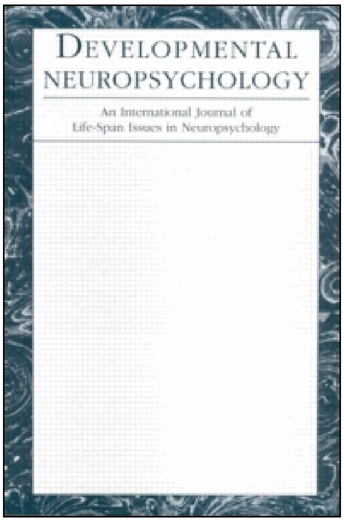

Developmental Neuropsychology
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t775653638

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Online publication date: 08 June 2010

To cite this Article Rosselli, Monica , Ardila, Alfredo , Bateman, Jose Ricardo and Guzman, Margarita(2001) 'Neuropsychological Test Scores, Academic Performance, and Developmental Disorders in Spanish-Speaking Children', Developmental Neuropsychology, 20: 1, 355 — 373

To link to this Article: DOI: 10.1207/S15326942DN2001_3
URL: http://dx.doi.org/10.1207/S15326942DN2001_3

DEVELOPMENTAL NEUROPSYCHOLOGY, *20*(1), 355–373

Neuropsychological Test Scores, Academic Performance, and Developmental Disorders in Spanish-Speaking Children

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Limited information is currently available about performance of Spanish-speaking children on different neuropsychological tests. This study was designed to (a) analyze the effects of age and sex on different neuropsychological test scores of a randomly selected sample of Spanish-speaking children, (b) analyze the value of neuropsychological test scores for predicting school performance, and (c) describe the neuropsychological profile of Spanish-speaking children with learning disabilities (LD). Two hundred ninety (141 boys, 149 girls) 6- to 11-year-old children were selected from a school in Bogotá, Colombia. Three age groups were distinguished: 6-

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to 7-, 8- to 9-, and 10- to 11-year-olds. Performance was measured utilizing the following neuropsychological tests: Seashore Rhythm Test, Finger Tapping Test (FTT), Grooved Pegboard Test, Children's Category Test (CCT), California Verbal Learning Test–Children's Version (CVLT–C), Benton Visual Retention Test (BVRT), and *Bateria Woodcock Psicoeducativa en Español* (Woodcock, 1982). Normative scores were calculated. Age effect was significant for most of the test scores. A significant sex effect was observed for 3 test scores. Intercorrelations were performed between neuropsychological test scores and academic areas (science, mathematics, Spanish, social studies, and music). In a post hoc analysis, children presenting very low scores on the reading, writing, and arithmetic achievement scales of the Woodcock battery were identified in the sample, and their neuropsychological test scores were compared with a matched normal group. Finally, a comparison was made between Colombian and American norms.

Limited information is currently available about performance of normal, Spanish-speaking children on different neuropsychological tests. The neuropsychological profile of Spanish-speaking children with learning disabilities (LD) is also poorly known. Moreover, there are few neuropsychological tests for Spanish-speaking children despite the fact that Spanish is the third most spoken language in the world and the second most spoken language in the United States. Cultural and background factors play a central role in neuropsychological test performance (Ardila, 1995; Puente, Mora, & Muñoz-Cespedes, 1997), particularly for disability groups such as those with LD or attention deficit hyperactivity disorder (ADHD). Current U.S. norms can be inappropriate and misleading when used with Spanish-speaking children.

The neuropsychology literature shows few studies using pediatric Spanish-speaking populations. Ardila and Rosselli (1994) obtained normative data from a monolingual, Spanish-speaking population ranging from 5 to 12 years of age, using language, memory, and visuoperceptual ability tests. They studied the effects of age and socioeconomic level on the Rey–Osterrieth Complex Figure Test (Osterrieth, 1944), the Boston Naming Test (Kaplan, Goodglass, & Weintraub, 1983), the Token Test (De Renzi & Faglioni, 1978), Verbal Fluency test (Ardila, Rosselli, & Puente, 1994), and the Wechsler Memory Scale (WMS) (Wechsler, 1945). A significant effect of socioeconomic level was found for most neuropsychological tests scores. Sex had a significant effect on the Rey–Osterrieth Complex Figure Test and the Boston Naming Test. Rosselli and Ardila (1993) found no differences between the performance of Colombian boys and girls from 5 to 12 years of age on the Wisconsin Card Sorting Test (WCST; Heaton, 1981).

Children's test scores are usually significantly correlated with age. Improvement in test performance is seen for most cognitive measurements. For example, scores on executive function tests, such as the Wechsler Intelligence Scale for Children (WISC), improve with the child's age (Ardila & Rosselli, 1992; Chelune & Baer, 1986; Rosselli & Ardila, 1993). This increase in test performance is argued to be related to underlying cognitive and cerebral development (Kolb & Fantie, 1997; Stuss, 1992; Welsh & Pennington, 1988). Other variables such as the school experience may also play a role in children's cognitive-test performance (Ardila & Rosselli, 1994).

The literature is devoid of neuropsychological studies on Spanish-speaking children with LD (Ardila, 1997). Learning disorders are diagnosed when an individual's achievement on individually administered standardized tests in reading, mathematics, or written expression is more than 2 *SD*s below the mean, although intellectual abilities are intact (*Diagnostic and Statistical Manual of Mental Disorders* [4th ed., *DSM–IV*]; American Psychiatric Association, 1994). These disorders are frequently considered specific difficulties in selective academic areas. Under a psychometric perspective, a child with LD presents with a very large dispersion of scores on different cognitive ability tests. It is estimated that the prevalence of learning disorders in the United States ranges from 2 to 10% of school-age children and the prevalence of reading disorders is estimated at 4% of school-age children (*DSM–IV*). Lower prevalence of reading disorders among Spanish speakers has been suggested (Rosselli, Ardila, Pineda, & Lopera, 1997).

Although many neuropsychological batteries have been developed for the assessment of English-speaking children, few cognitive-assessment batteries for children have been developed for Spanish speakers. The *Bateria Woodcock Psicoeducativa en Español* (Woodcock, 1982) and, most recently, the *Bateria Woodcock–Muñoz–Pruebas de Habilidad Cognoscitiva Revisada* (Woodcock & Muñoz, 1996) are among the few Spanish cognitive-test batteries. These batteries are comprehensive measures of cognitive ability, academic achievement, and scholastic aptitude. Norms for the *Bateria Woodcock Psicoeducativa en Español* were obtained using a sample of 802 children from Costa Rica, Mexico, Peru, Puerto Rico, and Spain. An age range between 4 and 19 years was used. Although this battery was designed for evaluation of academic ability and achievement, many of the tests may be useful for neuropsychological assessment (Lezak, 1995). The Woodcock instruments are used by 75% of U.S. school psychologists (Ochoa, Powell, & Robles-Pina, 1996), and they are considered reliable assessments of learning disorders.

Knowledge about the performance of Spanish-speaking children on the *Bateria Woodcock Psicoeducativa en Español* (Woodcock, 1982) and on neuropsychological tests of language, memory, motor and executive function may help to improve the diagnostic efficiency of assessment techniques for Hispanic populations. This study was designed to (a) analyze the effects of age and sex on different neuropsychological test scores of a randomly selected sample of Spanish-speaking children, (b) analyze the value of neuropsychological test scores for predicting school performance, and (c) describe the neuropsychological profile of Spanish-speaking children with LD.

METHOD

Participants

Two hundred and ninety children (aged 6 to 11 years) were selected from four elementary courses in a middle-class school in Bogotá, Colombia. The selected group was equivalent to 42% of the total children in these courses. In order to have a similar sex distribution per age group, participants were randomly selected separately from the group of boys and girls in each elementary school class. Handedness was assessed using the Waterloo Handedness Questionnaire (Bryden, 1977, 1982). The participants included 268 right-handed and 22 left-handed children. All children voluntarily agreed to participate after obtaining permission from their parents or legal guardians. A signed informed consent was obtained from each child's parent or legal guardian. The total sample was divided into three age groups: 6- to 7-, 8- to 9-, and 10- to 11-year-old children. None of the participants were mentally retarded, according to the school records. Table 1 presents the sex and age distribution of the sample.

Instruments

To have a general neuropsychological and psychoeducational evaluation, including different cognitive domains and educational areas, some basic and well-known neuropsychological and psychoeducational instruments were administered. The following measurements and information were obtained for each child:

1. Verbal memory, nonverbal memory, constructional abilities, motor skills, executive functions, and nonverbal auditory discrimination were assessed using the following neuropsychological tests:

A. The California Verbal Learning Test–Children's Version (CVLT–C; Delis, Kramer, Kaplan, & Ober, 1994). This is an individually administered measure of the child's ability to learn and remember verbal information. The Monday List was presented for five trials. Free recall and cued recall after 20 min were re-

TABLE 1
Age and Gender Distribution of the Sample

	Age			
Gender	*6-7 Years*	*8-9 Years*	*10-11 Years*	*Total*
Boys	38	62	41	141
Girls	45	59	45	149
Total	83	121	86	290

corded. A recognition trial was also used. The original Monday List was translated and adapted to Spanish (eight of the original words were modified). Plural words were used to avoid the use of the article. The immediate free-recall trials, the free delay (after 20 min), and the delayed cued recall were used. The following Spanish words were included in the Monday List: *bananos* (bananas), *camisas* (shirts), *dados* (dices), *abrigos* (coats), *uvas* (grapes), *muñecas* (dolls), *melones* (melons), *pantalones* (pants), *1ápices* (pencils), *duraznos* (peaches), *pelotas* (balls), *sombreros* (hats), *fresas* (strawberries), *cinturones* (belts), and *patines* (skates). After the cued recall the child was asked to identify items from the Monday List within a 45-word list. The number of correct responses was recorded. The 45 words are presented in the Appendix.

B. Benton Visual Retention Test (BVRT; Benton-Sivan, 1992). This is an individually administered test that measures visuoconstructive skills and nonverbal memory. Form C and Administration C (copying) were used to test visuoconstructive abilities. Form D and Administration A (each drawing is displayed 10 sec and then withdrawn) were used to test nonverbal immediate memory. Errors and correct responses were scored for each condition.

C. Children's Category Test (CCT; Boll, 1993). This is an individually administered measure of a child's ability to solve problems through the development and modification of strategies for responding to visual stimuli on the basis of verbal feedback (right or wrong) about the accuracy of responses. The CCT consists of two levels: Level 1 was administered to children between 7 and 8 years old and Level 2 was administered to children 9 years of age or older.

D. Finger Tapping Test (FTT; Reitan & Wolfson, 1985). This test is a simple measure of motor speed and motor control. Tapping speed with each hand is recorded. The child was first tested with the preferred hand over five 10-sec trials, followed by five 10-sec trials with the nonpreferred hand. The child was allowed to rest after every two trials. Scores corresponded to the average number of taps with each hand.

E. The Grooved Pegboard Test (Lafayette Instrument Company, 1997) was used to assess visual motor coordination. The task is to insert metal pegs with ridges along the sides into each hole in sequence. Scores represent time, in seconds, with each hand.

F. The Seashore Rhythm Test (Reitan & Wolfson, 1985). This is a nonverbal auditory discrimination test. The participant is required to note on a score sheet whether two pairs of rhythmic sequences are the same or different. The number of correct responses was scored.

2. In addition to the previously mentioned tests, the *Bateria Woodcock Psicoeducativa en Español* (Woodcock, 1982) was used. This battery is the Spanish version of the Woodcock–Johnson Psycho-Educational Battery (Woodcock, 1977). The battery measures cognitive ability, scholastic aptitude, and academic achievement. Some minor adaptations were made: On Subtest 13, Items 13, 18,

20, 22, 26, 29, 36, 38, and 43, we substituted American currency (pennies, dimes, quarters, and dollars) for Colombian currency (pesos). In addition, in Problem 28, feet and inches were substituted for centimeters, and in Problems 30, 37, 44–45, and 47, miles were substituted for kilometers. Raw scale and part-cluster scores were used. The new *Bateria Woodcock–Muñoz–Pruebas de Habilidad Cognoscitiva Revisada* (Woodcock & Muñoz, 1996) was not available when the data collection for this study began.

3. Finally, teacher-assigned grades in mathematics, music, science, social studies, and Spanish were also obtained for each child. These grades were scores that ranged from 1 (*unsatisfactory*) to 5 (*excellent*).

Reliability using the Spearman–Brown equation for the whole test battery was estimated at .85.

Procedure

Parents of the randomly selected children were contacted by mail or by phone or both. All of them agreed to participate, and informed consent forms were signed. All the tests were administered individually to each child in three sessions. Each child received a small gift (e.g., a box of crayons, a book, etc.) for participation in the study. Additionally, each child's teacher filled out a form providing that child's grades in mathematics, music, science, social studies, and Spanish during the last academic period.

Statistical Analyses

Two multivariate analyses of variance (MANOVAs) were performed using sex (boys and girls) and age (6–7-, 8–9-, and 10–11-year-old groups) as independent variables and the neuropsychological tests and the Woodcock subtests as dependent variables. After the overall MANOVA was calculated, univariate MANOVAs were obtained for each test. The overall multivariate test—Hotelling T^2—was found statistically significant for Age ($F = 10.83$, $p < .001$) and Sex ($F = 2.64$, $p < .001$), using the different neuropsychological tests as dependent variables. In the second MANOVA, the overall multivariate test—Hotelling T^2—was also found statistically significant for the Woodcock subtests (Age: $F = 7.83$, $p < .001$; Sex: $F = 2.64$, $p < .001$). Multiple comparisons between groups were done using Bonferroni post hoc correction.

Correlations between neuropsychological scores and grades in science, mathematics, Spanish, social studies and music grades were performed. Given the high number of test scores, only the following test scores were entered in the correlation analysis: FTT: preferred hand, Seashore Rhythm Test, CCT: total errors, CVLT–C: first trial, CVLT–C: fifth trial, CVLT–C: delayed recall, BVRT (copy): errors, and BVRT (memory): errors. All the scale scores from the *Bateria Woodcock Psicoeducativa en Español* (Woodcock, 1982) were included. To control for type I error, a two-tailed level of confidence was set at .01.

RESULTS

Tables 2 and 3 present the mean test scores and the effect of sex on analyses of the neuropsychological test scores using univariate MANOVAs. It was observed that boys significantly outperformed girls on the FTT (nonpreferred hands). Girls, on the other hand, performed significantly better than boys on the CVLT–C (first trial; Table 2). In the *Bateria Woodcock Psicoeducativa en Español* (Woodcock, 1982) subtests, boys outperformed girls in the Picture Vocabulary subtest (Table 3). No differences were observed between girls and boys on the other measurements.

Tables 4 and 5 show the mean test scores for the different age groups and the main age effect. It is observed that there is an increase in test scores associated with

TABLE 2
Multivariate Analysis of Variance: Sex Main Effect in the Neuropsychological Tests Scores

	Girls		*Boys*			
Test	*M*	*SD*	*M*	*SD*	*F*	*p*
Handedness questionnaire	0.80	0.45	0.76	0.45	0.39	0.532
Seashore rhythm test	22.71	4.48	23.73	3.83	4.66	0.032
FTT: Preferred hand	35.46	6.19	37.94	6.09	4.82	0.029
FTT: Nonpreferred hand	30.54	5.01	32.35	5.55	8.92	0.003
Grooved pegboard (time) preferred hand	80.91	18.14	81.63	15.07	0.27	0.869
Grooved pegboard (time) nonpreferred hand	93.35	22.41	89.70	18.07	3.15	0.077
CCT: Total errors	21.01	10.10	18.78	8.93	3.83	0.051
CVLT–C: 1st trial	7.46	1.77	6.87	1.75	8.01	0.005
CVLT–C: 5th trial	11.85	1.93	11.31	2.30	5.32	0.022
CVLT–C: Delayed cue recall	11.55	2.64	10.97	2.17	5.40	0.021
CVLT–C: Delayed recall	11.18	2.21	10.64	2.11	5.03	0.026
CVLT–C: Total recognition	14.56	0.76	14.53	0.83	0.20	0.653
BVRT (copy): Correct	8.54	1.67	8.56	1.68	0.04	0.834
BVRT (copy): Errors	1.57	1.88	1.51	1.88	0.02	0.962
BVRT (memory): Correct	5.09	1.71	5.26	1.72	0.75	0.393
BVRT (memory): Errors	7.39	3.29	7.24	3.23	0.25	0.613

Note. FTT = Finger Tapping Test; CCT = Childrens' Category Test; CVLT–C = California Verbal Learning Test–Children's Version; BVRT = Benton Visual Retention Test.

TABLE 3
Multivariate Analysis of Variance: Sex Main Effect in the Bateria Woodcock Psicoeducativa en Español Scores

	Girls		*Boys*			
Woodcock Subtests	*M*	*SD*	*M*	*SD*	*F*	*p*
Picture Vocabulary	11.12	2.46	12.03	2.55	9.15	0.003
Spatial Relations	34.82	5.77	35.75	5.91	2.74	0.096
Visual Auditory Learning	19.57	9.27	18.87	9.20	0.38	0.533
Quantitative Concepts	18.69	4.53	18.86	4.51	0.02	0.877
Visual Matching	21.29	4.12	21.00	4.33	2.28	0.132
Antonyms–Synonyms	17.42	4.82	17.55	5.27	0.10	0.749
Analysis–Synthesis	18.26	3.90	17.78	4.42	1.37	0.241
Numbers Reversed	6.56	2.04	6.55	1.96	0.01	0.914
Concept Formation	18.80	6.59	18.29	6.54	0.33	0.566
Analogies	15.07	3.91	14.90	4.59	0.14	0.706
Letter–Word Identification	45.36	3.81	43.40	3.00	9.34	0.002
Word Attack	24.10	3.04	23.54	3.37	2.45	0.118
Passage Comprehension	10.25	3.15	9.71	3.14	3.06	0.081
Calculation	13.03	4.78	12.48	4.99	1.91	0.167
Applied Problems	22.82	4.12	23.48	4.20	1.80	0.181
Dictation	19.42	4.64	18.38	4.59	4.64	0.032
Proofing	12.14	5.58	11.16	6.55	1.97	0.161
Broad Cognitive Ability	498.40	10.82	498.56	10.79	0.09	0.754
Oral Language	496.32	9.64	497.34	11.22	0.98	0.321
Reasoning	506.83	12.37	505.43	12.92	0.85	0.357
Visual–Perceptual Speed	493.83	13.47	494.06	13.70	0.21	0.645
Reading Aptitude	497.32	9.53	497.02	10.40	0.03	0.854
Mathematics Aptitude	500.58	11.30	499.82	12.05	0.27	0.603
Written Language Aptitude	495.88	9.65	495.84	10.12	0.01	0.946
Reading Achievement	508.28	10.02	505.00	13.40	6.03	0.015
Mathematic Achievement	483.55	19.60	482.87	18.14	0.05	0.824
Written Language Achievement	497.72	11.08	494.36	13.65	6.24	0.013
Skills	499.70	11.44	498.07	13.59	1.47	0.225

age. A significant age effect was observed on all subtests except on the questionnaire of handedness, CVLT–C recognition, and the Word Attack subtest of the *Bateria Woodcock Psicoeducativa en Español* (Woodcock, 1982). Bonferroni post hoc analyses disclosed significant differences among the three age groups for most Woodcock subtests and for the FTT, the Grooved Pegboard Test, and the BVRT copy and memory subtests. In the CCT and in the CVLT–C first trial, the youngest and the oldest groups differed significantly, but no significant differences were observed between these two groups and the 9- to-10-year-old group. The mean score of error of the older groups increased in the CCT due to the fact that they received a more difficult version of the test (CCT Level 2). In the

CVLT–C fifth trial, the CVLT–C delayed conditions and the BVRT (copy) showed no significant differences between the 9- to 10-year-olds and the 11- to 12-year olds. Age × Sex interactions were not statistically significant.

The intercorrelation analyses between neuropsychological tests and school grades are presented in Table 6. Woodcock Calculation subtest significantly correlated with grades in science. Woodcock Proofing and the CCT also significantly correlated with school grades in mathematics. Several language subtests from the *Bateria Woodcock Psicoeducativa en Español* (Woodcock, 1982) significantly correlated with school performance in language. Only one test score (CVLT–C: Delayed Recall) significantly correlated with social studies school grades, and none of the neuropsychological test battery scores correlated with performance in music.

In a post hoc analysis, three groups of children with LD were identified as having reading disorder, writting disorder, and mathematics disorder. The crite-

TABLE 4
Multivariate Analysis of Variance: Age Main Effect in the Neuropsychological Measurements (in Years)

	6–7			*8–9*			*10–11*			
Test	*M*	*SD*		*M*	*SD*		*M*	*SD*	*F*	*p*
Handedness questionnaire	0.78	0.44	<	0.68	0.44	<	0.79	0.46	0.01	0.988
Seashore rhythm test	21.65	4.57	<	23.21	4.05	<	24.72	3.47	11.89	0.001
FTT: Preferred hand	32.25	4.96	<	35.52	5.35	<	41.08	5.08	63.63	0.001
FTT: Nonpreferrred hand	28.16	3.81	<	30.76	4.65	<	35.48	4.99	60.04	0.001
Grooved pegboard (time): Preferred hand	92.46	17.80	<	81.96	13.79	<	69.47	10.47	37.90	0.001
Grooved pegboard (time): Nonpreferred	104.00	21.44	<	93.58	17.67	<	76.41	12.22	52.71	0.001
CCT: Total errors	17.28	7.94	=	19.69	10.51	=	22.80	9.00	7.38	0.001
CVLT–C: 1st trial	6.75	1.84	=	7.28	1.79	=	7.44	1.66	4.01	0.019
CVLT–C: 5th trial	10.51	2.23	<	11.86	1.91	=	12.24	1.25	18.39	0.001
CVLT–C: Delayed cue recall	10.30	2.75	<	11.40	1.93	=	12.01	1.69	15.14	0.001
CVLT–C: Delayed recall	9.79	2.33	<	11.12	2.02	=	11.70	1.78	19.53	0.001
CVLT–C: Recognition	14.35	1.02	<	14.55	0.71	<	14.73	0.60	5.10	0.015
BVRT (copy): Correct	7.85	2.18	<	8.73	1.52	=	8.97	0.98	11.30	0.001
BVRT (copy): Errors	2.40	2.52	<	1.31	1.63	=	1.02	1.00	13.99	0.001
BVRT (memory): Correct	4.27	1.52	<	5.16	1.54	<	6.06	1.67	26.65	0.001
BVRT (memory): Errors	9.02	2.81	<	7.33	2.93	<	5.66	3.29	26.73	0.001

Note. FTT = Finger Tapping Test; CCT = Childrens' Category Test; CVLT–C = California Verbal Learning Test–Childrens' Version; BVRT = Benton Visual Retention Test. < indicates significant differences ($p < .01$) between the two age groups using Bonferroni post hoc analyses; = indicates no significant differences between the two groups using Bonferroni post hoc analyses.

TABLE 5
Multivariate Analysis of Variance: Age Main Effect in the Bateria Woodcock Psicoeducativa en Español Scores (in Years)

	6–7			*8–9*			*10–11*			
Woodcock Subtest	*M*	*SD*		*M*	*SD*		*M*	*SD*	*F*	*p*
Picture Vocabulary	10.28	2.15	<	11.51	2.17	<	12.88	2.74	25.65	0.001
Spatial Relations	31.13	3.50	<	34.83	4.69	<	39.90	5.89	71.51	0.001
Visual–Auditory Learning	23.18	9.51	<	18.70	8.14	=	15.83	9.02	14.41	0.001
Quantitative Concepts	15.50	3.31	<	18.04	2.54	<	22.97	4.52	101.16	0.001
Visual Matching	17.84	2.80	<	21.02	3.69	<	24.52	3.41	82.32	0.001
Antonyms–Synonyms	14.62	3.24	<	17.98	4.18	<	20.95	5.26	45.94	0.001
Analysis–Synthesis	15.89	3.58	<	18.10	4.01	<	19.98	3.93	22.65	0.001
Numbers Reversed	5.62	1.70	<	6.55	1.83	<	7.46	2.08	20.15	0.001
Concept Formation	15.10	6.62	<	18.53	5.86	<	21.90	5.70	26.88	0.001
Analogies	12.34	3.53	<	14.86	3.63	<	17.70	4.05	44.25	0.001
Letter–Word Identification	42.45	6.88	<	44.29	5.73	<	46.46	3.03	12.30	0.001
Word Attack	23.21	4.01	<	24.04	3.06	<	24.12	2.41	2.32	0.100
Passage Comprehension	8.16	2.97	<	9.96	2.57	<	11.79	3.07	34.67	0.001
Calculation	8.59	2.66	<	12.19	3.82	<	17.60	3.53	146.50	0.001
Applied Problems	19.89	3.33	<	23.22	3.49	<	26.32	3.26	75.92	0.001
Dictation	15.41	4.07	<	18.96	4.11	<	22.23	3.18	66.26	0.001
Proofing	7.97	4.70	<	11.65	5.65	<	15.25	5.75	38.34	0.001
Broad Cognitive Ability	490.03	8.37	<	497.90	7.82	<	507.47	9.36	88.55	0.001
Oral Language	490.02	8.65	<	496.36	8.41	<	504.16	9.86	52.78	0.001
Reasoning	498.22	11.11	<	505.91	10.93	<	514.95	11.26	43.56	0.001
Visual–Perceptual Speed	482.72	7.25	<	492.99	10.91	<	506.25	11.41	113.36	0.001
Reading Aptitude	489.86	7.35	<	496.59	7.81	<	505.25	8.89	77.82	0.001
Mathematics Aptitude	491.27	8.10	<	499.50	9.15	<	510.00	10.23	86.60	0.001
Written Language Aptitude	488.34	7.26	<	495.34	7.67	<	504.01	8.58	83.44	0.001
Reading Achievement	501.95	12.93	<	506.52	11.19	<	511.58	9.66	16.03	0.001
Mathematic Achievement	465.86	14.68	<	482.55	16.26	<	501.77	12.28	123.18	0.001
Written Achievement	487.08	11.12	<	496.43	11.33	<	504.48	8.75	59.12	0.001
Skills	489.95	11.24	<	498.57	10.79	<	508.30	8.97	65.12	0.001

Note. < indicates significant differences ($p < .01$) between the two age groups using Bonferroni post hoc analyses; = indicates no significant differences between the two groups using Bonferroni post hoc analyses.

rion used to select the learning disabled participants was scores that were 2 *SD*s below the age group mean in Woodcock Reading Achievement, Woodcock Written Language Achievement, and Woodcock Mathematic Achievement clusters, respectively. The Woodcock Reading Achievement cluster includes Letter–Word Identification (LWID), Word Attack, and Passage Comprehension subtest scores. The Woodcock Written Language Achievement cluster includes Proofing and Dictation subtests. The Woodcock Mathematics Achievement cluster comprises Calculation and Applied Problems subtests. We found that 12 children (4.15%; 7, 3, and 2 children in each age range) scored 2 *SD*s below the mean on the Reading Achievement cluster ("dyslexia group"); 11 were boys and 1 was left-handed. Sixteen children (5.5%; 5, 6, and 5 children in each age range) scored 2 *SD*s below the mean on the Writing Achievement cluster ("dysgraphia group"); 12 were boys and 2 were left-handers. Six children (2.0%; 2, 3, and 1 children in each age range) scored 2 *SD*s below the group mean with regard to the Mathematics Achievement cluster ("dyscalculia group"); 5 were boys and 1 was a left-hander. The overlapping of children in different groups was observed in only four cases (two children met both the reading and writing disorder group criteria and another two fell into the three disorder groups). Using univariate MANOVAs, these three groups' test scores were compared with the scores of an age-, sex-, grade-, and handedness-matched sample taken from the overall sample. The overall multivariate

TABLE 6
Pearson Correlations Between Neuropsychological Test Scores and Grades in Different School Subjects

Test	*Science*	*Mathematics*	*Social Studies*	*Spanish*	*Music*
Seashore rhythm test	0.02	0.07	0.06	0.07	0.03
Grooved pegboard (preferred hand)	–0.08	0.00	–0.01	–0.05	0.08
CCT: Total errors	–0.07	–0.14	–0.08	–0.02	0.00
CVLT –C: 5th trial	0.01	0.04	0.06	0.16*	0.03
CVLT –C: Delayed free recall	0.04	0.07	0.16*	0.18*	0.03
BVRT (copy): Errors	0.00	–0.02	0.00	–0.04	0.00
BVRT (memory): Errors	0.02	–0.12	–0.03	–0.13	–0.04
Woodcock: Picture Vocabulary	0.04	0.15	0.00	0.09	0.00
Woodcock:Spatial Relations	0.12	0.06	0.05	0.04	0.03
Woodcock: Visual–Auditory Learning	–0.04	–0.18*	–0.07	0.16*	0.01
Woodcock: Quantitative Concepts	0.10	0.10	0.03	0.09	0.07
Woodcock: Visual Matching	0.04	0.06	0.05	0.10	0.04
Woodcock: Antonyms–Synonyms	0.01	0.06	0.03	0.15	0.03
Woodcock: Analysis–Synthesis	0.09	0.03	0.03	0.08	0.07
Woodcock: Numbers Reversed	0.00	0.14	0.07	0.16*	0.02
Woodcock: Concept Formation	0.02	0.18*	0.05	0.17*	0.00
Woodcock: Analogies	0.02	0.14	0.00	0.19*	0.04
Woodcock: Letter–Word Idenfication	0.00	0.14	0.00	0.14	0.01
Woodcock: Word attack	0.08	0.16*	0.08	0.22*	0.01
Woodcock: Passage Comprehension	0.04	0.18*	0.08	0.30*	0.01
Woodcock: Calculation	0.16*	0.05	0.05	0.09	0.09
Woodcock: Applied Problems	0.06	0.16*	0.02	0.14	0.00
Woodcock: Dictation	0.01	0.16*	0.05	0.21*	0.06
Woodcock: Proofing	0.05	0.21*	0.07	0.31*	0.00

Note. CCT = Childrens' Category Test; CVLT–C = California Verbal Learning Test–Childrens' Version; BVRT = Benton Visual Retention Test.
*$p < .01$.

test—Hotelling T^2—was found statistically significant ($F = 4.16$, $p < .001$). The Woodcock subtests used in the classification of children with LD were not included in the analysis.

To determine global intellectual differences between the groups with LD and the matched control group, the Broad Cognitive Ability score was used. Differences were not statistically significant for the dyslexia ($F = 3.66$, $p < .069$) and dyscalculia ($F = 1.97$, $p < .190$) groups. However, a statistically significant difference was observed between the dysgraphia ($F = 8.16$, $p < .008$) group and the matched control group. The group with writing difficulties scored significantly below their matched peers in the Broad Cognitive Ability cluster.

Statistically significant differences between the dyslexia group and the matched controls were observed in the CVLT–C fifth trial (dyslexia = 8.50 ± 2.54; controls = 11.58 ± 1.88; $F = 11.41$, $p < .003$). The dysgraphia group scores were significantly different from the matched control group in the Woodcock Visual–Auditory Learning (dysgraphia = 19.12 ± 5.39; controls = 28.25 ± 8.12; $F = 14.02$, $p < .001$) and Woodcock Analogies (dysgraphia = 10.68 ± 3.68; controls = 15.18 ± 3.79; $F = 11.57$, $p < .002$). The dyscalculia group did not show a significant difference from the control group in any of the tests.

DISCUSSION

The results from this research confirm the effect of age on most of the dependent variables. Few significant differences between girls and boys were observed. The age and sex effects, however, were independent from each other because the interactions were not significant. We can assume that sex differences in cognitive testing are independent of the maturational processes associated with age.

The age effect on neuropsychology test scores was not consistent across ages for all cognitive measures. Although for most tests the scores continued to improve into adolescence, for memory and constructional measures the effect was stronger in younger groups. The opposite was true for abstraction ability test scores (CTT) in which the improvement was seen mostly in the older groups. Witelson and Swallow (1988) pointed out that the age of 10 may be important in child development because such abilities as the visual recognition of spatial patterns, naming and discrimination of Braille, and map reading have been shown to develop and lateralize after this age (Spreen, Risser, & Edgell, 1995). Passler, Isaac, & Hynd (1985) concluded, from studying proactive and retroactive inhibition in 6- to 12-year-old children, that the major development of these executive-type cognitive skills occurred between ages 6 to 8; the development was fairly complete by age 10, and mastery was reached by age 12.

The relation between age and the neuropsychological test scores used in this study has been previously reported for American children (Benton-Sivan, 1992; Delis et al., 1994; Mitrushina, Boone, & D'Elia, 1999; Nussbaum & Bigler, 1997). Table 7 presents these data. Most of the test scores between the two national groups (Colombia and the United States) are similar. However, slightly better performance is found in the Colombian children in most of the tests scores. Differences in education and other cultural factors may account for these score differences. It can be conjectured that the Colombian educational system could be more demanding than the American one. Educational factors have been shown to significantly influence verbal and nonverbal neuropsychology tests (Ardila, 1999).

One of the most important differences between the two groups was found in the Seashore Rhythm Test. The Colombian children outperformed the American group. The mean score of the oldest group (24.72 ± 3.47) corresponds to the mean score of adult samples with low levels of education (24.0 ± 3.6) reported by Bornstein and Suga (1988), and to the mean score of the adult Norwegian sample (24.7) documented by Klove and Lochen (Klove, 1974). Some cultural effects on the Seashore Rhythm Test scores, likely associated with familiarity and relevance of tone discrimination tasks, have been reported (Klove, 1974).

On the FTT, American children (Findeis & Weight, cited by Nussbaum & Bigler, 1997) presented a much slower increase of taps with the preferred and nonpreferred hands than the Colombian group. However, in both samples the improvement is more evident for the preferred hand. The effect of age on the FTT has also been reported in adults. Villardita, Cultrera, Cupone, and Mejia (1985) found

TABLE 7
Norms for Some of the Neuropsychological Tests Used in the Study Reported for American Children (in Years)

	6–7		*8–9*		*10–11*		
Test	*M*	*SD*	*M*	*SD*	*M*	*SD*	*Source*
Seashore rhythm test	na		14.23	5.50	18.97	6.3	Nussbaum & Bigler (1997)
FTT: Preferred hand	31.77	3.95	35.20	4.35	39.12	5.1	Nussbaum & Bigler (1997)
FTT: Nonpreferrred hand	28.61	3.45	31.17	3.55	34.55	4.8	Nussbaum & Bigler (1997)
CTT: Total errors	17.08	na	18.08	na	21.60	na	Boll (1993)
CVLT–C: 1st trial	5.00	na	6.00	na	6.50	na	Delis, Kramer, Kaplan, & Ober (1994)
CVLT–C: 5th trial	8–9	na	10	na	11–12	na	Delis et al. (1994)
CVLT–C: Delayed cue recall	7–8	na	9–10	na	10–11	na	Delis et al. (1994)
CVLT–C: Delayed recall	7–8	na	8–9	na	10	na	Delis et al. (1994)
CVLT–C: Recognation	12–13	na	13	na	14.50	na	Delis et al. (1994)
BVRT (copy): Correct	6.19	2.28	7.22	1.96	8.28	1.32	Benton-Sivan (1992)
BVRT (memory): Correct	na		4.00	na	6.00	na	Benton-Sivan (1992)

Note. FTT = Finger Tapping Test; CCT = Childrens' Category Test; CVLT–C = California Verbal Learning Test–Childrens' Version; BVRT = Benton Visual Retention Test; na = not available.

that from ages 20 to 69 there is a decrease of 11 taps with the preferred hand and of 9 taps with the nonpreferred hand.

The sex effect found on the performance of the FTT with both hands has been previously reported with American samples. Better performance by men on the FTT has been consistently demonstrated among adult participants between ages 15 and 91 (Bornstein, 1985; Trahan, Patterson, Quintana, & Biron, 1987). Interestingly, this sex difference is still observed after brain damage (Mitrushina et al., 1999).

The differences between the Colombian and American children in the CVLT–C (Delis et al., 1994) may be due to the fact that the Spanish adaptation of the test had a different level of difficulty. The list of words in Spanish may be easier than the English list used in the original CVLT–C. In our study we did not have a List B. Therefore, no interference effect was given. In addition, the number of recognition hits in our sample presented a ceiling effect in all age groups. Moreover, in our study, girls outperformed boys on most of the CVLT–C measures. This sex effect was not found to affect performance on the CVLT–C (Delis et al., 1994). The Spanish version of the CVLT–C that we used in this study was a modified version, and the modifications may account for the sex effect found in our study.

It has been established, however, that sex affects performance on the CVLT adult version. Recall performances tend to decline with increasing age (Wiens, Tindall, & Crossen, 1994). Among English-speaking adults, women tend to outperform men on learning and recall measures, but no sex differences are reported for the recognition trial (Kramer, Delis, & Daniel, 1988).

The results of this study support the developmental age progression effect with the CCT and BVRT, which has been reported among American children (Boll, 1993). The highly consistent relation between age and CCT scores has been documented among adult samples too (Mitrushina et al., 1999). The number of errors increases as the sample ages. Sex differences have not been statistically significant for the CCT (Dodrill, 1979) and the BVRT (Benton-Sivan, 1992).

Our study described an age effect but not a sex effect on the Grooved Pegboard Test scores. The older the group, the faster the performance on this test and the smaller the difference in performance between the preferred and the nonpreferred hand. The effect of age on the Grooved Pegboard Test has been observed in studies with normal adult populations. Motor slowing is seen with advancing age (Bornstein, 1985). The performance of our older children's group on the Grooved Pegboard Test was similar to the performance of adults aged 40 to 59 (dominant hand = 68.1; nondominant hand = 74.7) in Heaton, Grant, and Matthew's (1986) study. Sex differences on the Grooved Pegboard Test have not been consistent. Some authors have found significant sex differences (Bornstein, 1985), but others (Heaton et al., 1986) have failed to corroborate this sex effect. Polubinski and Melamed (1986) found that adult women performed faster than adult men. Thompson, Heaton, Matthews, and Grant. (1987) reported greater intermanual differences for females compared to males. Intermanual percentage-difference scores were calculated as Preferred Hand – Nonpreferred Hand ÷ Preferred Hand. The female disparity was 9.8% and the male disparity was only 6.7%. In our sample of children, the intermanual percentage difference is also greater in girls (15%) than in boys (9%).

No differences between boys and girls were found in most of the Woodcock subtests. Occasionally, sex differences in some Woodcock subtests have been reported. For example, Laurent (1997) found sex differences on the Visual Matching and Picture Vocabulary subtests. Our results point to a better vocabulary but a lower reading and writing ability in boys.

The correlations between neuropsychological test scores and school grades demonstrated that the Woodcock scores were exceedingly better predictors of school performance than the rest of the neuropsychological tests. This is understandable, considering that the Woodcock is a psychoeducationally oriented test battery. The CVLT–C, however, predicted performance in social studies and Spanish. The rest of the neuropsychological test scores were not significantly associated with school performance. A negative correlation between the CCT total error score and math and reading grades are reported in the CCT manual (Boll, 1993). Woodcock Calculation subtest was the single best predictor of school performance in science. Noteworthy, calculation abilities were found to be the best predictor of general cognitive-test performance (Ardila, Galeano, & Rosselli, 1998). The modest value of neuropsychological tests for predicting academic performance was previously reported (Ardila & Rosselli, 1994).

Some statistically significant differences were observed between normal children and children with LD. The differences were observed not only in reading, writing, and calculation ability tests but also in memory and learning and language understanding. It seems that this group of children, who were designated as learning disabled by a psychometric criterion, presented verbal learning difficulties with preserved recall and recognition capacities. They did not seem to have constructional deficits, although their motor speed was below average. The fact that the children with the lowest scores on the Reading Achievement cluster presented the lowest scores on the Woodcock Written Language cluster and Woodcock Mathematics cluster also supports the coexistence of reading disorders with written and mathematical disorders in Spanish-speaking children. This association between dyslexia and dysgraphia was also documented in English-language literature (e.g., Critchley, 1985). It is important to note that the definition used in this study is not exactly the one proposed by the *DSM–IV*. The discrepancy between the cognitive level and academic achievement was not used as a criterion on an individual level. Although the school records report that none of the participant children had mental retardation, we did not test for IQ. It might be possible that some slow learners were included in our groups with LD.

Current results may have a twofold importance: (a) From a basic point of view, they can contribute to a better understanding of cultural factors in cognitive and educational test performance. Our results are partially coincidental with the American norms. Coincidences, but also differences, are noted. Furthermore, some learning disabilities, particularly dyslexia, are correlated with the idiosyncrasies of the written system. (b) From a clinical point of view, they can provide some norms for the evaluation of Spanish-speaking schoolchildren. Much more research, however, is required in this area.

ACKNOWLEDGMENTS

This research was supported by Colciencias (Fondo Colombiano para el Desarrollo de la Ciencia y la Tecnología) and the Fundación Universitaria Konrad Lorenz (Bogotá, Colombia).

We thank the Colsubsidio school staff and Breatriz Barragán, Omar Calvache, Eduardo Pinzon, Martha Peña, Luz Marina Romero, and Carlos Valencia, who helped with the data collection. We also thank Janna Taft for her editorial support and the anonymous reviewer for valuable and encouraging suggestions.

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APPENDIX
Recognition List to the California Verbal Learning Test
Monday List (45 Words)

Pantalones
Anteojos
Mesas
Lápices
Blusas
Ciruelas
Escobas
Bananos
Talones
Patines
Galletas
Manzanas

Escritorios
Presas
Llaves
Sombreros
Uvas
Dulces
Raquetas
Alfombras
Melones
Cojines
Revistas
Muñecas
Mangos
Camisas
Helados
Cunas
Naranjas
Abrigos
Fresas
Pelotas
Piñas
Títeres
Rosas
Peras
Tapices
Dados
Pasteles
Lámparas
Peinillas
Duraznos
Cinturones
Vestidos
Relojes