings were made of what they read in order to analyze the form as well as the frequency of reading errors. Regarding error categorization, the dual-route proposed by Coltheart (1978) was used. With this theoretical model of reading, errors were classified in the following categories: (a) the errors that we would expect to find if a lexical procedure was used in reading aloud (e.g., lexicalizations, morphological, and visual errors); and (b) the errors that would appear to reflect a sublexical procedure for reading aloud (e.g., word non-word conversion, phonological, substitution, omission, addition, repetition, and reversal errors). Scoring of reading errors in words was based on the following criteria:

1. Word/non-word conversion errors were scored when a word was read as a pseudoword (e.g., *imparcial* [impartial] as "*esplateciar*").

2. Phonological errors resulted from a misapplication of context dependent on phonological rules and in this latter case, produced a change in pronunciation (e.g., *funcionar* [to function] as "*funkionar*," *viga* [beam] as "*vixa*," *araña* [spider] as "*arraña*"). For purposes of this study, an error was noted if all letters were read correctly except one phoneme. In the Spanish language, the process of translating print to sound is never ambiguous because each letter of the alphabet has a unique pronunciation, except the letters *c*, *g*, and *r* (e.g., *c* is pronounced as /k/ when followed by the vowels *a*, *o*, and *u* and as /th/ when followed by the vowels *e* and *i*; *g* is pronounced as /g/ when followed by the vowels *a*, *o*, and *u* and as /h/ when followed by the vowels *e* and *i*; and *r* is pronounced as /rr/ when it appears at the beginning of the word or when it is preceded by the letters *l*, *n*, and *s*, and as /r/ in the rest). Moreover, phonological errors can result from a misapplication of accent rules (e.g., *melón* [melon] as "*mélon*"). Some Spanish words must have an acute accent (´) on the last, second last, or third last vowel.

3. Visual errors were scored when the response was a real word and it did not bear a semantic relationship to an inferred visually confusable mediator (e.g., *monumento* [monument] as "*momento*" [moment]).

4. Morphological errors were identified when the response and target words shared the same root or stem (e.g., *funcionar* [to function] as "*función*"[function]). Further, this type of error was not scored in those words where there was a conversion from plural to singular form. This scoring procedure was employed because in the Canary Islands, where these data were collected, the pronunciation of /s/ is aspirated when it appears at the end of a word.

5. Substitution errors included all vowel or consonant substitutions (e.g., *oxigenada* [oxygenated] as "*otigenada*").

6. Omission errors were scored when a vowel or a consonant was not pronounced by the child (e.g., *rebanada* [slice] as "*reba-ada*").

7. Addition errors were scored when a new phoneme was pronounced that did not belong to the word (e.g., *jugar* [to play] as "*julgar*").

8. Repetition errors were scored when the child repeated parts of a word (e.g., *fundamental* [fundamental] as "*fun-fun-da-men-men-tal*").

9. Reversal errors were scored when a word, or part of a word, was read from right to left (e.g., *copla* [verse] as "*copal*").

The scoring of reading errors in pseudowords was based on the following criteria:

1. Lexicalizations arose in converting a pseudoword into a word (e.g., *delce* as "*dulce*" [sweet]).

2. Substitutions, omissions, additions, repetitions, phonological and reversal errors were also computed in pseudowords. The same scoring of reading errors for words was also used for pseudowords.

Many authors consider the naming task to be the best for detecting reading problems (Olson, Wise, Conners, Rack, & Fulker, 1989; Perfetti, 1986; Siegel, 1986; Siegel & Heaven, 1986). Nevertheless, there is evidence that naming tasks are lexically mediated both in opaque (e.g., Balota & Chumbley, 1984; Baluch & Besner, 1991; Forster & Chambers, 1973; Seidenberg, Waters, Barnes, & Tanenhaus, 1984) and in transparent orthographies (for a review, see Sebastián, 1991).

Phonological awareness tasks. We used three different phonological awareness tests: (1) an odd-word-out task, (2) phoneme segmentation, and (3) phoneme reversal. In another study, Jiménez (1997) conducted a reliability analysis on the different phonological awareness tasks and the alpha coefficient was calculated for each task. The alpha for the odd-word-out task was .70. In both the phoneme segmentation and the phoneme reversal tests, it was .98.

(1) The odd-word-out task. This task, based on the work of Bowey and Francis, (1991), was designed to test the awareness of intrasyllabic units using pictures. The examiner presented a list of four pictures for the children to name. The instructions were:

> I am going to show you some pictures. Look at these pictures. Tell me the names of the pictures. There is an *oveja* [sheep], an *oso* [bear], an *ojo* [eye], and an *araña* [spider]. Now, we have to guess which pictures begin with a different sound. Here is an *oveja*, does it begin with /o/? Yes, it does. Now, here is an *oso*, does it begin with /o/? Yes, it does. Now, here is an *ojo*, does it begin with /o/? Yes, it does. Now, here is an *araña*, does it begin with /o/? No, it does not begin with /o/.

The examiner did not provide any additional help in the task, and the child had to identify the picture that began with a different sound. This task had 3 examples and 10 items. Each item had four pictures. The phonemes that the children had to isolate on this task were the following: /r/, /l/, /ll/, /n/, /t/, /k/, and /p/.

(2) The phoneme segmentation test. In this test, the children counted the phonemes of words that were presented orally and used aids such as rods. In the examples, the examiner pronounced a word as he tapped each phoneme with the rod. The instructions were "Listen, '*sapo*' [toad]. How many parts does it have? It has four parts, doesn't it? The parts are /s/-/a/-/p/-/o/. Do you understand the game? If you need some help, you can use these rods." The examiner did not help the children any further. Each word was presented individually and the examiner asked the children how many parts the word had. This task had 2 examples and 14 items.

(3) The phoneme reversal test. In this test, the children counted the phonemes of words by reversing the order of segments in each word. In the examples, the examiner pronounced a word and the instructions were "Listen, '*misa*' [mass]. How many parts does it have? It has four parts, doesn't it? The parts are /a/-/s/-/i/-/m/. Do you understand the game?" The examiner did not provide any further help to the children. Each word was presented individually and

the examiner asked the children how many parts the word had. This task had 2 examples and 14 items.

Visual-phonological reading tasks. These tasks were adapted from one designed by Siegel (1992). In each of these tasks, there were 32 trials in which two stimuli were presented for each trial. For the phonological task, the child was required to specify which of two visually presented pseudowords (e.g., *kiero-ciero, dotor-doktor*) sounded like a real word. For the visual task, the child was presented with a real word and pseudoword (e.g., *sonrisa* [smile]-*sonrrisa, koche-coche* [car]) and was asked to specify which of the two was a real word. A reliability analysis was used and the alpha coefficient was calculated for each task. In the visual task, it was .81 and in the phonological task, .77

Procedure

We used the regression-based procedure developed by Castles and Coltheart (1993). The dependent variable was the RT to high-frequency words and pseudowords, controlling for the number of letters. That is, the RT for each stimuli (word and pseudoword) is divided by the number of letters.

Results

Table 2 shows the means and standard deviations for the 39 reading-level controls, 37 normal readers matched in age, and the 89 dyslexics. Due to the number of comparisons being made with interrelated variables, Bonferroni's correction was used to determine the acceptable alpha level for rejecting the null hypothesis. There were statistically significant differences in RTs between dyslexics and the age-matched control group both for pseudowords, $t(126) = 4.93$, $p < .001$, and familiar words, $t(126) = 5.26$, $p < .001$. There were no statistically significant differences between dyslexics and the reading-level-matched group in RTs either for pseudoword reading, $t(124) = 1.84$, $p = .69$, or familiar-word reading, $t(124) = 1.59$, $p = .11$. However, dyslexics performed more poorly than the reading-level-matched control group on the odd-word-out task, $t(124) = -4.06$, $p < .001$, the phoneme segmentation task, $t(124) = -2.95$, $p < .01$, and the phoneme reversal task, $t(124) = -3.91$, $p < .001$. In addition, dyslexics produced more errors both for familiar words, $t(124) = 8.37$, $p < .001$, and pseudowords, $t(124) = 5.07$, $p < .001$. The reading-level-matched group made far fewer total errors (and fewer errors in several categories) on the word pronunciation task.

Overall, these results show that our dyslexic group was impaired as a group relative to the age-matched peers on all tasks analyzed. Also, the dyslexics performed significantly below the reading-level-matched younger group on the measures of phonological awareness and accuracy. The finding of a dyslexic deficit in an age-matched peer group was consistent with that reported in other studies conducted using a transparent orthography (i.e., Spanish) (Jiménez, 1997; Jiménez & Hernández-Valle, 2000).

Identification of "Pure" Surface and Phonological Dyslexics

The same procedure suggested by Manis et al. (1996) was used in this study for identifying "pure" cases of surface and phonological dyslexia. Cut-off scores were set at one standard deviation below the age-matched control group's mean on each variable; 53 (59.6%) of the 89 dyslexics had high RTs in pseudoword reading, 67 (75.3%) had high RTs in familiar word reading, and 49 (55.5%) had high RTs in both pseudoword and familiar word reading. Using the same cut-off scores, 4 participants had high RTs in pseudoword reading only, and 18 participants had high RTs in familiar word reading only. According to these findings, more than half of the dyslexic group was made up primarily of individuals who had high RTs in both pseudoword and familiar word reading, relative to normal readers of the same age. Using a stringent criterion (normal performance on one task and abnormal performance on the other), 22 participants (24.7%) were identified who appeared to have a selective deficit on only one task. This result is very similar to the proportions obtained by Castles and Coltheart (1993), Manis et al. (1996), and Genard et al. (1998) (32%, 20%, and 23%, respectively). However, if the distribution of "pure" dyslexic subtypes in this sample is compared with those found in the English studies, the percentage of each of the dyslexic subtypes was different. Castles and Coltheart (1993) classified 15.1% of the sample as phonological dyslexics and 7% as surface dyslexics; Manis et al. (1996) identified 9.8% of their sample as phonological dyslexics, and 9.8% as surface dyslexics. In our study, we found 4.4% of the sample identified as phonological dyslexics and 20.2% of surface dyslexics. These percentages were similar to those obtained by Genard et al. (1998), who found 3% of phonological dyslexics and 23% of surface dyslexics in their research conducted in the French language. A possible explanation for this observation is that the French orthographic system is not as transparent as languages such as German, Spanish, and Italian in the consistency of the grapheme-phoneme relations, but it is considerably more predictable than English.

Identification of Dyslexic Subgroups Using the Regression Method

As suggested by Genard et al. (1998, p. 3),

> [...] the previously described method allows one to identify quite simply the rather "pure"cases of each distinct profile, it does not take into account the relationship between the two reading skills in order to isolate children who are more impaired in one task relative to the other.

Therefore, in the current study, the same regression-based procedure introduced by Castles and Coltheart (1993) was employed using the same-aged normal readers'

Table 2
Group Means, Standard Deviations, and t-Values in Age, Word RTs (in ms/letter), Pseudoword RT (in ms/letter), Phonological Awareness Tasks, and Total Errors in Words and Pseudowords

	Group	*M*	*SD*	*t* RL	*t* A
Age	RL	82.26	4.45		
	A	106.84	5.18	22.03***	
	DG	104.63	7.87	16.46***	−1.93
	SD	104.04	7.81	15.39***	−1.89
	PD	106.09	8.26	14.56***	−.42
Word RT	RL	282	93		
	A	174	41	−6.61***	
	DG	316	173	1.59	5.26***
	SD	378	188	2.95**	6.49***
	PD	264	91	−.73	5.21***
Pseudoword RT	RL	284	95		
	A	210	50	−3.92***	
	DG	332	187	1.84	4.93***
	SD	290	111	2.70	4.09***
	PD	501	249	4.87***	6.91***
Total Errors in Words	RL	5.90	2.89		
	A	3.57	3.08	−3.40***	
	DG	20.93	11.02	8.37***	9.41***
Total Errors in Pseudowords	RL	13.28	8.60		
	A	4.22	2.00	−6.25**	
	DG	21.99	9.70	5.07***	11.02***
Odd Word–Out	RL	8.63	1.81		
	A	9.46	1.02	2.45*	
	DG	7.00	2.17	−4.06***	−6.58***
Phoneme Segmentation	RL	8.68	1.42		
	A	9.51	.73	3.17**	
	DG	7.38	2.56	−2.95**	−4.98***
Phoneme Reversal	RL	7.32	2.47		
	A	8.76	1.21	3.19**	
	DG	5.01	3.25	−3.91***	−6.81***

Note. RL = Reading-level-matched controls; A = Age-matched controls; DG = Dyslexic group. SD = Surface dyslexics; PD = Phonological dyslexics.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

performance criterion to identify subtypes of dyslexics. This analysis provided an estimate of how much the dyslexics' performance differed from that of normal readers of the same age (Manis et al., 1996).

In the current study, a statistically reliable linear relationship was obtained between pseudoword-RTs and familiar-word-RTs for the age-matched groups, $F(1, 36) = 61.6$, $p < .001$, with 64% of the variance in one task accounted for by variation in the other. For familiar-word-RTs, the slope of the regression line was .98 and the intercept, 40.3. For pseudoword-RTs, the slope was .66 and the intercept was 36.6. The residual variances provided estimates of the range of normal variation around the regression lines, and were taken to determine the cut-off scores. Standard deviations of the residuals were 30.5 for familiar words and 24.9 for pseudoword reading, respectively. The soft-subtype cut-off scores were defined by running a regression line with 90% confidence intervals through the Word RTs × Pseudoword-RTs plot for the age-matched and reading-level-matched control groups. These regression line and confidence intervals were then superimposed on the scatterplot of the performance of the dyslexic sample. A surface dyslexic classification was made when a plot met two conditions: (1) an outlier resulted when word-RTs were plotted against pseudoword-RTs, and (2) the point fell within the normal range when pseudoword-RTs were plotted against word-RTs. Phonological dyslexics were defined conversely. This procedure is consistent with Castles and Coltheart (1993) and Stanovich et al. (1997b) who also used a 90% confidence interval. However, Manis et al. (1996) employed the 95% confidence interval. Recently, Genard et al. (1998) compared the effects of three different cut-off criteria on the relative proportions of children classified as dyslexic, fitting either the surface or the phonological profile. They showed that the relative proportions of dyslexics fitting either the phonological or the surface profile did not change as a function of the cut-off criterion adopted (i.e., 1 or 1.96 standard deviation). Further, in the current study, the data were analyzed using different cut-off criteria and we found the same results as reported by Genard et al. (1998).

Figure 1 illustrates the data from the sample of 89 third-grade children classified as dyslexic and plots word-RTs against pseudoword-RTs. The regression line and confidence intervals from the 37 age-matched controls are also shown. All four groups that are defined by conjoining these results with the converse plot (pseudoword-RTs vs. word-RTs) are indicated in Figure 2. The points labeled with squares are the surface dyslexics (high in the word-RTs × pseudoword-RTs plot and in the normal range on the converse plot); the circles are the phonological dyslexics (high in the pseudoword-RTs × word-RTs plot and in the normal range on the converse plot); the crosses are individuals in the normal range on both measures; and the asterisks are individuals who have high RTs on both measures.

A comparison of these results with those reported in the English studies shows that the percentage of dyslexic subtypes was quite different. In the current research, 17.8% of the respondents were classified as phonological dyslexics, compared to 54.7% reported by Castles and Coltheart (1993), 33.3% by Manis et al. (1996), and 25% by Stanovich et al. (1997b). However, a greater proportion of surface dyslexics (52.8%) was found in the present study, in comparison to the 30.1% reported by Castles and Coltheart (1993), 29.4% by Manis et al. (1996), and 22.1% by Stanovich et al. (1997b). In findings similar to those reported in the current research, Genard et al. (1998) found 56% of surface dyslexics, but the percentage of phonological dyslexics was also smaller (4%), and in Chinese orthography, Ho (2001) found 26% of surface dyslexics and 13% of phonological dyslexics.

Comparison of Dyslexic Subgroups and Reading-Level-Matched Control Group

This analysis informs whether the performance of this sample of third graders classified as dyslexic resembled that of younger children learning to read at a normal rate (Manis et al., 1996). In order to test whether the reading-level-matched group may provide a valid comparison, scores obtained from respondents classified as surface and phonological dyslexics were examined to determine whether these provided a generally lower scoring subset than the dyslexic sample as a whole. To test the hypothesis that the

□ = Surface dyslexics (SD); O = Phonological dyslexics (PD); X = Normal on both; * = High on both; ∇ = Chronological-age-matched controls.

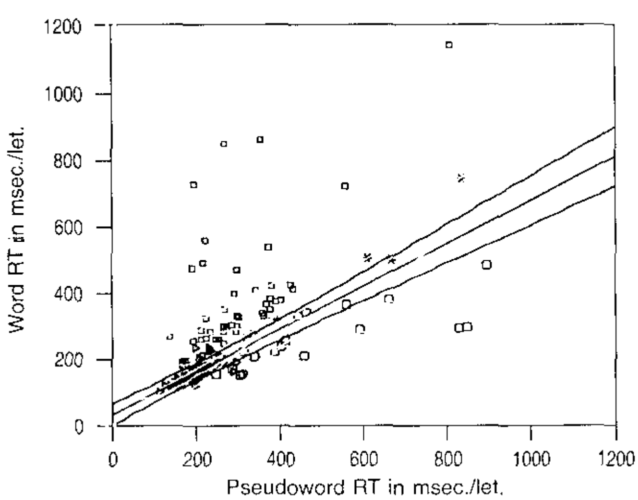

Figure 1. Familiar-word-RTs plotted against pseudoword-RTs for the reading-disabled children. The regression line and the confidence intervals were derived from the data of the chronological-age-matched controls.

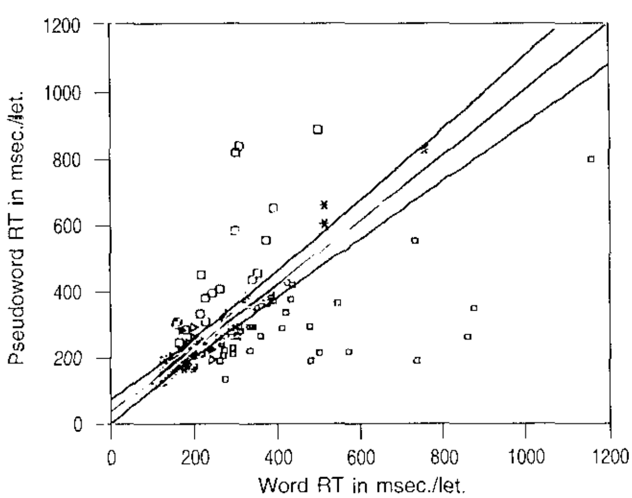

Figure 2. Pseudoword-RTs plotted against familiar-word-RTs for the reading-disabled children. The regression line and the confidence intervals were derived from the data of the chronological-age-matched controls.

reading-level-matched group scores are higher than the scores obtained from both subgroups in reading, the TALE measures were compared. The results indicated that there were no statistically significant differences between surface dyslexics and the reading-level-matched group in letters, $t(82) = -1.29$, $p = .20$; syllables, $t(82) = -0.56$, $p = .57$; or words, $t(82) = -0.44$, $p = .66$. Nor were any statistically significant differences found when scores were compared for the phonological dyslexic group and the reading-level-matched group in letters, $t(51) = 0.56$, $p = .57$; syllables, $t(51) = 0.36$, $p = .71$; or words, $t(51) = -0.47$, $p = .63$. According to the review of Spanish studies, there appears to be a very rapid development of the alphabetic route in children aged 5-6 because of the consistency of the writing system to which they are exposed. This finding might explain why younger normal readers commit so few reading errors. In fact, our findings coincide with research made in other languages with regular orthography. So, for instance, Wimmer (1996) found that for poor readers at the end of Grade 1, the error rates for words and corresponding simple pseudowords were 30% and 44%, respectively, whereas the error rates for normal readers at the end of Grade 1 were 1% and 4%, respectively.

As was the case with the age-matched group, familiar word and pseudoword reading scores showed a strong linear relationship, $F(1, 38) = 165.2$, $p < .001$, with 81% of the variance in one task accounted for by the other task. For familiar word scores regressed against pseudoword scores, the slope of the regression line was .93, and the intercept, 22.9. For pseudoword reading scores regressed against familiar word scores, the slope was .89, and the intercept, 31.4 Standard deviations of the residuals were 41.1 for familiar word scores and 40.0 for pseudoword reading scores, respectively. Figure 3 shows the RTs of the dyslexics plotted so as to identify phonological dyslexics (children with high pseudoword-RTs relative to word-RTs). The pseudoword-RTs are plotted against the word-RTs. The regression line and confidence intervals shown in the figure are based on the data obtained from the 39 reading-level-matched controls.

Figure 4 illustrates the RTs plotted to identify surface dyslexics (children with high RTs on familiar words relative to pseudoword-RTs). The RTs of words is plotted against the pseudoword-RTs. The regression line and confidence intervals shown in Figure 4 are based on the data from the 39 reading-level-matched controls.

Overall, 19 of the 48 plots associated with surface dyslexics and identified in the regression analysis for the age-matched group fell below the confidence limit for the reading-level-matched control group. In contrast, the 20 plots identified as corresponding to phonological dyslexics were identical to those identified from the age-matched group's regression lines.

Validity of Subtypes

"It is important to determine whether the subgroups can be validated using different, but conceptually related measures of the same skills" (Manis et al., 1996, p.174). Further exploration of the validity and reliability of the subgroup assignments as identified using the reading-level-matched group was conducted by examining word naming errors, and the performance on phonological awareness tasks and visual-phonological reading tasks.

□ = Surface dyslexics (SD); O = Phonological dyslexics (PD); X = Normal on both; ∇ = Reading-level controls.

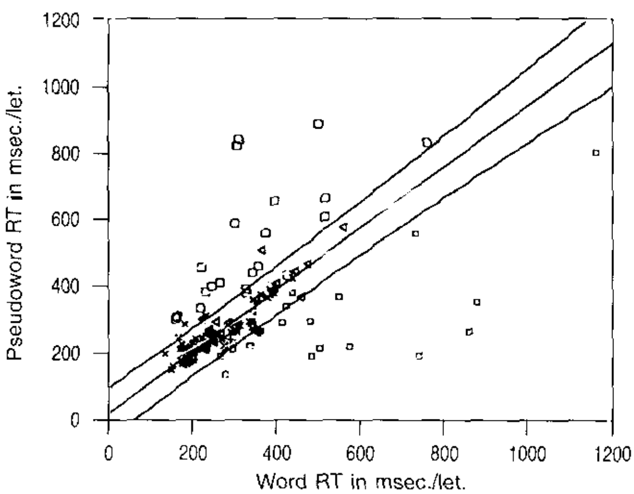

Figure 3. Pseudoword-RTs plotted against familiar-word-RTs for the reading-disabled children. The regression line and the confidence intervals were derived from the data of the reading-level controls.

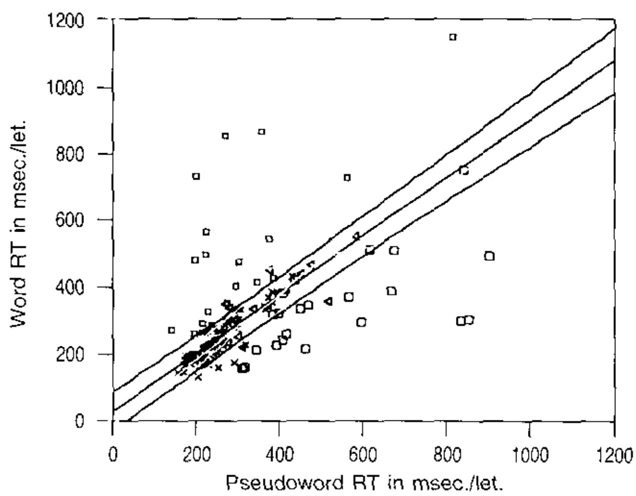

Figure 4. Familiar-word-RTs plotted against pseudoword-RTs for the reading-disabled children. The regression line and the confidence intervals were derived from the data of the reading-level controls.

Analysis of Errors

This procedure allowed for the examination of whether phonological and surface dyslexics showed the characteristic pattern of errors reported in previous case studies. Phonological dyslexics would be expected to produce more errors than surface dyslexics, who would appear to reflect a sublexical procedure for reading aloud. However, surface dyslexics would be expected to produce fewer errors than phonological dyslexics, who would appear to reflect a lexical reading. In an effort to validate these classifications, the influence of reading level on errors in the naming task was examined. Analyses of variance for one factor (the phonological dyslexic vs. the surface dyslexic vs. the younger normal readers) were conducted using the number of errors as a dependent variable. A Tukey test was performed on all the variables. The alpha criterion was set at .05. The mean and standard deviations from the total number of errors and type of errors for the three groups in words and pseudowords are shown in Tables 3 and 4.

In the analysis of words, the F values for the different ANOVAs were as follows: additions, $F(2, 106) = .55$, $p = .57$, $MSE = .98$; word-non word conversions, $F(2, 106) = 6.78$, $p < .01$; $MSE = 1.01$; phonological errors, $F(2, 106) = 31.0$, $p < .001$, $MSE = 89.9$; reversals, $F(2, 106) = 1.13$, $p = .32$, $MSE = .16$; omissions, $F(2, 106) = 28.1$, $p < .001$, $MSE = 1030.3$; repetitions, $F(2, 106) = 89.7$, $p < .001$, $MSE = 147.2$; substitutions, $F(2, 106) = 37.9$, $p < .001$, $MSE = 559.7$; and total number of errors, $F(2, 106) = 35.7$, $p < .001$, $MSE = 2781.6$. The surface dyslexics and phonological dyslexics committed a significantly higher number of errors, and in particular, phonological errors, omissions, and substitutions, than did younger normal readers. There were no statistically significant differences between younger normal readers and the dyslexic subtypes in additions and reversals.

In the analysis of pseudowords, the F values for the different ANOVAs were as follows: additions, $F(2, 106) = .70$, $p = .49$, $MSE = 2.41$; phonological errors, $F(2, 106) = 52.4$, $p < .001$, $MSE = 161.0$; reversals, $F(2, 106) = 6.83$, $p < .01$, $MSE = 6.29$; lexicalizations, $F(2, 106) = 7.19$, $p < .001$, $MSE = 4.29$; omissions, $F(2, 106) = 43.9$, $p < .001$, $MSE = 1129.9$; repetitions, $F(2, 106) = 4.60$, $p < .01$, $MSE = .72$; substitutions, $F(2, 106) = 2.40$, $p = .09$, $MSE = 50.2$; and total number of errors, $F(2, 106) = 9.59$, $p < .001$, $MSE = 784.6$. There was a significantly higher number of errors, and in particular reversals, lexicalizations, and omissions for both dyslexic subtypes than for the younger normal readers, except in phonological errors, where younger normal readers made significantly more errors than the dyslexic subtypes.

Phonological Awareness

If the subgrouping is valid, phonological dyslexics should perform more poorly on the phonological awareness tasks than younger normal readers, and this would support a specific deficit in phonological processing, whereas there should be no differences between surface dyslexics and younger normal readers on the phonological awareness tasks. Table 5 contains means and standard deviations for the three groups in each of the phonological awareness tasks.

ANOVAs for one factor (younger normal readers vs. phonological dyslexics vs. surface dyslexics) were conducted using the number correct responses as a dependent variable. The ANOVA on the odd-word-out task was statistically significant, $F(2, 104) = 9.48$, $p < .001$. A multiple comparison test indicated that younger normal readers scored significantly higher than did phonological dyslexics, $t(51) = 4.50$, $p < .001$, and surface dyslexics, $t(82) = 2.19$, $p < .05$. The ANOVA on the phoneme segmentation task revealed statistically significant differences, $F(2, 105) = 3.26$, $p < .05$, and the test indicated that the younger normal readers performed significantly higher than did phonological dyslexics, $t(51) = 2.56$, $p < .01$, and surface dyslexics, $t(82) = 3.80$, $p < .001$. Also, the ANOVA on the phoneme reversal revealed similar results because there was a statistically significant difference, $F(2, 105) = 5.95$, $p < .01$, and the test revealed that younger normal readers scored significantly higher than did surface dyslexics, $t(82) = 3.84$, $p < .001$, and phonological dyslexics, $t(51) = 3.72$, $p < .001$.

Other reading tasks

Surface dyslexics should perform relatively poorly on the visual task, perhaps reflecting possible problems in knowledge of specific word spellings, and phonological dyslexics should perform relatively poorly on a phonological task. There were no statistically significant differences between phonological dyslexics and surface dyslexics in visual task, $t(61) = .91$, $p = .82$, or phonological task, $t(61) = .09$, $p = .85$.

Discussion

A regression-based procedure introduced by Castles and Coltheart (1993) was employed to identify dyslexic subtypes in a transparent orthography. Children identified as dyslexics were classified into different subtypes, characterized by difficulties in using a lexical procedure, or phonological route, or both. Twenty children were identified as phonological dyslexics by using the two scatterplots and regressions. However, when surface dyslexics were defined by age-matched comparisons, 48 children were identified and 29 were not identical to those identified from the reading-level-matched regression lines.

Developmental phonological dyslexia is apparently less common in Spanish than in English, and these findings suggest that the specific orthographic characteristics of alphabetic languages could explain the differences found in the studies from English and Spanish. The simplicity of the

Table 3
Group Means, Standard Deviations, and t-Values in each of the Errors Analyzed in Words

				t		
Error	Group	*M*	*SD*	A	SD	PD
Additions	RL	1.28	1.61	3.81***	.93	.76
	A	.24	.43		–4.31***	–3.43**
	SD	1.00	1.11			.00
	PD	1.00	1.21			
Word non-word Conversions	RL	.35	.54	3.19**	3.08**	3.10**
	A	.05	.23		–.53	.07
	SD	.08	.28			.52
	PD	.05	.22			
Morphological Errors	RL					
	A	.24	.49		.33	.81
	SD	.21	.46			.55
	PD	.15	.37			
Phonological Errors	RL	.51	.72	–3.81***	–7.86***	–7.16***
	A	1.22	.89		–5.57***	–4.91***
	SD	3.23	2.05			.14
	PD	3.15	2.08			
Reversals	RL	.10	.31		–1.10	–1.49
	A					
	SD	.19	.39			–.55
	PD	.25	.44			
Omissions	RL	.06	.16	–3.61***	–7.66***	–7.12***
	A	.76	1.26		–6.28***	–6.20***
	SD	9.31	7.56			.30
	PD	8.70	7.66			
Repetitions	RL	3.46	2.11			7.17***
	A					
	SD					
	PD	.05	.22			
Substitutions	RL	.15	.43	–3.01**	–9.53***	–7.06***
	A	.70	1.05		–8.40***	–6.10***
	SD	7.06	4.51			.51
	PD	6.35	5.49			
Visual Errors	RL					
	A	.35	.59		1.35	1.78
	SD	.19	.53			.85
	PD	.10	.31			
Total Errors	RL	5.90	2.89	3.40***	–8.91***	–7.02***
	A	3.57	3.08		–9.97***	–7.95***
	SD	21.27	10.45			.49
	PD	19.80	11.78			

Note. RL = Reading-level-matched controls; A = Age-matched controls; DG = Dyslexic group; SD = Surface dyslexics; PD = Phonological dyslexics.
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Table 4
Group Means, Standard Deviations, and t-Values in each of the Errors Analyzed in Pseudowords

				t		
Error	Group	*M*	*SD*	A	SD	PD
Additions	RL	.87	1.01	1.67	−1.18	−1.17
	A	.54	.69		−1.89	−2.77**
	SD	1.33	2.47			.18
	PD	1.25	1.25			
Phonological Errors	RL	4.36	2.58	8.70***	8.46***	6.55***
	A	.51	.77		−.70	.07
	SD	.88	1.10			1.69
	PD	.50	.69			
Reversals	RL	.10	.31	−.05	−3.63***	−3.58***
	A	.11	.66		−3.21**	−3.01**
	SD	.77	1.12			1.69
	PD	.90	1.33			
Lexicalizations	RL	.10	.31	−.43	−3.78***	−3.51***
	A	.14	.35		−3.44**	−3.18**
	SD	.69	.93			−.05
	PD	.70	.98			
Omissions	RL	1.48	2.28		−9.11***	−8.68***
	A					
	SD	11.44	6.50			1.11
	PD	9.80	5.09			
Repetitions	RL	.25	.63	−14.15***	2.49*	1.79
	A	2.59	.80		21.93***	
	SD	.02	.14			
	PD					
Substitutions	RL	5.10	4.39	6.52***	−1.15	−2.10*
	A	.32	.78		−7.73***	−9.15***
	SD	6.21	4.58			−1.28
	PD	7.85	4.92			
Total Errors	RL	13.28	8.60	6.25***	−4.12***	−3.31**
	A	4.22	2.00		−10.63***	−11.62***
	SD	21.33	9.62			.14
	PD	21.00	8.40			

Note. RL = Reading–level–matched controls; A = Age-matched controls; SD = Surface dyslexics; PD = Phonological dyslexics.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

phonological structure of Spanish and the shallowness of its orthography should foster phonological processing in early reading. Signorini (1997) reported that word reading strategies from Spanish-speaking children displayed a tendency to use a phonological recoding mechanism in word reading.

With regard to surface dyslexia, our research revealed a greater proportion of surface dyslexics—compared with phonological dyslexics—than observed in English studies. Lexical reading is less relevant in Spanish, and this reason could explain why there are more surface dyslexics. The infrequent use of the lexical procedure would thus cause difficulties for the Spanish readers to master the direct visual route to read. In the French language also, Genard et al. (1998) found there were many more surface dyslexics in their study than in the studies conducted to examine English-speaking children. They suggested that the discrepancy found in the relative proportion of phonological and surface profiles in English and French suggest that the nature of the impairment is strongly determined by the relative importance of the analytical and lexical knowledge in the course of

Table 5
Group Means and Standard Deviations in each of the Phonological Awareness Tasks and other Reading Tasks

				t		
Task	Group	*M*	*SD*	A	SD	PD
Odd Word-Out	RL	8.63	1.81	−2.45*	2.19*	4.50***
	A	9.46	1.01		7.60***	5.27***
	SD	6.81	1.92			.89
	PD	6.95	2.57			
Phoneme Segmentation	RL	8.68	1.42	−3.17***	3.80***	2.56**
	A	9.51	0.73		4.74***	4.87***
	SD	6.72	2.44			-1.47
	PD	7.69	2.18			
Phoneme Reversal	RL	7.32	2.47	−3.19***	3.84***	3.72***
	A	8.76	1.21		6.28***	6.57***
	SD	4.50	2.75			−.62
	PD	5.00	3.31			
Visual Task	RL					
	A					
	SD	26.72	5.07			.91
	PD	25.25	6.14			
Phonological Task	RL					
	A					
	SD	16.78	3.12			.09
	PD	16.69	3.75			

Note. RL = Reading-level-matched controls; A = Age-matched controls; SD = Surface dyslexics; PD = Phonological dyslexics.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

development. The source of individual differences in reading between older children could be the transition from the use of grapheme-phoneme correspondences to the development of a complete amalgamation between the orthographic and phonological identities of words. More recently, Ho (2001) found in the Chinese logographic writing system a different dyslexic reading pattern from that of English reading and a similar dyslexic pattern to that of Spanish reading. The proportion of children with a surface dyslexic pattern was greater than the proportion with a phonological dyslexic pattern. The complexity in graphic appearance of Chinese characters would be likely to cause difficulties for children learning to read. Whenever children use their lexical procedure to read, they have to deal with the complexity of the internal structure of Chinese characters. In addition, the phonetic components of Chinese characters are unreliable, although over 80% of Chinese characters are phonograms.

On the other hand, studies in English have presented a consistent picture of developmental deviancy and developmental lag that appears to characterize the phonological and surface subtypes (e.g., Manis et al., 1996; Samuelson, Finnström, Leijon, & Mard, 2000; Stanovich et al., 1997b). Phonological dyslexia reflects developmental deviancy whereas, in contrast, surface dyslexia resembles a form of developmental delay. Stanovich et al. (1997b, p. 123) pointed out that "surface dyslexia may arise from a milder form of phonological deficit than that of the phonological dyslexic, but one conjoined with exceptionally inadequate reading experience." However, in the current study, both surface and phonological subtypes represent deviations from normal developmental, because both performed more poorly than the younger children in analyzing the phonemic structure of spoken words. In the French language, Genard et al. (1998) also found that error analysis did not validate dyslexic subtypes, and Sprenger-Charolles, Colé, Lacert, and Serniclaes (2000) found specific deficits in phonemic awareness and in phonological short-term memory both for phonological and surface dyslexics.

We also used tasks that tapped orthographic skill in order to test whether there were differences between surface dyslexics and phonological dyslexics. Surface dyslexics are assumed to be relatively poor on the orthographic task, which would reflect possible deficits in knowledge of specific word spellings, as has been used in previous research (e.g., Manis et al., 1996; Stanovich et al., 1997b). However, no differences between the groups were found and that is probably due to the task used to test orthographical processing because it did not include recall of specific spelling or orthographic awareness (see for example, Siegel, Share, & Geva, 1995). Nevertheless, according to the literature reviewed by Stanovich et al. (1997b), it has been shown that in individuals with reading disabilities, the orthographic processing problems are less severe than their phonological processing problems.

In conclusion, the aim of this study was to examine the dyslexic subtypes within the context of a reading-level match in a transparent orthography (i.e., the Spanish language). We examined whether the differences in the orthographic systems has an influence on the incidence of dyslexic subtypes. We have shown that, in a transparent orthography, developmental dyslexics do form a homogeneous population with a unique underlying phonological impairment.

References

Álvarez, C., Carreiras, M., & de Vega, M. (1992). Estudios estadísticos de la ortografía castellana: (1) la frecuencia silábica. *Cognitiva, 4*, 75-105.

Balota, D.A., & Chumbley, J.I. (1984). Are lexical decisions a good measure of lexical access? The role of word frequency in the neglected decision stage. *Journal of Experimental Psychology: Human Perception and Performance, 10*, 340-357.

Baluch, B., & Besner, D. (1991). Visual word recognition: Evidence for strategic control of lexical and nonlexical routines in oral reading. *Journal of Experimental Psychology: Learning, Memory and Cognition, 17*, 644-652.

Boder, E. (1973). Developmental dyslexia: A diagnostic approach based on three atypical reading-spelling patterns. *Developmental Medicine and Child Neurology, 15*, 663-687.

Bowey, J., & Francis, J. (1991). Phonological analysis as a function of age and exposure to reading instruction. *Applied Psycholinguistics, 12*, 91-121.

Bryant, P., & Impey, L. (1986). The similarity between normal readers and developmental acquired dyslexics. *Cognition, 24*, 121-137.

Castles, A., & Coltheart, M. (1993). Varieties of developmental dyslexia. *Cognition, 47*, 149-180.

Coltheart, M. (1978). Lexical access in simple reading tasks. In G. Underwood (Ed.), *Strategies of information processing* (pp. 151-216). London: Academic Press.

Cuetos, F., Valle-Arroyo, F., & Suárez, M.P. (1996). A case of phonological dyslexia in Spanish. *Cognitive Neuropsychology, 13*, 1-24.

Defior, S., Justicia, F., & Martos, F. (1996). The influence of lexical and sublexical variables in normal and poor Spanish readers. *Reading and Writing: An Interdisciplinary Journal, 8*, 487-497.

De Vega, M., & Carreiras, M. (1989, September). The role of graphemic frequency in visual word processing. *Communication presented at the 3rd European Conference for Learning and Instruction*. Madrid

De Vega, M., Carreiras, M., Gutiérrez, M., & Alonso-Quecuty, M. L. (1990). *Lectura y comprensión. Una perspectiva cognitiva*. Madrid: Alianza Editorial.

Domínguez, A., Cuetos, F., & de Vega, M. (1993). Efectos diferenciales de la frecuencia silábica posicional: dependencia del tipo de prueba y características de los estímulos. *Estudios de Psicología, 50*, 5-31.

Escribano, J.L. (1991). *Programa UNICEN* [UNICEN Software]. Santa Cruz de Tenerife, Spain.

Felton, R.H., & Wood, F.B. (1992). A reading level match study of nonword reading skills in poor readers with varying IQ. *Journal of Learning Disabilities*, 25, 318-326.

Forster, K.I., & Chambers, S.M. (1973). Lexical access and naming time. *Journal of Verbal Learning and Verbal Behavior, 12*, 627-635.

Frith, U. (1999) Paradoxes in the definition of dyslexia. *Dyslexia: AnInternational Journal of Research and Practice, 5*, 192-214.

Frost, R., Katz, L., & Bentin, S. (1987). Strategies for visual word recognition and orthographical depth: A multidimensional comparison. *Journal of Experimental Psychology: Human Perception and Performance, 13*, 104-115.

García-Albea, J.E., Sánchez-Casas, R.M., & Viso, S. del. (1982). Efectos de la frecuencia de uso en el reconocimiento de palabras. *Investigaciones Psicológicas, 1*, 24-61.

Genard, N., Mousty, P., Content, A., Alegria, J., Leybaert, J., & Morais, J. (1998). Methods to establish subtypes of developmental dyslexia. In P. Reitsma & L. Verhoeven (Eds.), *Problems and interventions in literacy development* (pp. 163-176). Dordrecht, Netherlands: Kluwer Academic Press.

Grompone, M.A.C. (1975). Colonialismo y dislexia. In. J.B. de Quirós, O. Schrager, & J. Feldman (Eds.), *El lenguaje lectoescrito y sus problemas* (pp. 72-83). Buenos Aires: Panamericana.

Guzmán, R., & Jiménez, J.E. (2001). Estudio normativo sobre parámetros psicolingüísticos en niños de 6 a 8 años: la familiaridad subjetiva. *Cognitiva, 13*, 153-191.

Ho, F.J. (2001). *Subtypes of dyslexia in Chinese orthography*. Unpublished Doctoral Dissertation. The University of New South Wales, Sidney, Australia.

Hynd, G.W., & Hynd, C.R. (1984). Dyslexia: Neuroanatomical/neurolinguistic perspectives. *Reading Research Quarterly, 19,4*, 482-498.

Iribarren, I.C., Jarema, G., & Lecours, A.R. (1999). Lexical reading in Spanish: Two cases of phonological dyslexia. *Applied Psycholinguistics, 20*, 407-428.

Jiménez, J.E. (1997). A reading-level match study of phonemic processes underlying reading disabilities in a transparent orthography. *Reading and Writing: An Interdisciplinary Journal, 9*, 23-40.

Jiménez, J.E., & Hernández-Valle, I. (2000). Word identification and reading disorders in the Spanish language. *Journal of Learning Disabilities, 33*, 44-60.

Manis, F.R., Seidenberg, M.S., Doi, L.M., McBride-Chang,C., & Petersen, A. (1996). On the bases of two subtypes of developmental dyslexia. *Cognition, 58*, 157-195.

Martínez, J.A. (1995). *La dislexia evolutiva: un enfoque neuropsicológico.* Unpublished Doctoral Dissertation, University of Salamanca, Salamanca, España.

Olson, R.K., Wise, B., Conners, F., Rack, J., & Fulker, D. (1989). Specific deficits in component reading and language skills: Genetic and environmental influences. *Journal of Learning Disabilities, 22*, 339-348.

Perfetti, C.A. (1986). Continuities in reading acquisition: Reading disability. *Remedial and Special Education, 7*, 11-21.

Perfetti, C.A., Bell, L.C., & Delaney, S.M. (1988). Automatic (prelexical) phonetic activation in silent word reading: Evidence from backward masking. *Journal of Memory and Language, 27*, 59-70.

Ruíz, A., Ansaldo, A.I., & Lecours, A.R. (1994). Two cases of deep dyslexia in unilingual hispanophone aphasics. *Brain and Language, 46*, 245-256.

Samuelson, S., Finnström, O., Leijon, I., & Mard, S. (2000). Phonological and surface profiles of reading difficulties among very low birth weight children: Converging evidence for the developmental lag hypothesis. *Scientific Studies of Reading, 4*, 197-217.

Sebastián, N. (1991). Reading by analogy in a shallow orthography. *Journal of Experimental Psychology: Human Perception and Performance, 17*, 471-477.

Seidenberg, M.S. (1985). The time course of phonological code activation in two writing systems. *Cognition, 19*, 1-30.

Seidenberg, M.S., Waters, G.S., Barnes, M.A., & Tanenhaus, M.K. (1984). When does irregular spelling or pronunciation influence word recognition? *Journal of Verbal Learning and Verbal Behavior, 23*, 383-404.

Siegel, L.S. (1986). Phonological deficits in children with a reading disability. *Canadian Journal of Special Education, 2*, 45-54.

Siegel, L.S. (1992). An evaluation of the discrepancy definition of dyslexia. *Journal of Learning Disabilities, 25*, 618-629.

Siegel, L.S., & Heaven, R. (1986). Categorization of learning disabilities. In S.J. Ceci (Ed.), *Handbook of cognitive, social, and neuropsychological aspects of learning disabilities* (pp. 95-123). Hillsdale, NJ: Erlbaum.

Siegel, L.S., Share, D., & Geva, E. (1995). Evidence for superior orthographic skills in dyslexics. *Psychological Science, 6*, 250-254.

Signorini, A. (1997). Word reading in Spanish: A comparison between skilled and less skilled beginning readers. *Applied Psycholinguistics, 18*, 319-344.

Sprenger-Charolles, L., Colé, P., Lacert, P., & Serniclaes, W. (2000). On subtypes of developmental dyslexia: Evidence from processing time and accuracy scores. *Canadian Journal of Experimental Psychology, 54*, 87-103.

Stanovich, K.E., & Siegel, L.S. (1994). Phenotypic performance profile of children with reading disabilities: A regression-based test of the phonological-core variable-difference model. *Journal of Educational Psychology, 86*, 24-53.

Stanovich, K.E., Siegel, L.S., & Gottardo, A. (1997a). Progress in the search for dyslexia subtypes. In C. Hulme & M. Snowling (Eds.), *Biology, cognition and intervention* (pp. 108-130). London: Whurr.

Stanovich, K.E., Siegel, L.S., & Gottardo, A. (1997b). Converging evidence for phonological and surface subtypes of reading disability. *Journal of Educational Psychology, 89*, 114-127.

Tabossi, P. (1989, April). La lectura en un lenguaje con ortografía superficial: consideraciones teóricas y metodológicas. *Paper presented at the V Simposio Escuelas de Logopedia y Psicología del Lenguaje*, Salamanca, Spain.

Toro, J., & Cervera, M. (1980). *Test de análisis de lectoescritura.* Madrid: Visor.

Valle-Arroyo, F. (1996). Dual-route models in Spanish: Developmental and neuropsychological data. In M. Carreiras & N. Sebastián (Eds.), *Language processing in Spanish* (pp. 89-118). Hillsdale, NJ: Erlbaum.

Wilding, J. (1989). Developmental dyslexics do not fit in boxes: Evidence from the case studies. *European Journal of Cognitive Psychology, 1*, 105-127.

Wimmer, H. (1996). The nonword reading deficit in developmental dyslexia: Evidence from children learning to read German. *Journal of Experimental Child Psychology, 61*, 80-90.

Received November 14, 2000
Revision received October 11, 2001
Accepted November 7, 2001

APPENDIX

Stimuli used in the study: Familiar words

Item [translation]	FL	A Group		RL Group		D Group	
		M	*SD*	*M*	*SD*	*M*	*SD*
Arroz [rice]	3.63	848	344	1680	811	1624	1104
Boda [wedding]	3.76	1004	464	1794	873	1616	1203
Cama [bed]	3.83	1128	940	1186	289	1496	1306
Comer [to eat]	3.76	843	335	1329	628	1566	1230
Gato [cat]	3.90	1142	2276	1360	651	1364	843
Ojo [eye]	3.89	801	244	1167	459	1318	1053
Patio[court]	3.67	1118	1180	1610	774	1839	1506
Plato[dish]	3.76	839	237	1475	784	1622	1161
Árbol [tree]	3.85	1300	1483	2094	1385	1846	1746
Cine [cinema]	3.78	1226	564	2120	1319	1724	1518
Fuego [fire]	3.85	884	327	1762	1021	1800	1486
Grapa [staple]	3.63	904	339	1435	711	1719	1376
Huevo [egg]	3.73	1454	2954	1731	712	2016	1984
Jugar [to play]	3.82	985	419	1713	813	1696	1353
Largo [long]	3.69	1072	487	1874	848	1678	1951
Leche [milk]	3.71	1012	315	1747	1217	1569	1147
Abecedario [alphabet]	3.81	1584	2132	2196	1470	2353	2189
Adelante [forward]	3.65	1183	498	1914	917	2018	1590
Amarilla [yellow]	3.65	1083	447	2345	1601	2226	1811
Apellidos [surname]	3.81	1130	560	2095	1487	2176	1579
Camiseta [undershirt]	3.81	1119	660	1735	793	1867	1324
Divertida [funny]	3.68	1029	467	1705	942	2529	2015
Habitación [room]	3.73	1185	468	2156	1426	2226	1886
Plastilina [plasticine]	3.78	961	314	1756	939	2447	2419
Ascensor [lift]	3.67	992	521	1537	686	2516	2320
Bolígrafo [pen]	3.75	1188	934	1718	848	2178	1425
Descalzo [barefoot]	3.76	1002	592	1939	800	2191	1849
Funcionar [to function]	3.68	1007	509	1735	653	2729	2491
Lágrimas [tears]	3.66	978	372	1584	993	2372	2083
Merienda [snack]	3.87	934	345	1807	1268	2111	1723
Nochebuena [Christmas Eve]	3.80	1012	418	1913	878	2553	2333
Servicios [lavatories]	3.65	858	344	1646	1087	2562	2467

Note. FL = Familiarity coefficient; A = Age-matched controls; RL = Reading-level-matched controls; D = Dyslexic group.

Stimuli used in the study: Pseudowords

Item [translation]	A Group		RL Group		D Group	
	M	*SD*	*M*	*SD*	*M*	*SD*
Redas	1111	439	1592	629	1810	1150
Nate	1151	530	1532	695	2037	1766
Proce	1104	278	1949	1128	1712	1441
Pona	1283	1171	1598	775	1972	1828
Esco	1058	337	1583	791	1645	1321
Sunos	1146	452	1594	762	1759	1172
Alnes	1067	523	1395	428	1766	1799
Seron	1149	404	1663	792	1551	1186
Indos	1016	378	1538	584	1679	1197
Delce	1062	468	1465	490	1500	1086
Lasda	1237	717	1619	706	2021	1757
Losmo	1710	3917	1920	1677	1893	1523
Vendor	1527	653	2049	866	1989	2155
Golmar	1721	850	1929	1165	2080	1654
Noslla	1657	1034	1884	925	1726	1119
Troros	1364	678	2077	1232	1892	1624
Genmor	1545	671	2069	1129	2410	2255
Palchos	1321	539	1897	955	1937	1458
Polton	1411	648	1812	769	1767	1726
Ritgo	1307	450	1871	963	2136	1571
Tesgro	1328	409	1685	807	1979	1568
Dulle	1497	592	2092	1015	1863	1321
Brufas	1455	570	1793	926	2099	1776
Lartia	1471	1146	1763	813	2230	1553
Pomacos	1166	408	1586	641	2222	1998
Sucires	1138	347	1862	824	2117	1576
Jomanto	1542	1782	1802	1019	2216	1703
Delnico	1331	521	1817	958	1991	1527
Bocueto	1403	554	2300	1388	2268	1728
Protuto	1375	724	1913	781	1803	1492
Socanos	1138	327	1767	1001	2192	2227
Codidas	1660	961	1928	1129	2120	1544
Setudad	1246	420	1637	824	2432	2144
Unsiles	1319	1073	1656	825	2373	1849
Inbiles	1745	1060	2320	1583	2441	1786
Portuto	1383	616	2511	2203	2079	1777
Renpertal	2012	1437	2325	2168	2233	2007
Talgunbros	1647	866	1877	1382	2475	2894
Linsosrial	1679	1083	2080	1366	3190	3665
Mestruyen	1712	983	2514	1690	2615	2301
Biocamcir	1837	1098	2520	1798	2809	2497
Barcurcaz	1447	767	2563	1588	2344	1988
Puertindor	1766	773	2154	1104	2548	2828
Benmacer	1345	541	2381	1572	2433	1965
Choflegio	1628	804	2166	1600	2581	2584
Berciclas	1528	634	2154	1182	2082	1553
Dosglubis	1765	975	2234	1007	2473	2133
Dengelio	1478	694	2045	978	2452	2395

Note. A = Age-matched controls; RL = Reading-level controls; D = Dyslexic group.