The Relationship Between IQ and Reading Disabilities in English-Speaking Canadian and Spanish Children

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Abstract

This study was designed to examine the role of intelligence (IQ) in the definition of reading disabilities (RD) in languages with different orthographic systems. A sample of 94 Spanish children and 157 English-speaking Canadian children with RD was classified into four groups on the basis of IQ scores from the *Wechsler Intelligence Scale for Children–Revised* (< 80; 81–90; 91–109; 110–140). We examined the reading and spelling skills of Canadian and Spanish children as a function of Full Scale, Verbal, and Performance IQ scores. Significant differences between the languages were found when reading performance was analyzed as a function of Verbal IQ scores, in that there were some differences between the groups of Canadian children with RD but not between the groups of Spanish children. The Canadian children with Verbal IQ scores < 80 demonstrated relatively lower performance in reading and spelling skills than the Canadian groups with higher IQ scores. There were differences in reading tasks as a function of Performance IQ in English but not in Spanish. The differences in the role of IQ as a function of orthographic systems may relate to the greater significance of visual–orthographic as opposed to phonological processing in English.

In the field of learning disabilities (LD), a discrepancy between IQ and achievement is often considered an element in the identification of children with LD. "An implicit part of the discrepancy definition of a learning disability is the assumption that intelligence can be measured independently of academic achievement" (Siegel, 1990, p. 115). However, one of us has suggested that the IQ scores of children with LD may be spuriously low because these scores measure areas (e.g., factual knowledge, expressive language abilities, short-term memory) in which these children have deficits. Therefore, a low IQ could be the *consequence* of these difficulties and, therefore, may not be an accurate measure of the level of intelligence of the child (Stanovich, 1986). Moreover, there is evidence that low IQ scores do not necessarily result in poor reading (e.g., Jiménez & Rodrigo, 1994; Rodrigo & Jiménez, 2000; Siegel, 1988, 1989).

As a consequence of these and other factors, there has been growing criticism of the use of IQ as a predictor of reading potential. As Siegel (1990) has suggested, a critical test of the possible relationship between IQ and reading disabilities (RD) requires the examination of reading and spelling skills as a function of IQ scores in the children with RD. The irrelevance of IQ to RD has been demonstrated by studies that showed no differences in reading performance among children with different levels of IQ, all of whom had a reading disability (e.g., Jiménez & Rodrigo, 1994; Rodrigo & Jiménez, 2000; Share, Jorm, Matthews, & McLean, 1988; Share et al., 1987; Siegel, 1992). Moreover, other evidence has suggested that certain cognitive processes of children with LD with lower IQ scores may not differ from those of children with higher IQ scores (Siegel, 1992). No significant differences have been found between children with RD at different IQ levels on tasks involving naming, speech rate, and visual search (Das, Mensink, & Mishra, 1990); short-term memory, spelling, and reading tasks (Graham & Kline, 1991); or tasks that involved the rejection of meaningless sentences that contained pseudohomophones and tasks that involved the recognition of the incorrect spelling of pseudohomophones (Johnston, Rugg, & Scott, 1987) and the classification of pseudohomophones as words (Johnston, Rugg, & Scott, 1988). However, these studies did not compare the performance of children with RD as a function of different types of IQ scores. We do not know if the results would be the same in relation to Verbal IQ as in relation to Performance IQ (PIQ). In fact, it has not been clear which IQ score (i.e., Verbal, Performance, or Full

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Scale IQ on the *Wechsler Intelligence Scale for Children–Revised*; WISC-R) should be used to identify LD (Siegel, 1992). For children with a significant discrepancy between their Verbal IQ and Performance IQ scores, the use of one of these IQ scores may define them as having RD but the other may not (e.g., Valtin, 1978–1979).

Some evidence does exist in the English language that a lower Verbal IQ score may be causally related to LD. For example, a longitudinal study of Bishop and Butterworth (1980) provided suggestive evidence that the verbal IQ score of children with RD may decrease over time. Bishop and Butterworth showed that a large discrepancy between Performance IQ and Verbal IQ scores at 4½ years of age did not predict subsequent reading problems; however, such a discrepancy was more common in 8½-year-old children with RD. Also, Share and Silva (1987) found that the language skills, particularly vocabulary and syntax, declined with increasing age for children with RD but not for typical readers. In a cross-sectional study comparing children with and without RD of different ages, Siegel and Himel (in press) found that the WISC-R Vocabulary scores of children with RD declined from age 7 to 16 years, whereas the Block Design scores, a measure of visual–spatial skills and presumably not related to reading, did not show a similar decline. Furthermore, the reading scores of the children with RD did not show a decline with increasing age but remained below age levels, indicating that it was not a general decline in all cognitive processes. In contrast, WISC-R Vocabulary and Block Design scores of the typically achieving children did not decline with increasing age.

Stanovich (1986) suggested that the development of vocabulary does not always occur as a result of direct instruction, but rather by a process of inferring the meaning of words from their context when they are encountered in written and oral language. Therefore, differences in the amount of reading can result in differences in vocabulary development. There is reason to believe that children with RD have much less experience in reading, in terms of the number of words read and perhaps also in terms of the time spent reading. Thus, children with RD do not develop their vocabulary at the same rate as typical readers and will progressively show deficits in vocabulary.

However, there is no empirical evidence concerning the relationship between the type of IQ score and RD in languages with a transparent orthography, such as Spanish. We do not know whether the relationship between different types of IQ and RD could be different as a function of the orthographic system. There is a great variability in alphabetical systems in the consistency of the correspondences between graphemes and phonemes. If we consider a continuum in the predictability of grapheme–phoneme relationships, at one extreme are the languages with a very high degree of orthographic transparency, where the mapping between graphemes and phonemes is largely consistent (e.g., Serbo-Croatian, Spanish, Finnish), whereas at the other extreme of the continuum are languages with an opaque orthography, which have many ways of sounding out graphemes and wherein many of the correspondences cannot be predicted from context-dependent grapho-phonological rules (e.g., English).

It has been suggested that these differences in the depth of alphabetic codes imply distinctive ways of processing written languages (e.g., Baluch & Besner, 1991; Frost, Katz, & Bentin, 1987; Seidenberg, 1985). In languages with an opaque orthography, such as English, skilled readers use both orthographic and phonemic cues in printed-word recognition (e.g., Perfetti, Bell, & Delaney, 1988). However, in the Spanish language, it is possible that lexical access may show a greater influence of phonological decoding. As has been suggested by Frost et al. (1987), in transparent orthographies, phonology is activated directly from print. The Spanish language shows phonological and orthographic differences from the English language. For instance, Spanish has a very transparent orthography; that is, the pronunciation of a string of letters can always be derived from print (Sebastián, 1991). Each grapheme has only one possible pronunciation, and in this language, irregular words do not exist. Recently, Morais (1995) has suggested that languages with a highly transparent orthography might exhibit a more systematic use of phonological decoding than is the case in English. Also, Morais noted that access to phonological transcoding might be easier in languages that have a low number of vowels and few complex syllabic structures. For instance, whereas in Spanish, Cuetos (1989) found a very rapid development of the understanding of grapheme–phoneme correspondences in children ages 5 and 6, there is evidence that this route develops more slowly in typical English readers and does not reach the level of mature readers until approximately 9 years of age (Backman, Bruck, Herbert, & Seidenberg, 1984; Siegel & Faux, 1989; Siegel & Ryan, 1988). As has been suggested by several authors (e.g., Bryson & Werker, 1989; Venezky, 1970; Werker, Bryson, & Wassenberg, 1989), because of the irregular nature of the sound–symbol correspondences in English, acquiring this knowledge is a very complex process.

Therefore, it is possible that IQ scores would be more influenced by an opaque orthography than by a transparent orthography, particularly when we are considering the relationship between the type of IQ score and RD. Reading skills and, thus, vocabulary may be easier to acquire in a transparent orthography. Therefore, the mutual interaction between IQ scores and reading (e.g., Stanovich, 1986) may be more relevant in an opaque orthography. The generalizations made on the basis of the English language may not be substantiated in languages with more transparent orthographies. If the difference between the languages is a critical factor, then the performance of children with RD on a variety of tasks may be related to IQ. Moreover, it might be expected that the Verbal IQ score, because of the language requirements of that test, would show a greater relationship to reading and spelling skills than the Performance IQ score, which is based on visual–spatial and fine motor skills. In fact, some studies in the English language have demonstrated that higher scores on the Performance IQ subtests were negatively associated with achievement scores among students with LD (see Humphries & Bone, 1993, for a review). Therefore, a critical test of these hypotheses requires the examination of reading and spelling skills as a function of IQ scores (i.e., Verbal, Performance, or Full Scale) in individuals with RD in different orthographic systems. The main purpose of this study is to examine the relationship between IQ and reading disabilities as a function of the type of IQ score and the type of orthographic system (opaque vs. transparent).

Method

Participants

Data were collected independently, because the studies were not originally designed to be parallel. The Spanish sample was obtained as follows: From a local population of 1,000 children, teachers were asked to identify which children they considered to be poor readers. The children came from urban areas, from average socioeconomic backgrounds, and from Grades 4 and 5 of several different state schools. A first sample of 168 poor readers was identified. Each child was then individually tested using the *Test de Análisis de Lectoescritura* (TALE; Toro & Cervera, 1980), and the participant group of 94 poor readers was formed (64 boys, 30 girls; average age 112.8 months, *SD* = 9.13), who achieved a performance below the Grade 3 norms on TALE word reading. The Canadian, English-speaking sample consisted of 157 children (122 boys, 35 girls) between ages 7 and 16. The children were referred by teachers, physicians, or parents to be classified as having RD; the children's score on the Reading subtest of the *Wide Range Achievement Test* (WRAT; Jastak & Jastak, 1978) was required to be below the 25th percentile. The children from both samples were classified into four groups according to their Full Scale, Verbal, or Performance IQ measured by the *Wechsler Intelligence Scale for Children–Revised* (WISC-R; Wechsler, 1974; IQs < 80, 81–90, 91–109, and 110–140, respectively). Children were excluded if they had sensory, acquired neurological, or other problems traditionally used as exclusionary criteria for LD.

Materials

For the Spanish sample, the materials used were as follows:

Test of Intelligence. The Spanish version of the *Wechsler Intelligence Scale for Children–Revised* (WISC-R; Wechsler, 1989) was administered.

Reading Measures. The *Test de Análisis de Lectoescritura* (TALE; Test for Assessment of Reading and Writing Skills; Toro & Cervera, 1980) has different reading subtests; Letter, Syllable, Word, and Text subtests were administered. In the Letter subtest, the participants read all the letters in the Spanish alphabet presented in lower- and uppercase letters. The Syllable subtest included a list of syllables with different structures (i.e., CV, VC, CVC). The Word subtest required the correct identification of high- and low-frequency words. The Text subtest used a short paragraph with high-frequency words. For each of these subtests, a grade score was calculated.

Writing Measures. The Writing subtests of the TALE (Toro & Cervera, 1980) were used. In the Copy subtest, the child was required to copy a short paragraph. In the Spelling subtest, the child was asked to write a short paragraph that was read aloud by the examiner. In each subtest, spelling errors were analyzed.

Lexical Decision Task. All stimuli were presented to each child on a computer screen using APT PC system software (Foltz & Poltrock, 1987). The stimuli were presented randomly, and each stimulus was preceded by an asterisk that remained on screen for 1,000 ms. Each child was presented with 192 stimuli—96 words and 96 pseudowords. The children were exposed to several practice trials to enable them to become familiar with the procedure; they were required to press the L key when they were shown real words and the A key when shown pseudowords

Naming Task. The children read aloud the stimuli that appeared, one by one, on the computer screen. The sequence of administration of stimuli was as follows:

1. blank screen (200 ms);
2. fixation spot in the middle of the screen (*), so that the child would know where the stimulus would appear (400 ms);
3. word stimulus or pseudoword stimulus.

In all, the time between items was 2,000 ms. The experiment was conducted in a single session. For half of the children, we administered the block of words first and then the block of pseudowords; for the other half, the pseudowords were administered first. The presentation order of stimuli was determined randomly.

For the Canadian children, the materials used were as follows:

Test of Intelligence. The *Wechsler Intelligence Scale for Children–Revised* (WISC-R; Wechsler, 1974) is a standardized intelligence test for children. Verbal, Performance, and Full Scale IQ scores were calculated.

Reading Measures. The Reading and Spelling subtests of the *Wide Range Achievement Test–Revised* (WRAT-R;

Jastak & Jastak, 1978) were used. The Reading subtest required the child to read an increasingly difficult series of words. In the Spelling subtest, the child was required to write the correct spelling of an increasingly difficult series of words.

The Word Attack subtest of the Woodcock Reading Mastery Test (WRMT; Woodcock, 1973) was used as well. In the Word Attack subtest, the child was required to read an increasingly difficult series of pseudowords such as *cyr, roo,* and *wrey* according to the phonological rules of English.

Reading of Nonwords. The children completed the Reading of Symbols subtest of the *GFW Sound-Symbol Tests* (Goldman, Fristoe, & Woodcock, 1974), in which they were required to read pronounceable nonwords, such as *bim, rayed, neap, toaf,* and *cedge*.

Some of the children received the Word Attack subtest of the WRMT and some received the Reading of Nonwords subtest of the GFW. As these tests both measured pseudoword reading and used similar or identical items, we combined the scores into one variable.

Spelling of Nonwords. The children were administered the Spelling of Symbols subtest of the *GFW Sound-Symbol Test*. The child was asked to spell words read aloud such as *tash, chid, plen, etbom,* and *spong*. Any acceptable phonetic equivalent was scored as correct. For example, the sound of *imbaf* could be spelled *imbaf* or *imbaff*. Before spelling the word, the child was asked to repeat it to ensure that he or she had heard it correctly. Mispronunciations were corrected.

Results

We examined the influence of different types of IQ score (i.e., Full Scale, Verbal, and Performance) on reading, spelling, and writing measures in Canadian and Spanish children with RD. Also, reaction time (RT) in the lexical decision and naming tasks was recorded in the Spanish group. The performance on the reading and writing tasks of the Canadian and Spanish children as a function of Full Scale IQ is shown in Table 1.

The F values for the different ANOVAs for the Spanish children were as follows: Letters, $F(3, 93) = 8.42$, $p < .0001$; Syllables, $F(3, 93) = 2.40$, $p < .07$; Words, $F(3, 93) = 1.11$, $p < .34$; Copy, $F(3, 93) = 0.13$, $p < .93$; and Spelling, $F(3, 93) = .71$, $p < .54$. The F values for Canadian children were as follows: WRAT-R Reading, $F(3, 15) = 5.82$, $p < .001$; Pseudoword Reading, $F(3, 12) = 2.92$, $p < .04$; WRAT-R Spelling, $F(3, 15) = 4.17$, $p < .007$; Pseudoword Spelling, $F(3, 71) = 2.02$, $p < .11$ There were no significant differences among Spanish children with RD as a function of Full Scale IQ, except that the children with RD with IQ scores less than 80 did have lower letter recognition scores. The Canadian children with RD with IQ scores between 91 and 109 did have significantly higher scores in word reading, pseudoword reading, and word spelling than the IQ < 80 group.

The performance on reaction time (RT) in lexical decision and naming

TABLE 1
Means and Standard Deviations on Reading and Writing Measures for all Groups by Country and Full Scale IQ (FSIQ)

Group /Measure	FSIQ < 80			FSIQ 81–90			FSIQ 91–109			FSIQ 110–140		
	n	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Spanish												
Reading (TALE)												
Letters	21	1.80	1.12	20	2.80***	1.19	35	2.91***	1.14	18	3.50***	0.70
Syllables	21	2.95	1.32	20	3.55	0.88	35	3.48	1.03	18	3.77	0.54
Words	21	3.42	0.87	20	3.25	1.11	35	3.57	0.77	18	3.72	0.57
Text	21	3.23	1.17	20	3.45	0.94	35	3.37	0.97	18	3.77	0.54
Writing (TALE)												
Copy	21	0.82	0.32	20	0.84	0.25	35	0.79	0.29	18	0.83	0.26
Spelling	21	0.45	0.30	20	0.40	0.36	35	0.32	0.36	18	0.42	0.43
Canadian												
Reading												
Words (WRAT-R)	42	7.24	7.70	40	9.90	6.97	64	13.28***	7.68	11	11.09	5.70
Pseudowords (WRMT)[a]	35	9.17	8.78	33	11.06	10.69	51	15.65*	11.70	6	12.17	5.63
Spelling												
Words (WRAT-R)	42	7.60	8.70	40	8.53	6.67	64	12.78**	10.74	11	14.91	9.15
Pseudowords (GFW)	20	6.65	6.83	19	9.95	10.22	29	11.31	9.57	4	2.00	0.82

Note. TALE = *Test de Análisis de Lectoescritura* (Toro & Cervera, 1980) scores based on grade level; WRAT-R = *Wide Range Achievement Test–Revised* (Jastak & Jastak, 1978) percentile scores; WRMT = *Woodcock Reading Mastery Test* (Woodcock, 1973) Word Attack subtest, percentile scores; GFW = *Goldman-Fristoe-Woodcock Sound-Symbol Tests* (Goldman, Fristoe, & Woodcock, 1974) percentile scores.
[a]For some participants, scores for this measure were obtained from the GFW rather than from the WRMT Word Attack subtest.
*$p < .05$. **$p < .01$. ***$p < .001$.

tasks of the Spanish children as a function of Full Scale IQ is shown in Table 2. The *F* values for the different ANOVAs for Spanish children were as follows: in the lexical decision task, Words, $F(3, 93) = 2.63$, $p <. 054$; Pseudowords, $F(3, 93) = 1.78$, $p < .15$; and in the naming task, Words, $F(3, 86) = 1.40$, $p < .24$; Pseudowords, $F(3, 87) = 3.56$, $p < .01$. In the Spanish children with RD, the effect of IQ on the lexical decision task on word RT did not reach conventional levels of statistical significance ($p < .054$). In the naming task, we found an effect of IQ on pseudowords RTs for Full Scale IQ. In both cases, the RTs of the children with IQ < 80 were significantly longer than those of the groups with 81–90 and 110–140 IQ scores.

The means and standard deviations on the reading and writing measures in Canadian children and Spanish children as a function of Verbal IQ are shown in Table 3. For Verbal IQ, the *F* values for the different ANOVAs for Spanish children were as follows: Letters, $F(3, 93) = 7.34$, $p < .0002$; Syllables, $F(3, 93) = .96$, $p < .41$; Words, $F(3, 93) = 1.21$, $p < .30$; Copy, $F(3, 93) = .28$, $p < .83$; Spelling, $F(3, 93) = .87$, $p < .45$. There were no significant differences among Spanish children with RD as a function of Verbal IQ except for the children with RD with IQ scores between 91 and 109, who did have higher letter recognition scores than the IQ < 80 group. The *F* values for Canadian children were as follows: WRAT-R Reading, $F(3, 15) = 6.18$; $p < .001$; Pseudo-

TABLE 2
Means and Standard Deviations on Reaction Time Measures by Full Scale IQ (FSIQ) for Spanish Groups

	FSIQ < 80[a]		FSIQ 81–90[b]		FSIQ 91–109[c]		FSIQ 110–140[d]	
Reaction time (ms)	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Lexical decision task								
Words	2,222	859	1,757	463	1.871	750	1,620	629
Pseudowords	2,976	1,112	2,437	787	2,571	1,074	2,254	1,049
Naming task								
Words	1,369	447	1,064	213	1,202	779	1,018	280
Pseudowords	1,892	915	1,341**	276	1,434	655	1,292**	280

[a]*n* = 21. [b]*n* = 20. [c]*n* = 35. [d]*n* = 18.
***p* < .01.

TABLE 3
Means and Standard Deviations on Reading and Writing Measures for All Groups by Country and Verbal IQ (VIQ)

	VIQ < 80			VIQ 81–90			VIQ 91–109			VIQ 110–140		
Group/Measure	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Spanish												
Reading (TALE)												
Letters	33	2.09	1.25	24	2.83	1.16	28	3.39***	0.87	9	3.00	0.86
Syllables	33	3.21	1.21	24	3.54	0.97	28	3.50	0.96	9	3.77	0.44
Words	33	3.42	0.86	24	3.33	1.09	28	3.75	0.58	9	3.44	0.72
Text	33	3.27	1.06	24	3.45	1.06	28	3.57	0.79	9	3.55	0.72
Writing (TALE)												
Copy	33	0.81	0.30	24	0.78	0.32	28	0.84	0.24	9	0.87	0.26
Spelling	33	0.43	0.32	24	0.38	0.41	28	0.30	0.37	9	0.48	0.36
Canadian												
Reading												
Words (WRAT-R)	63	7.56	7.30	40	12.78***	6.46	48	12.65***	8.10	6	13.00	7.87
Pseudowords (WRMT)[a]	52	9.29	8.39	33	15.27*	12.66	36	14.06	11.17	4	16.00*	8.83
Spelling												
Words (WRAT-R)	63	7.46	7.65	40	12.20	9.39	48	12.27**	10.83	6	15.63	9.06
Pseudowords (GFW)	31	6.68	6.64	22	11.82	9.48	16	9.13	8.41	3	15.00	23.39

Note. TALE = *Test de Análisis de Lectoescritura* (Toro & Cervera, 1980) scores based on grade level; WRAT-R = *Wide Range Achievement Test–Revised* (Jastak & Jastak, 1978) percentile scores; WRMT = *Woodcock Reading Mastery Test* (Woodcock, 1973) Word Attack subtest, percentile scores; GFW = *Goldman-Fristoe-Woodcock Sound-Symbol Tests* (Goldman, Fristoe, & Woodcock, 1974) percentile scores.
[a]For some participants, scores for this measure were obtained from the GFW rather than from the WRMT Word Attack subtest.
**p* < .05. ***p* < .01. ****p* < .001.

word Reading, $F(3, 12) = 2.80$, $p < .04$; WRAT-R Spelling, $F(3, 15) = 4.00$, $p < .009$; Pseudoword Spelling, $F(3, 71) = 1.90$, $p < .13$ The Canadian children with RD with Verbal IQ scores 81–90 and 91–109 did have significantly higher scores in word reading than the IQ < 80 group. Also, the children with Verbal IQ scores 91–109 scored higher in word spelling in comparison to the IQ < 80 group.

The performance on lexical decision and naming tasks of the Spanish children as a function of Verbal IQ is shown in Table 4. The F values for the different ANOVAs for Spanish children were as follows: in the lexical decision task, Words, $F(3, 93) = 1.76$, $p < .15$; Pseudowords, $F(3, 93) = 1.28$, $p < .28$; and in the naming task, Words, $F(3, 86) = 1.06$, $p < .36$; Pseudowords, $F(3, 87) = 1.13$, $p < .33$. There were no significant differences among Spanish children with RD as a function of Verbal IQ; their RTs were very similar.

The performance on the reading and writing tasks in Canadian children and Spanish children as a function of Performance IQ is shown in Table 5. For Performance IQ, the F values for the different ANOVAs for Spanish children were as follows: Letters, $F(3, 93) = 2.62$, $p < .055$; Syllables, $F(3, 93) = 1.33$, $p < .26$; Words, $F(3, 93) = .38$, $p < .76$; Copy, $F(3, 93) = 0.18$, $p < .90$; and Spelling, $F(3, 93) = .19$, $p < .89$. There were no significant differences among Spanish children with RD as a function of Performance IQ. The F values for Canadian children were as follows: WRAT-R Reading, $F(3, 15) = 3.60$, $p < .01$; Pseudoword Reading, $F(3, 12) =$

TABLE 4
Means and Standard Deviations on Reaction Time Measures by Verbal IQ (VIQ) for Spanish Groups

Reaction time (ms)	VIQ < 80[a]		VIQ 81–90[b]		VIQ 91–109[c]		VIQ 110–140[d]	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Lexical decision task								
Words	2,081	806	1,880	680	1,661	576	1,796	867
Pseudowords	2,842	1,066	2,454	890	2,350	962	2,589	1,429
Naming task								
Words	1,195	387	1,303	910	1,036	229	1,081	357
Pseudowords	1,577	681	1,573	842	1,311	342	1,369	349

[a]*n* = 33. [b]*n* = 24. [c]*n* = 28. [d]*n* = 9.

TABLE 5
Means and Standard Deviations on Reading and Writing Measures for All Groups by Country and Performance IQ (PIQ)

Group /Measure	PIQ < 80			PIQ 81–90			PIQ 91–109			PIQ 110–140		
	n	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Spanish												
Reading (TALE)												
Letters	14	2.07	1.38	19	2.52	1.21	25	2.92	1.07	36	3.02	1.13
Syllables	14	3.00	1.30	19	3.36	1.06	25	3.44	1.00	36	3.63	0.89
Words	14	3.28	1.06	19	3.47	0.90	25	3.56	0.76	36	3.55	0.80
Text	14	3.00	1.30	19	3.63	0.83	25	3.56	0.71	36	3.41	0.99
Writing (TALE)												
Copy	14	0.82	0.36	19	0.78	0.25	25	0.85	0.29	36	0.81	0.26
Spelling	14	0.43	0.35	19	0.35	0.28	25	0.41	0.37	36	0.37	0.40
Canadian												
Reading												
Words (WRAT-R)	36	7.06	7.60	23	11.13	8.63	61	11.76**	7.56	31	12.06**	6.54
Pseudowords (WRMT)[a]	29	10.34	9.15	21	12.52	12.63	54	12.76	11.08	21	14.52	9.93
Spelling												
Words (WRAT-R)	36	8.25	9.32	23	7.70	6.48	67	10.97*	9.98	31	13.97*	9.52
Pseudowords (GFW)	15	8.33	8.24	12	11.42	12.77	30	9.07	8.92	15	8.27	6.93

Note. TALE = *Test de Análisis de Lectoescritura* (Toro & Cervera, 1980) scores based on grade level; WRAT-R = *Wide Range Achievement Test–Revised* (Jastak & Jastak, 1978) percentile scores; WRMT = *Woodcock Reading Mastery Test* (Woodcock, 1973) Word Attack subtest, percentile scores; GFW = *Goldman-Fristoe-Woodcock Sound-Symbol Tests* (Goldman, Fristoe, & Woodcock, 1974) percentile scores.
[a]For some participants, scores for this measure were obtained from the GFW rather than from the WRMT Word Attack subtest.
*$p < .05$. **$p < .01$.

.64, $p < .59$; WRAT-R Spelling, $F(3, 15) = 2.89$, $p < .04$; Pseudoword Spelling, $F(3, 71) = .33$, $p < .80$. The Canadian children with RD with IQ scores 91–109 and 110–140 did have higher word reading scores than the IQ < 80 group.

The performance on the lexical decision and naming tasks of the Spanish children as a function of Performance IQ is shown in Table 6. For Performance IQ, the *F* values were as follows: in the lexical decision task, Words, $F(3, 93) = 1.22$, $p < .30$; Pseudowords, $F(3, 93) = .36$, $p < .77$; and in the naming task, Words, $F(3, 86) = .25$, $p < .85$; Pseudowords, $F(3, 87) = .85$, $p < .46$. There were no significant differences among Spanish children with RD as a function of Performance IQ; their RTs were very similar.

Discussion

The purpose of this study was to examine whether the relationship between IQ and RD could be explained as a function of type of IQ and orthographic system. We examined the reading and spelling skills of Canadian children and Spanish children as a function of type of IQ scores (i.e., Full Scale, Verbal, or Performance). For both languages, the group with IQ scores < 80 did have lower scores on some reading measures when Full Scale IQ scores were considered. Specifically, we found that the Full Scale IQ < 80 group had lower scores on reading measures in both languages and on spelling measures in the English language. This may reflect the fact that English has an opaque orthography (i.e., spelling cannot be predicted from the sound of the words), so vocabulary is important for English spelling. The English-speaking children with Full Scale IQ scores below 80 had lower scores on spelling at least partially because of vocabulary.

We also found differences between the languages as a function of Verbal IQ scores. There were no significant differences among Spanish children with RD as a function of Verbal IQ scores on measures of reading, spelling, lexical decision, and naming. However, differences were found among Canadian children with RD as a function of Verbal IQ scores. Specifically, the Canadian children with Verbal IQ scores < 80 showed poorer performance in reading and spelling skills in comparison to the Spanish group at the same level of Verbal IQ. The WISC-R Verbal subtests rely on specific knowledge and vocabulary. In the language with an opaque orthography, the children with RD with Verbal IQ scores < 80 did have lower scores in achievement. In reading English, vocabulary may have more influence because words cannot reliably be read with reference to grapheme–phoneme correspondences alone, and the reader must rely more on the knowledge of specific lexical items to achieve the correct pronunciation. Therefore, reading is at least in part a function of vocabulary.

There is a reciprocal relationship between vocabulary growth and reading. In spite of the assumption that IQ scores should not be influenced by RD, there is evidence that LD may be causally related to lower IQ scores. Stanovich (1986) has described what he has called *Matthew effects* in relationship to the development of reading problems and reading skills. There is evidence that children who have difficulty learning to read have less experience with print and lower self-esteem and motivation, which in turn lead to further problems in the development of reading skills. There may be a decrease in the IQ test scores of children with RD, perhaps as a consequence of reading failure. Arnold et al. (1977) found that children with LD who were not exposed to an intensive remedial program showed significant decreases in IQ scores over a period of 18 months, whereas a group of children with LD who received intensive remediation showed significant improvements in IQ scores. There is additional evidence in English that Verbal IQ and Verbal subtest scores of children with LD are good predictors of their WRAT-R reading and spelling scores (Humphries & Bone, 1993) and that their verbal intelligence test score may be influenced by reading (Share & Silva, 1987).

There were also differences in the word recognition task as a function of Performance IQ in English, but not in Spanish. Performance IQ is a measure of visual–spatial skills. Children with RD with higher Performance IQ scores

TABLE 6
Means and Standard Deviations on Reaction Time Measures by Performance IQ (PIQ) for Spanish Groups

Reaction time (ms)	PIQ < 80[a]		PIQ 81–90[b]		PIQ 91–109[c]		PIQ 110–140[d]	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Lexical decision task								
Words	2,219	984	1,804	516	1,825	654	1,819	748
Pseudowords	2,799	1,268	2,568	845	2,612	960	2,459	1,107
Naming task								
Words	1,227	530	1,186	338	1,082	256	1,194	762
Pseudowords	1,632	1,055	1,627	631	1,383	384	1,413	616

[a]*n* = 14. [b]*n* = 19. [c]*n* = 25. [d]*n* = 36.

and, therefore, more developed visual–spatial skills, may be using a visual–orthographic strategy in reading. This strategy would be advantageous for reading in English but not in Spanish.

The characteristics of a particular language may be a critical factor in determining the relationship between IQ scores and reading tasks within the population of individuals with RD. Why did the English-speaking group with IQ scores < 80 show a poorer performance in reading and spelling compared to the Spanish group? Our findings suggest that a lack of reading experience may influence Verbal IQ in languages with an opaque orthography. However, in languages with a transparent orthography, Verbal IQ scores may have less of an influence, because the children are using a phonological route in reading and do not need to rely on vocabulary in accessing the pronunciation of specific lexical items. There is evidence that the phonological route develops more slowly in typical English readers and does not reach the level of mature readers until approximately 9 years of age (Backman et al., 1984; Siegel & Faux, 1989; Siegel & Ryan, 1988). Moreover, skilled readers are usually assumed to recognize words through the orthographic–graphemic code, whereas in transparent orthographies, readers are assumed to rely more heavily on the phonemic, prelexical code. The simplicity of the phonological structure of Spanish and the shallowness of its orthography may foster the use of phonological processing in early reading. For instance, Signorini (1997) compared Spanish-speaking first- and third-grade skilled and less skilled readers on their ability to read words. In both groups of first-grade readers, the use of spelling–sound correspondences appeared to be the main source of information for reading familiar words. These results indicated that the connections between spelling and pronunciation within words were still incomplete. The results from third-grade, less skilled readers suggested that these children also relied on knowledge of grapheme–phoneme correspondences, because they apparently did not use word-specific knowledge to solve the problem of reading a list of words with irregular stress patterns and were unaffected by the word spellings. As has been suggested by several authors (e.g., Bryson & Werker, 1989; Venezky, 1970; Werker, Bryson, & Wassenberg, 1989), because of the irregular nature of the sound–symbol correspondences in English, acquiring this knowledge is a very complex process. However, as Morais (1995) has suggested, languages with a highly transparent orthography might exhibit a more systematic use of phonological decoding than is the case in English. Therefore, we did not find significant differences among Spanish children with RD in reading and spelling skills, lexical decision, and naming as a function of Verbal IQ scores.

In conclusion, we examined the relationship between IQ and RD as a function of the type of IQ score and the orthographic system. Our findings demonstrate that the differences between languages is a critical factor, because the performance of children with RD was related to IQ, but more so in English than in Spanish. The lack of reading experience has a greater influence on Verbal IQ in a language with an opaque orthography; however, in a language with a transparent orthography, Verbal IQ scores have less influence because children are using a phonological route. The relationship found between Performance IQ and reading disabilities also demonstrates that the visual–orthographic strategy may be more advantageous in reading in English than in Spanish.

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