Journal of Learning Disabilities

http://ldx.sagepub.com/

Neuropsychological Profile on the WISC-IV of French Children With Dyslexia

Maryse De Clercq-Quaegebeur, Séverine Casalis, Marie-Pierre Lemaitre, Béatrice Bourgois, Marie Getto and Louis Vallée

J Learn Disabil published online 8 July 2010
DOI: 10.1177/0022219410375000

The online version of this article can be found at:
http://ldx.sagepub.com/content/early/2010/07/06/0022219410375000

Published by:
Hammill Institute on Disabilities

and

http://www.sagepublications.com

Hammill Institute on Disabilities

Journal of Learning Disabilities
XX(X) 1–12

DOI: 10.1177/0022219410375000
http://journaloflearningdisabilities.sagepub.com
SAGE

Neuropsychological Profile on the WISC-IV of French Children With Dyslexia

Maryse De Clercq-Quaegebeur[1], Séverine Casalis[2], Marie-Pierre Lemaitre[1], Béatrice Bourgois[1], Marie Getto[2], and Louis Vallée[1]

Abstract

This study examined the pattern of results on the *Wechsler Intelligence Scale for Children* (WISC-IV; French version) for 60 French children with dyslexia, from 8 to 16 years of age. Although use of WISC-III failed to clearly identify typical profiles and cognitive deficits in dyslexia, WISC-IV offers an opportunity to reach these objectives with new indexes and subtests. The mean performance analysis showed a Working Memory Index (WMI) at a limit level, significantly lower compared to the three other indexes. The WMI was the lowest index for 68% of the population studied and was significantly weaker for children with phonological dyslexia compared to children with surface dyslexia. WISC-IV evidenced preserved language and reasoning abilities in contrast to limited verbal working memory efficiency. Theoretical and clinical implications are discussed.

Keywords

dyslexia, Wechsler's scale, WISC-IV, working memory

The diagnosis of developmental dyslexia requires identifying specific reading disabilities, demonstrated by reading achievement below that expected at the given age, the appropriate education, and the intellectual potential (American Psychiatric Association, 1994). Usual practice considers as significant a gap of 2 years between reading level and school level and a gap of 18 months for children younger than 9 years old (Cheminal & Brun, 2002). Standardized measures, such as the *Wechsler Intelligence Scale for Children* (WISC), are used to estimate general intellectual ability. To help diagnosis when dyslexia is suspected with a child, the psychologist assesses reasoning capacities to exclude mental deficiency as being responsible for the reading disability. Beside the necessity to estimate cognitive abilities as a whole to establish a diagnosis of dyslexia, psychologists use standardized tests to consider strengths and weaknesses on cognitive tests.

Establishing a cognitive profile of those with dyslexia based on standard tests may lead to several objectives. One of them is to examine whether a particular profile on the WISC may help diagnose dyslexia; another one is to check whether IQ subtests may help to determine cognitive deficits that are identified in children with dyslexia.

Previous studies, based on WISC-III and WISC-R, have tried to determine a WISC profile for dyslexia. In all, they have shown results with different patterns.

Particular profiles on the subtests of IQ assessments, observed in clinical studies of dyslexic child groups, have been estimated to be characteristics of dyslexia. On the WISC-R (Wechsler, 1981), several subtests evaluate verbal and non-verbal (performance) capacities. Bannatyne (1974) classified the WISC-R subtests into three categories: spatial abilities (Block Design, Object Assembly, Picture Completion), conceptual abilities (Vocabulary, Similarities, Comprehension), and sequential abilities (Digit Span, Coding, Arithmetic). This group study indicates a greater spatial than conceptual, itself greater than sequential, pattern of results for learning disabled children. This pattern by group, however, is not consistent at the individual level. Berk (1983) recommends that clinicians not use the WISC-R profile to diagnose specific learning disabilities but instead seek prevention and remediation of learning problems. Bannatyne's profile was also studied for

[1]Regional Reference Center for Learning Disabilities Diagnosis (CRDTA), in Lille Régional and Universitary Hospital Center (CHRU)
[2]Unity of Research on the Evolution of the Behavior and Learning (URECA), University of North France

Corresponding Author:
Maryse De Clercq-Quaegebeur, CRDTA, 150 rue du Dr Yersin, 59120 Loos, FRANCE
Email: m-quaegebeur@chru-lille.fr

the WISC-III. Comparing a dyslexic child group to a control group (French samples), Grégoire (2000) found a 15.4% false positive rate of diagnosis (existence of Bannatyne's profile in the control group) and a 64.3% false negative rate of diagnosis (absence of Bannatyne's profile in the children with dyslexia group). Thus, Bannatyne's profile is not specific enough to account for dyslexia.

Another profile emphasizes deficits on the Arithmetic, Coding, Information, and Digit Span subtests. This so-called ACID profile (Kaufman, 1981) is at the origin of the discrepancies between verbal and nonverbal IQ (verbal IQ [VIQ] < performance IQ [PIQ]). A variation was proposed by Kaufman in 1994 (the SCAD profile), with the lowest scores in Symbol Search, Coding, Arithmetic, and Digit Span. However, it appears that not all children diagnosed with dyslexia show deficits on the four subtests, and the reverse pattern (VIQ > PIQ) has also been found, illustrating variability within dyslexia. Watkins, Kush, and Glutting (1997) underlined the risk of diagnosis error based on this profile and showed the lack of discriminant and predictive validities of the WISC-III ACID profile for learning disabilities.

Thomson (2003) has shown that only 40% of a group of 252 children with dyslexia displayed a complete ACID profile and 50% a complete SCAD profile (which seems more robust). Also, 68% present the lowest scores on Digit Span and Coding, and 62% present the lowest scores on Coding, Digit Span, and Symbol Search. Looking at the index scores, 80% of the group of children with dyslexia had significantly weaker mean scores on the Freedom from Distractibility (Arithmetic and Digit Span) and Processing Speed Index (PSI) scores compared to the others.

Thus, there is a lack of consistency in identifying a whole IQ profile in children with dyslexia, at least when IQ is assessed by WISC-R and WISC-III. This has led to a progressive abandonment of the idea that cognitive profile may help diagnose a specific reading disability.

As pointed out above, another reason to examine more deeply IQ profiles lies in the establishment of cognitive deficits. The research literature points out a quantity of cognitive deficits that are strongly connected to developmental dyslexia (for reviews, see Démonet, Taylor, & Chaix, 2004; Vellutino, Fletcher, Snowling, & Scanlon, 2004). In the clinical investigation, an important question is if such deficits are caught by the standard assessment.

The weakness in different subtests of the Wechsler scales is related to particular impairments in those with dyslexia, such as working memory and phonological coding. The Digit Span and Arithmetic subtests (mental calculation) require processes from the phonological loop and the central executive of working memory (Baddeley, 1996, 2001), which are perturbed in those with dyslexia (Swanson, 1999). Jeffries and Everatt (2004) gave evidence about the impairments of the group with dyslexia on forward and backward Digit Span task. Tasks that involve the phonological loop can be used to distinguish those with dyslexia and controls. The problem with verbal short-term memory is with the difficulties in phonological awareness, the manifestation of a problem at the level of phonological representation (Snowling, 2001). The phonological theory of dyslexia, predominant in the literature, postulates that the cognitive explanation of dyslexia is an underlying phonological deficit. Those with dyslexia have a specific impairment in the representation, storage, and/or retrieval of speech sounds (Ramus et al., 2003b). The phonological hypothesis is supported by neuroimaging studies that show evidence of hypo-activation in the left peri-sylvian areas, implicated in phonological analysis and phonological working memory (Galaburda, Sherman, Rosen, Aboitiz, & Geschwind, 1985; Paulesu et al., 1996).

However, according to Wolf and Bowers (1999), single deficit in phonological processing is unlikely to fully account for dyslexia. Speed of processing impairment could be an additional factor of risk. Scores on the Coding and Symbol Search subtests could be lower for at least some children with dyslexia (Catts, Gillipsie, Leonard, Kail, & Miller, 2002; Thomson, 2003; Whitehouse, 1983) because, as timed subtests, they are in position to measure processing speed. However, it has to be noted that identifying a weakness on a WISC subtest should not mean that the cognitive ability connected to this subtest originates with the reading difficulty.

Stanovich (1986) has convincingly described the relationship between intelligence and reading development, called the "Mathew effect." Slow reading acquisition has cognitive, behavioral, and motivational consequences that slow down the development of other cognitive skills and inhibit performance on many academic tasks, particularly general and lexical acknowledgment. This could explain weakness on the Information and Vocabulary subtests of the Verbal Scale. With less exposure to text, those with dyslexia fail to build a large lexicon and to enrich their general knowledge. As a consequence, the WISC profile may differ across age, with lower performance on verbal subtests.

Overall, the use of the WISC-R and WISC-III has failed to lead to a clear picture of the putative dyslexia profile. Note that the existence of dyslexia subtypes may obscure the picture. Dyslexia subtypes have been defined in reference to Coltheart's model (Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001; Ellis & Young, 1988), which considers two routes for reading: a lexical one, based on orthographic coding, and a sublexical one, based on phonological coding. Such classification is the most consensual one in the literature, even though alternative models have been considered (Harm & Seidenberg, 1999). It has led to three main categories of those with developmental dyslexia (Castles & Coltheart, 1993; Manis, Seidenberg, Doi, McBridge-Chang, & Petersen, 1996). Those with phonological dyslexia are more specifically disabled in the phonological route—the procedure based on grapheme to phoneme correspondences—as attested by a low level in pseudo-words reading. Those with surface dyslexia are more specifically disabled in the lexical route—the procedure that is based on an orthographic matching between an input and a stored orthographic representation—as revealed by poor performance in irregular word reading. Finally, children with impairments in both procedures display mixed dyslexia. Studies that have tried to quantify a proportion of those with dyslexia in each category have led to some inconsistencies (Manis et al., 1996; Stanovich, Siegel, & Gottardo, 1997). Moreover, stability of subtyping across time has been questioned. For example, Griffiths and Snowling (2002) have provided longitudinal studies indicating that a larger proportion of those with phonological dyslexia have been found when children became older (also see Sprenger-Charolles, Lacert, Béchennec, Colé, & Serniclaes, 2001, for a French study). Thomson (1999) had also noted changes in profiles (phonological vs. surface) with age. However, in spite of these limitations, subtyping could be considered a useful tool in catching well-known heterogeneity in developmental dyslexia. To our knowledge, no study has tried to examine the IQ profile of these subtypes of dyslexia.

Considering now the WISC-IV, a number of changes were built into this battery of tests (the last version, edited in France in 2005). The subtests and index improvement were based on up-to-date theoretical knowledge. It was standardized on a representative sample of 1,100 French children aged 6 years to 16 years 11 months. WISC-IV consists of 10 main subtests (in each subtest, the mean is 10 with a standard deviation of 3), which combine to yield four index scores and a Total Intellectual Quotient (M = 100, SD = 15). Qualitative comments are made as a function of the score (Table 1).

Table 1. Qualitative Description of the Index Scores of the *Wechsler Intelligence Scale for Children*

Index Score	Qualitative Description
130 or more	Very superior
120–129	Superior
110–119	High average
90–109	Average
80–89	Low average
70–79	Borderline
69 or less	Extremely low

Fluid reasoning is now assessed in the Perceptual Reasoning Index (PRI) with Matrix Reasoning and Picture Concepts, added to Block Design. PRI is also characterized by a decreased reliance on speed (compared to PIQ in WISC-III). The Verbal Comprehension Index (VCI) includes the Similarities, Vocabulary, and Comprehension subtests and is more focused on verbal abilities and is therefore more homogeneous than WISC-III VIQ. The Working Memory Index (WMI) is specifically assessed through changes made to the Digit Span subtest and the addition of a new subtest, Letter–Number Sequence. Digit Span evaluates the forward and backward digit spans: Sequences of random digits are presented verbally one after another, and the child is required to verbally repeat these digits in the presented order or in the reversed order. The test begins with sequences of two digits (two trials) and carries on with sequences of increasing length until a ceiling is reached, when both sequences at a given length are failed. In the second subtest (Letter–Number Sequence), the child listens to sequences of random letters and digits and repeats the digits in numerical order and then the letters in alphabetic order. PSI is the last component, including two subtests, Coding and Symbol Search. Here only the main subtests are given. Arithmetic and Information have become optional subtests; therefore, the ACID profile cannot be detected as only the main subtests of the WISC-IV are administered to a child.

Two studies on disabled children have already been conducted using the WISC-IV and are reported in the manual for the test (Wechsler, 2005). In the American version, WISC-IV has been administered to a group of 56 children aged from 7 to 13 years identified as having reading disabilities (criteria based on the fourth edition of the *Diagnostic and Statistical Manual for Mental Disorders*; *DSM-IV*). Compared to the control group, all the index scores were weaker, and the largest difference was observed for WMI (87). For the subtests, the most important differences between the two groups were obtained in Vocabulary, Information, Letter–Number Sequence, and Arithmetic, with children with reading disabilities obtaining the lowest scores. This has been interpreted as reflecting, first, the lack of knowledge usually acquired through reading and, second, low working memory in reading disabilities. In the French version, the sample was composed of 30 children with dyslexia (criteria are not precise), aged from 6 years 4 months to 12 years 11 months. In this study, all the index scores obtained by the children with dyslexia were at least one standard deviation less than the mean scores obtained by the calibration sample. There was no significant difference between the index scores (ranged from 80.0 for WMI to 85.5 for PSI). Mean scores on subtests showed more variability, with weaknesses similar to those in the American study. In our view, at least two points limit the validity of this study: the small size of the sample (N = 30) and the validity of the initial diagnosis. For example, a main concern was that some of those with dyslexia had been diagnosed at 6 years old, which is rather inconsistent with the dyslexia definition (children should have learned reading for 18 months at school). It is also surprising to obtain VCI and PRI scores at a low mean level with high standard deviations, which suggests that some children reach an extremely low level. In this condition, one can wonder whether the criterion for normal intelligence was still met.

In all, previous studies based on WISC-R and WISC-III have failed to find consistent evidence for a specific profile of children with dyslexia. Many reasons may have led to such an inconsistency. It could be that the WISC-III is unable to catch cognitive deficits specifically linked to dyslexia. Another possibility is that dyslexia is not consistently associated with a specific cognitive profile. Alternatively, cognitive profiles are more likely to emerge if dyslexia subtype is taken into account. In addition, given the instability of subtypes across time, the age of participants is also to be taken into consideration.

Thus, the present study aims at examining whether a neuropsychological profile can be identified through the WISC-IV in children with dyslexia. Providing a picture of dyslexic performance on WISC-IV would pursue clinical and theoretical objectives: supporting the diagnosis discussion, orienting clinical practices, and eventually examining theoretical points of view. To explore more precisely the link between IQ profile and reading disabilities, dyslexia subtypes and the age of participants have been considered.

Method

Participants

Children were patients consulting for learning disabilities and assessed at the Regional Center for Learning Disabilities Diagnosis in northern France (socioeconomic status is varied). All were native French speakers and attended school regularly.

Their diagnoses of developmental dyslexia were based on *DSM-IV* criteria and the use of both clinical interview and testing procedures. Standard test criteria were (a) a reading age at least 18 months lower than expected according to chronological age, (b) a score more than two standard deviations below the average on tests of word or pseudo-word reading on either accuracy or speed, and (c) PRI or VCI score on WISC-IV greater than 80 to exclude global intellectual difficulties.

The interview with the parents suggested a significant impact of reading disabilities on school performance and the need for pedagogic help. Participants were free from any medical treatment. They had normal or corrected to normal visual acuity. Children presenting with attention-deficit/hyperactivity disorder (ADHD), a specific language impairment (SLI), an anxiety disorder, or a neurological or psychiatric disease were excluded.

A total of 60 children with dyslexia (15 girls, 45 boys) were included according to the inclusion and exclusion criteria. They ranged in age from 8 years 1 month to 16 years 1 month ($M = 11$ years 4 months, $SD = 2$ years). Their grade level ranged from 2nd grade to 10th grade. None of them attended special schools. A total of 39 had repeated a grade 2 had repeated two grades, and 19 had no delay at school.

The mean reading delay, comparing the reading age from the "L'Alouette" standardized reading test (Lefavrais, 1967) and the chronological age, was 46 months ($SD = 18$; range = 18–98).

Dyslexia subtypes were established with the pseudo-word and irregular word scores—considering both accuracy and speed—from the ODEDYS-2 battery, a french screening test of dyslexia ("Outil de Dépistage des Dyslexies - version 2," (Jacquier-Roux, Valdois, Zorman, Lequette, & Pouget, 2005). Convergence with other tests of reading was clinically used to confirm the classification. Six children were diagnosed as with "surface dyslexia" (deficit in irregular words reading), 6 as with "phonological dyslexia" (deficit in nonword reading), and 48 as with "mixed dyslexia" (both deficits). Given the narrow subtype groups, it was not possible to further separate participants given their chronological age.

However, given the potential importance of age in the dyslexic profile, a separate analysis was conducted while considering younger and older participants. For this purpose, the sample was divided by median age into two groups: a "child group" of 31 participants, mean age of 9 years (from 8 years 1 month to 11 years 5 months), and a "teenager group" of 29 participants, mean age of 13 years (from 11 years 5 months to 16 years 1 month). Table 2 presents the main characteristics of the sample.

Tests

All the children were administered the WISC-IV (Wechsler, 2005) to assess cognitive abilities. Reading disability was assessed with the French reading test L'Alouette, which yields a reading age (Lefavrais, 1967) and two indexes of accuracy and speed when reading a text (revised version; Lefavrais, 2005). Word recognition procedures were assessed with the ODEDYS-2 test (Jacquier-Roux et al., 2005). Series of 20 regular words, 20 irregular words, and 20 nonwords are presented to be read aloud. Both accuracy and speed are taken into account. This test is used to subdivide the reading profile of participants (viz., displaying phonological, surface, or mixed dyslexia).

Complete evaluations were carried out using assessments of reading comprehension of sentences and text and spelling of a dictation of words and text (L2MA, "Langage oral et écrit, Mémoire et Attention", test of oral and written language, memory and attention—Chevrie-Muller, Simon, & Fournier, 1997; ANALEC, "Analyse de la lecture", reading analysis—Inizan, 1998; ODEDYS-2—Jacquier-Roux et al., 2005; LMC-R, "Lecture de mots et Compréhension - Révisée", words reading and comprehension test-revised—Khomsi, 1999; ECL, "Evaluation des Compétences linguistiques écrites", evaluation of written linguistic capacities—Khomsi, Nanty, Parbeau-Guéno, & Pasquet, 2005). These last tests, which are not further considered, aimed at broadly analyzing reading abilities.

Oral language abilities were assessed using French batteries (N-EEL, "Nouvelles Epreuves pour l'Examen du Langage", new tests for examining language-Chevrie-Muller & Plaza, 2001; EVIP, "Echelle de Vocabulaire en Images Peabody", french version of the "Peabody Picture Vocabulary Test-Revised"—Dunn, Theriault-Whalen, & Dunn, 1993; ELO, "Evaluation du Langage Oral", oral language evaluation—Khomsi, 2001; ECOSSE, "Epreuve de Compréhension

Table 2. Characteristics of the Sample of 60 French Children With Dyslexia (Whole Group and Distinction Between Two Age Groups)

	Chronological Age (years, months)		Reading Delay With L'Alouette Test in Months		ODEDYS-2 Score							
					Pseudo-Words Reading z Score[a]				Irregular Words Reading z Score[a]			
					Accuracy		Time		Accuracy		Time	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Whole group (*N* = 60)	11, 5	2, 0	46	18	–2	1.6	3.1	4	–1.9	1.1	3.4	3.2
Range	8, 1 to 16, 1		18 to 98		–6 to 0.9		–0.7 to 23		–3.8 to 0.8		–0.3 to 12	
Age groups												
Child (*n* = 31)	9, 10	0, 11	32	8	–2.2	1.6	2.9	4.4	–2.2	0.9	3.3	3.2
Range	8, 1 to 11, 4		18 to 46		–4.8 to 0.9		–0.7 to 23		–3.8 to 0.8		–0.3 to 12	
Teenager (*n* = 29)	13, 1	1, 3	61	14	–1.8	1.7	3.3	3.6	–1.7	1.3	3.5	3.3
Range	11, 6 to 16, 1		37 to 98		–6 to 0.5		0.5 to 17		–3.7 to 0.5		–0.1 to 11.7	

Note: ODEDYS-2 = "Outil de Dépistage des dyslexies", french screening test of dyslexia.
[a]z score is given because items differ according to class level (one list for second grade, another list for third to seventh grade).

Syntaxico-Sémantique", syntaxic and semantic comprehension test—Lecocq, 1996). Several subtests of the NEPSY, Neuropsychological battery for children (Korkman, Kirk, & Kemp, 2003) assessed selective and divided attention. These tests were used to exclude SLI and ADHD. The neuropediatric clinical interview and examination searched for neurological and psychiatric diseases.

Procedure

Children completed a multidisciplinary evaluation over a day, led by a neuropediatrist, a speech therapist, and a psychologist. For the present study, children were selected from the database obtained from an epidemiologic study conducted from October 2005 to May 2006 and from October 2006 to April 2007 (Bourgois, 2008). Children who received a diagnosis of developmental dyslexia and underwent the main subtests of the WISC-IV at the center (battery administered by experimented psychologists) were included.

Results

Descriptive Data

Raw scores obtained from the WISC-IV were converted to age-scaled scores using tables in the WISC-IV administration and scoring manual (standard scores for subtest $M = 10$, $SD = 3$; standard scores for index $M = 100$, $SD = 15$).

Two categories of scores are considered for analyses: (a) index scores, including VCI, PRI, WMI, and PSI, and (b) subtest scores, including Similarities, Vocabulary, Comprehension, Block Design, Picture Concepts, Matrix Reasoning, Digit Span, Letter–Number Sequence, Coding, and Symbol Search.

Before examining descriptive data from WISC-IV, it is important to draw special attention to the VCI and PRI. Indeed,

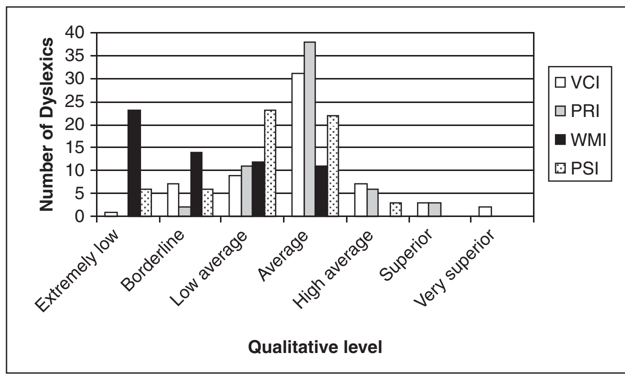

Figure 1. Number of children with dyslexia (out of 60) as a function of the qualitative level on the *Wechsler Intelligence Scale for Children* index scores

these indexes played a specific role in the selection of the participants because a poor reader was excluded from the dyslexic group if both VCI and PRI were less than 80. As a result, there could be, in our sample, some children who displayed a borderline or extremely low level on one of these indexes (Figure 1).

Concerning verbal and reasoning capacities, 8 children had a VCI less than 80 (7 at a borderline level, over 73; 1 extremely low, at 59), and 2 other children had a PRI less than 80, equal to 79. Thus, our sample included very few children who displayed a borderline or extremely low level on only one index among VCI and PRI. Results from the whole group are presented in Table 3.

The VCI and PRI scores fell within the average level (96.5 and 96.8, respectively), the PSI scores fell within a low average level (86.4), and the WMI scores fell at a borderline level (75.3). For VCI, the three main subtests stayed at an average level, as mean standard scores ranged from 9.0 to 9.9. Among the three subtests composing the PRI,

Table 3. Mean Scores Obtained by the Group Made of 60 French Children With Dyslexia on the *Wechsler Intelligence Scale for Children*

	Score		
Index and Subtests	*M*	*SD*	Qualitative Level
Verbal Comprehension Index	96.5	14.6	Average
Similarities	9.6	3.2	
Vocabulary	9.0	2.7	
Comprehension	9.9	3.5	
Perceptual Reasoning Index	96.8	11.4	Average
Block Design	9.7	3.1	
Picture Concepts	9.7	2.7	
Matrix Reasoning	9.3	1.8	
Working Memory Index	75.3	12.9	Borderline
Digit Span	6.0	2.6	
Letter–Number Sequence	5.5	2.6	
Processing Speed Index	86.4	13.4	Low average
Coding	7.2	2.8	
Symbol Search	8.1	3.0	

mean scores also remained within an average range (from 9.3 to 9.7). For WMI, the two subtests joined a low average level (Digit Span = 6.0, Letter–Number Sequence = 5.5). For PSI, Symbol Search fell within the average level, with a score of 8.1, whereas Coding, with a score of 7.2, was near a low average level.

Statistic Analysis

We compared on one hand the index scores and on the other hand the subtest scores; an ANOVA was run to evaluate between-age-group differences. Post hoc least significant difference pairwise comparisons (Newman–Keuls test) were then performed to contrast the scores. To compare the profile in function of the dyslexia type, within two small samples, we used a nonparametric test (Mann–Whitney). For all tests, the alpha level was set at $p = .05$.

There were great differences among the four index scores, ANOVA, $F(3, 174) = 45.85$, $p < .01$, $\eta^2 = .44$. Post hoc pairwise comparisons showed that the WMI score was weaker than the three other index scores and that the PSI score was lower than the VCI and PRI scores ($p < .01$). There was no difference between those last indexes (Figure 2).

Further analyses aimed at comparing the level of achievement on the 10 subtests. ANOVA indicates great differences between the standard scores at subtests, $F(9, 522) = 23.84$, $p < .001$, $\eta^2 = .29$). Newman–Keuls tests indicate that differences between Digit Span, Letter-Number Sequence, and Coding on one hand and all others subtests on the other hand are significant ($p < .01$), except the difference between Coding and Symbol Search. Digit Span, Letter–Number Sequence, and Coding have the lowest scores Figure 3.

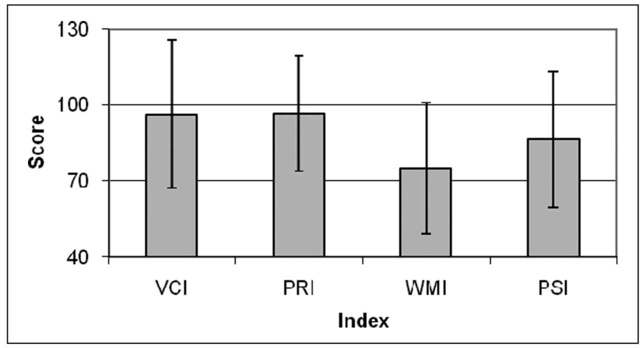

Figure 2. Mean index scores on the *Wechsler Intelligence Scale for Children* for 60 children with dyslexia (± 2 *SD*)

Group analysis revealed a weakness for the WMI and PSI and for the Digit Span, Letter–Number Sequence, and Coding subtests. Making a visual inspection, we looked at each child with dyslexia for the presence of such a profile as found in the group to know how often these weaknesses were observed in the individual data.

Several comparisons were made, particularly looking if the score on a subtest was equal to or lower than the lowest of the other subtests. This analysis, conducted as per Thomson's (2003) work, might help to find consistencies in the dyslexia profile without considering parametric values but alternatively a relative order of achievement of indexes or subtests.

Table 4 shows the number and the percentage of children with dyslexia in our sample showing some profile based on order of achievement. These orders were extracted from the group analysis. For each comparison we calculated the probability of obtaining this arrangement. For example, there was 1 chance out of 10 to obtain the weaker score on one particular subtest. There was 1 chance out of 720 to obtain an arrangement of weakness on three particular subtests ($10 \times 9 \times 8$), which means 0.1 out of 100. Following this we compared the percentage listed in our sample (observed frequency) to the chance level (theoretical frequency), using binomial law. Values reported in Table 4 clearly show that these orders of achievement were above the chance level among participants with dyslexia.

Of the sample, 68% had a WMI lower than the other index scores. Concerning the subtests, for 57 of 60 participants, the lowest performance was observed for Digit Span, Letter–Number Sequence, or Coding. However, these three subtests were together poorly performed for only 12 children.

We then focused on the 12 children who presented a dissociated reading profile: 6 displayed a phonological dyslexia, 6 displayed a surface dyslexia. We first used the nonparametric Mann–Whitney *U* test to compare these small groups before analyzing individual profiles.

When comparing the index scores, the only significant difference concerned the WMI ($z = -2.66$, $p < .05$), which was lower in the group with phonological dyslexia than in

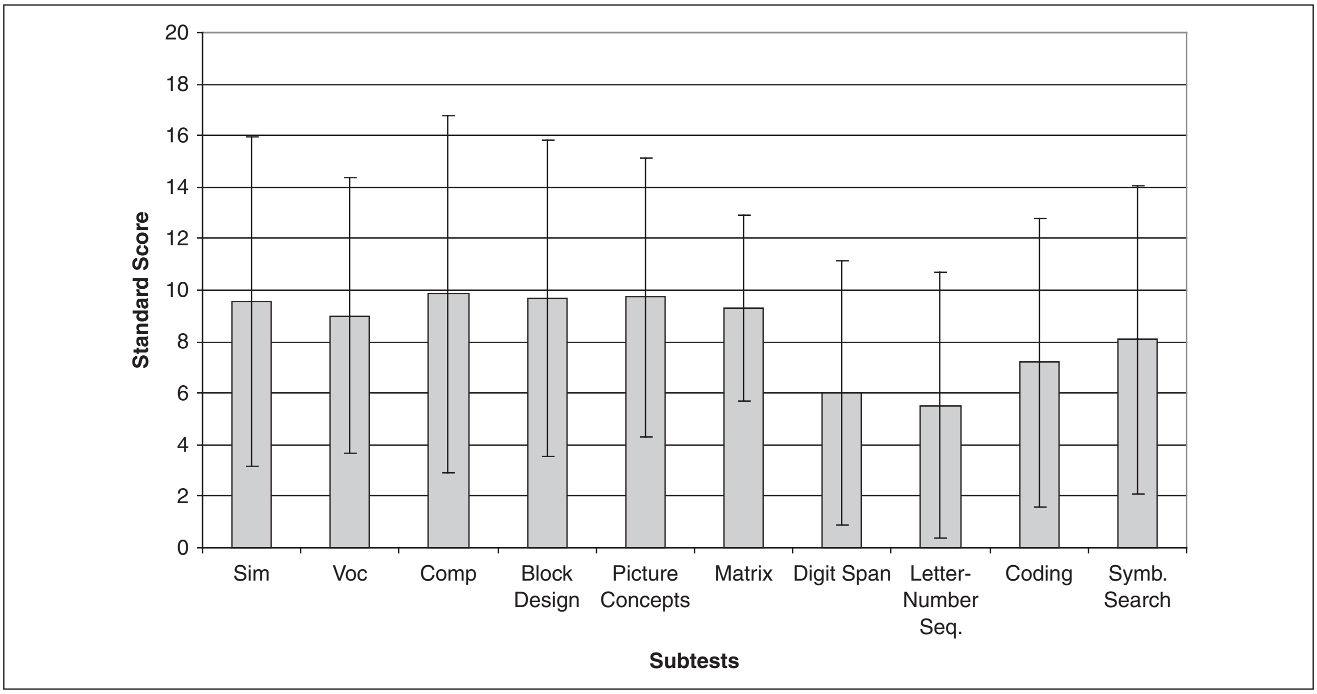

Figure 3. Mean subtest scores on the *Wechsler Intelligence Scale for Children* for 60 children with dyslexia (± 2 *SD*)

Table 4. Percentages of Some Subtest, or Index, Discrepancies

Order of Achievement	*n*	Observed (%)	Chance Level (%)	*p*
Digit Span ≤ lowest of the 9 other subtest scores	18	30.0	10.0	*
Letter-Number Seq. ≤ lowest of the 9 other subtest scores	25	42.0	10.0	*
Coding ≤ lowest of the 9 other subtest scores	14	23.0	10.0	*
Digit Span and Letter-Number Seq. ≤ lowest of the 8 other subtest scores	21	35.0	1.1	*
Digit Span, Letter-Number Seq., and Coding ≤ lowest of the 7 other subtest scores	12	20.0	0.1	*
WMI ≤ lowest of the 3 other index scores	41	68.0	25.0	*
WMI and PSI ≤ lowest of the 2 other index scores	37	62.0	8.3	*

Note: WMI = Working Memory Index; PSI = Processing Speed Index.
*$p < .05$.

the group with surface dyslexia. Furthermore, performance of the phonological subgroup fell to the pathologic level (69.5), whereas the surface group performed within the normal range (85.5). At the individual level, all of those with phonological dyslexia performed WMI as the lowest index; this weakness on WMI was obtained by only one of six children with surface dyslexia (Figure 4).

The comparison among the subtest scores shows differences for two tests only. The group with phonological dyslexia obtained lower scores than the group with surface dyslexia on Digit Span (5.50 8.50; $z = -2.02$, $p < .05$) and on Letter–Number Sequence (4.17 < 6.67; $z = -2.16$, $p < .05$).

Concerning the eventual influence of age on the profile, we remind readers that the whole group was split into two subgroups by median age. The ANOVA revealed no main effect of group age on the index or on the subtest scores, $F(1, 58) < 1$. There was no interaction effect between the age group and the index score, $F(3, 174) = 1.47$, $p > .05$, $\eta^2 = .03$, nor between the age group and the subtest scores, $F(9, 522) = 1.22$, $p > .05$, $\eta^2 = .02$.

Discussion

The main purpose of the present study was to examine the WISC-IV profile of French children with dyslexia. Therefore, several objectives were pursued. First, the study aimed at providing a picture of a dyslexic pattern on the WISC-IV test. WISC could be used to point out strengths and weaknesses in cognitive development. Second, more focused analyses aimed at determining discrepancies in the profile across dyslexia subtype. Third, the study aimed at

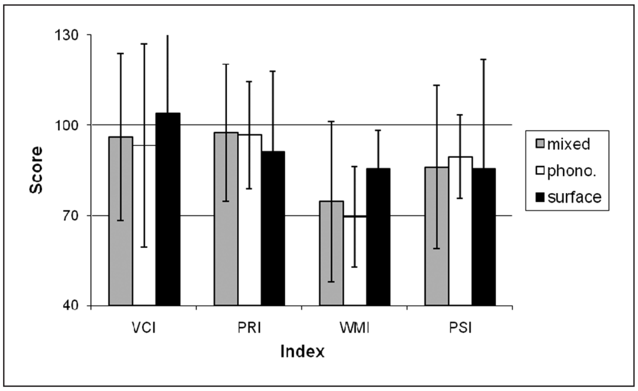

Figure 4. Mean index scores as a function of the type of dyslexia
Note: mixed $n = 48$; phonological $n = 6$; surface $n = 6$.

examining the impact of age on dyslexic profile. Reading profile may be differently associated with cognitive functioning (Stanovich et al., 1997). The question raised is to know whether WISC-IV is or is not able to catch them. Implications for both assistance with diagnosis and theoretical analysis may be discussed.

The most striking result lies in the discrepancy among the four indexes. Although VCI and PRI were very close to the mean, on the contrary WMI was very close to the limit of deficiency, whereas PSI had an intermediate position. This illustrates the lack of deficiencies in many parts of the cognition in dyslexia and the presence of more focused disabilities strongly associated with dyslexia.

In particular, analyses of subtests display strong deficiencies in Digit Span and Letter–Number Sequence and to a lesser extent in Coding. Besides, one of these three subtests was the lowest (in terms of order of achievement) for almost all of the participants. WMI is the lowest index score for two thirds of our sample.

Profile of the WISC-IV for Children With Dyslexia

In the introduction, we pointed out inconsistencies in the cognitive profile of those with dyslexia raised with the WISC-III. It is important to point out such inconsistencies because, in usual practice, psychologists tend to expect a discrepancy between verbal and performance scores, with a higher level of PIQ on WISC-III, and even rely on it for suspecting dyslexia. We, however, pointed out in our review that such discrepancy was far from systematic. Thus, we examined if the use of WISC-IV improves profile consistency.

The use of WISC-IV showed no significant difference between VCI and PRI, and both stayed at an average level. We remind readers, however, that either VCI or PRI must be at a normal range to exclude mental deficiency. This is a necessary criterion for a dyslexia diagnosis.

Consequently, a strong difference for practitioners using WISC-IV after WISC-III is that it appears to have no weakness in VCI. This point is particularly important because dyslexia is frequently considered to be associated with—even slight—language impairments. The WISC-IV verbal scale fails to reveal any disability. We can propose several explanations concerning the absence of weakness on VCI on the WISC-IV comparing it to VIQ of WISC-III. Subtests that involve school knowledge, such as Information and Arithmetic, are now excluded from the main subtests. The Digit Span subtest is excluded from the verbal subtests and joins a specific WMI index. Therefore, VCI measures more homogeneously verbal expression and conceptualization. The average score suggests that reading disabilities are not systematically linked to poor language abilities. Of course, one cannot exclude the possibility that WISC subtests are not sufficiently sensitive to detect some specific difficulties that could be present in those with dyslexia. For example, the Vocabulary subtest may not have enough literary lexicon, which is supposed to be hardly acquired by children with reading disabilities. However, it confirms, as well, that a high level of language processes can be normally developed in dyslexia (Vellutino et al., 2004).

It has been shown that PRI stays at an average level, just as with the WISC-III Performance Scale. Indeed, spatial abilities have been shown to be efficient (Bannatyne, 1974).

Perhaps the most obvious contribution of WISC-IV is to give a separate index for Working Memory, as it has been consistently found to be impaired in children with dyslexia (Jeffries & Everatt, 2004; Swanson, 1999). The introduction of the PSI is interesting as well when considering dyslexia. In the Coding subtest, there is a slight impairment in dyslexia. This result consolidates previous results in the literature (coding composed the ACID and SCAD profiles of WISC-III).

Finally, it is important to examine whether age modifies the cognitive profile as displayed by the WISC-IV. Results at the average level on VCI and PRI are consistent across child and teenager cohorts: The comparison of two groups of different ages does not show weaker VCI with teenagers than with children. Even though our cross-sectional study prevents us from concluding, we can refer to a longitudinal study (Thomson, 2003) examining 250 children attending a specialist school for dyslexic children. At least two years after the children joined the school, the results at Wechsler scales did not show any drop-off effect in intelligence. This suggests that the intellectual capacities drop-off can be circumvented with appropriate help. Today, children with dyslexia often benefit from a specific reeducation with speech therapists and from pedagogic help at school (Coste-Zeitoun et al., 2005).

Cognitive Deficits in Dyslexia

One of the objectives was to examine whether use of WISC-IV could help in identifying cognitive impairments in dyslexia. Two specific points have been discussed in the previous literature: phonological working memory and speed processing.

First, working memory has for a long time been acknowledged as a strong impairment in dyslexia. In this group of children with dyslexia, the weakness appears to lie in the WMI, with values at a borderline level and significantly below those of the other indexes. Such a result was expected and is congruent with those obtained with WISC-R and WISC-III (Spafford, 1989; Thomson, 2003; Vargo, Grosser, & Spafford, 1995). Because of the presence of WMI, using WISC-IV allows researchers to identify more clearly this deficit in short-term verbal recall. This weakness was frequently observed in our sample at an individual level: nearly 70% of our children with dyslexia showed their lowest index score for WMI. This profile was observed in all of those with phonological dyslexia and rarely in those with surface dyslexia. The literature has given lots of evidence of a phonological deficit in dyslexia (for a review, see Snowling, 2000). This phonological deficit leads to poor verbal memory scores. Besides, 30% of our sample did not show a particular weakness in working memory capacities. Even if a phonological memory deficit is frequent in dyslexia, it is not always present.

Second, the speed of processing has been pointed to as a potential cause of dyslexia (Wolf & Bowers, 1999). PSI was at a mean low level, weaker than VCI and PRI. Looking with the scale, the weakness of PSI is explained by the weakness on the Coding subtest, whereas Symbol Search was normally performed. The difference between levels of achievement on these two subtests is not in favor of a global slowing down for information processing.

In the literature concerning speed processing, there is a debate. According to Wolf and Bowers (1999), speed of processing is impaired in those with dyslexia, but the findings of a recent study (Bonifacci & Snowling, 2008) showed that dyslexia could arise in the context of normal speed of processing. Our results join Bonifacci and Snowling's position.

It however remains to account for the difference observed between performance on Coding and Symbol Search. Coding and Symbol Search involve both visual serial scanning, but Coding also implicates graphic movement. Whitehouse (1983) specifically studied the performance on this subtest of WISC-R. Those with dyslexia performed significantly more poorly than the normal readers on the Coding subtest and on a writing speed task but showed no evidence of impaired memory for the number or symbol associates. A second explanation is based on the possible strategy that can be used: encoding some signs verbally could solicit short-term memory (Thomson, 2003). Indeed, in normal development, working memory and processing speed are strongly linked (Fry & Hale, 2000).

Effect of the Subtype of Dyslexia

An important question that curiously has not been deeply assessed is the difference between those with surface and phonological dyslexia in the WISC profile. Although the question of the cognitive profile of those with dyslexia has already been examined (Sprenger-Charolles et al., 2001; Stanovich et al., 1997), it has not been, to our knowledge, considered through the use of WISC.

In our study, subtypes strongly differed on WMI; no other differences were significant. However, we checked the presence of impairment at the individual level and observed that although six of six of those with phonological dyslexia exhibited a working memory deficit, one of six of those with surface dyslexia displayed such deficit. Most of those with dyslexia have a mixed profile, making it difficult to get substantial groups including contrasted subtypes. However, broader samples are necessary to draw conclusions. Our study suggests that although working memory impairment is more frequent (even systematically associated) in phonological dyslexia, it also could be associated with surface dyslexia. No other difference appears.

To conclude, our study has explored the WISC-IV profile for children with dyslexia, considering alternatively both age and subtypes. Some trends have appeared, summed up by relative weakness at WMI and Coding subtest. As an exploratory study, it presents some limitations, even though it suggests implications.

Limitations and Implications

One of the limitations of our study is that the pattern of Wechsler scores found in clinical samples of children with dyslexia is not compared that of other clinical samples. Some studies illustrated the diagnostic interest of WISC-III subtest profile patterns for children with ADHD (Ek et al., 2007; Snow & Sapp, 2000) but also the inability to distinguish children with ADHD and children with learning disability from the WISC-III test or their ACID profile (Filippatou & Livaniou, 2005). Utilizing the indexes of WISC-IV may be more helpful: Mayes and Calhoun (2006) showed that all of their 118 children with ADHD scored lowest on WMI or PSI on WISC-IV.

Ek et al. (2007) have suggested that the ACID profile should be considered as a marker of potential attention problems in children. We suggested that weaknesses on Digit Span, Letter–Number Sequence, and Coding in children with dyslexia without ADHD are correlated with phonological coding and short-term memory deficits. Morris (1996, cited by Jeffries & Everatt, 2004) has advocated the possibility that these tasks involve some attention processing and are an indication of short-term memory ability. The cognitive weakness reflected in these profiles might play a role as an underlying factor shared in various developmental disorders (Ek et al., 2007; Pennington, 2006).

In clinical practice, weaknesses on the two subtests of WMI and in Coding are not sufficient criteria for diagnosing dyslexia, and the absence of this profile should not suggest a lack of dyslexia. This profile is, however, not "clinically meaningless" (Thomson, 2003). The higher incidence of the profile among those with dyslexia can be used to guide the diagnosis and should raise question about special educational needs and strategies of compensation (Closset & Majerus, 2007; Swanson, Kehler, & Jerman, 2010) concerning children with dyslexia.

Acknowledgements

Support for this work was provided by the Association for Congenital Disease Studies (AEAC), directed by Carole Beaumont.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interests with respect to the authorship and/or publication of this article.

Financial Disclosure/Funding

The authors received no financial support for the research and/or authorship of this article.

References

American Psychiatric Association. (2003). *DSM-IV-TR: Manuel diagnostique et statistique des troubles mentaux* [Diagnostic and Statistical Manual of Mental Disorders] (4th ed.). Paris, France: Masson.

Baddeley, A. D. (1986). *Working memory*. Oxford, UK: Oxford University Press.

Baddeley, A. D. (2001). Is working memory still working? *American Psychologist*, *56*, 849–864.

Bannatyne, A. (1974). Diagnosis: A note on recategorization of WISC scaled scores. *Journal of Learning Disabilities*, *17*, 272–274.

Berk, R. A. (1983). The value of WISC-R profile analysis for the differential diagnosis of learning disabled children. *Journal of Clinical Psychology*, *39*, 133–136.

Bonifacci, P., & Snowling, M. J. (2008). Speed of processing and reading disability: A cross-linguistic investigation of dyslexia and borderline intellectual functioning. *Cognition*, *107*, 999–1017.

Bourgois, B. (2008). Etude de 614 enfants évalués au Centre Régional de Diagnostic des Troubles d'Apprentissage de Lille. Mémoire de DIU de neuropédiatrie (non publié), Université Lille 2.

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

Catts, H. W., Gillipsie, M., Leonard, L. B., Kail, R. V., & Miller, C. A. (2002). The role of speed of processing, rapid naming, and phonological awareness in reading achievement. *Journal of Learning Disabilities*, *35*, 509–524.

Cheminal, R., & Brun, V. (2002). *Les dyslexies*. Paris, France: Masson.

Chevrie-Muller, C., & Plaza, M. (2001). *N-EEL: Nouvelles Epreuves pour l'Examen du Langage.* Paris, France: Editions du Centre de Psychologie Appliquée.

Chevrie-Muller, C., Simon, A. M., & Fournier, S. (1997). *Batterie Langage oral et écrit, Mémoire, Attention (L2MA)*. Paris, France: Editions du Centre de Psychologie Appliquée.

Closset, A., & Majerus, S. (2007). Short-term phonological memory reeducation: Application to a 10 years old girl. In Aubin, G., Coyette, F., Pradat-Diehl, P., & Vallat-Azouvi, C. (Eds.) *Neuropsychologia of working memory* (pp. 323–349), 2007, Marseille, France : Solal.

Coltheart, M., Rastle, K., Perry, C., Langdon, R., & Ziegler, J. C. (2001). DRC: A dual route cascaded model of visual word recognition and reading aloud. *Psychological Review*, *108*, 204–256.

Coste-Zeitoun, D., Pinton, F., Barondiot, C., Ducot, B., Warszawski, J., & Billard, C. (2005). Specific remedial therapy in a specialist unit: Evaluation of 31 children with severe, specific language or reading disorders over one academic year. *Revue Neurologique, 161*, 299–310.

Démonet, J. F., Taylor, M. J., & Chaix, Y. (2004). Developmental dyslexia. *Lancet*, *363*, 1451–1460.

Dunn, L. M., Theriault-Whalen, C. M., & Dunn, L. M. (1993). *EVIP*, *Echelle de vocabulaire en images peabody*. Toronto, Canada: PSYCAN.

Ek, U., Fernell, E., Westerlund, J., Holmberg, K., Olsson, P. O., & Gillberg, C. (2007). Cognitive strengths and deficits in schoolchildren with ADHD. *Acta Paediatrica*, *96*, 756–761.

Ellis, A. W., & Young, A. W. (1988). *Human cognitive neuropsychology*. Mahwah, NJ: Lawrence Erlbaum.

Filippatou, D. N., & Livaniou, E. A. (2005). Comorbidity and WISC-III profiles of Greek children with attention deficit hyperactivity disorder, learning disabilities, and language disorders. *Psychological Reports*, *97*, 485–504.

Fry, A. F., & Hale, S. (2000). Relationships among processing speed, working memory, and fluid intelligence in children. *Biological Psychology*, *54*, 1–34.

Galaburda, A. M., Sherman, G. F., Rosen, G. D., Aboitiz, F., & Geschwind, N. (1985). Developmental dyslexia: Four consecutive patients with cortical anomalies. *Annals of Neurology*, *18*, 222–233.

Grégoire, J. (2000). *L'évaluation clinique de l'intelligence de l'enfant. Théorie pratique du WISC III*. Liège, Belgium: Mardaga.

Griffiths, Y. M., & Snowling, M. J. (2002). Predictors of exception word and nonword reading in dyslexic children: The severity hypothesis. *Journal of Educational Psychology*, *94*, 34–43.

Harm, M. W., & Seidenberg, M. S. (1999). Phonology, reading acquisition and dyslexia: Insights from connectionist models. *Psychological Review*, *106*, 491–528.

Inizan, A. (1998). *ANALEC, Analyse du savoir lire de 8 ans à l'âge adulte*. Paris, France: ECPA.

Jacquier-Roux, M., Valdois, S., Zorman, M., Lequette, C., & Pouget, G (2005). *ODEDYS-2, outils de dépistage des dyslexies*. Grenoble, France : Laboratoire Cogni-sciences.

Jeffries, S., & Everatt, J. (2004). Working memory: Its role in dyslexia and other specific learning difficulties. *Dyslexia*, *10*, 196–214.

Kaufman, A. S. (1981). The WISC-R and learning disabilities assessment: State of the art. *Journal of Learning Disabilities*, *14*, 520–526.

Kaufman, A. S. (1994). *Intelligent testing with the WISC-III.* New York, NY: John Wiley.

Khomsi, A. (1999). *LMC-R, épreuve d'évaluation de la compétence en lecture*. Paris, France: ECPA.

Khomsi, A. (2001). *ELO: évaluation du langage oral*. Paris, France: ECPA.

Khomsi, A., Nanty, I., Parbeau-Guéno, A., & Pasquet, F. (2005). *ECL-Collège: évaluation des compétences linguistiques écrites au collège.* Paris, France: ECPA.

Korkman, M., Kirk, U., & Kemp, S. (2003). *NEPSY*. Paris, France: ECPA.

Lecocq, P. (1996). *Epreuve de Compréhension Syntaxico-Sémantique*. Villeneuve-d'Ascq, France: Presses universitaire du Septentrion.

Lefavrais, P. (1967). *Test de l'Alouette*. Paris, France: Edition du Centre de Psychologie Appliquée.

Lefavrais, P. (2005). *Test de l'Alouette, version révisée*. Paris, France: ECPA.

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

Mayes, S. D., & Calhoun, S. L. (2006). WISC-IV and WISC-III profiles in children with ADHD. *Journal of Attention Disorders*, *9*, 486–493.

Morris, R. D. (1996). Relationships and distinctions among the concepts of attention, memory and executive function: A developmental perspective. In G. R. Lyon & N. A. Krasnegor (Eds.), *Attention, memory, and executive function* (pp. 11–16). Baltimore, MD: Brookes.

Paulesu, E., Frith, U., Snowling, M., Gallagher, A., Morton, J., Frackowiak, R. S., & Frith, C. D. (1996). Is developmental dyslexia a disconnection syndrome? Evidence from PET scanning. *Brain*, *119*, 143–157.

Pennington, B. F. (2006). From single to multiple deficit models of developmental disorders. *Cognition*, *101*, 385–413.

Ramus, F., Pidgeon, E., & Frith, U. (2003). The relationship between motor control and phonology in dyslexic children. *Journal of Child Psychology and Psychiatry*, *44*, 712–722.

Ramus, F., Rosen, S., Dakin, S. C., Day, B. L., Castellote, J. M., White, S., & Frith, U. (2003). Theories of developmental dyslexia: Insights from a multiple case study of dyslexic adults. *Brain*, *126*, 841–865.

Snow, J. B., & Sapp, G. L. (2000). WISC-III subtest patterns of ADHD and normal samples. *Psychological Reports*, *87*, 759–765.

Snowling, M. J. (2000). *Dyslexia*. Oxford, UK: Blackwell.

Snowling, M. J. (2001). From language to reading and dyslexia. *Dyslexia*, *7*, 37–46.

Spafford, C. S. (1989). Wechsler Digit Span subtest: Diagnostic usefulness with dyslexic children. *Perceptual and Motor Skills*, *69*, 115–125.

Sprenger-Charolles, L., Lacert, P., Béchennec, D., Colé, P., & Serniclaes, W. (2001). Stabilité dans le temps et inter-langues dessous-types de dyslexie développementale. *Approche Neuropsychologique des Apprentissages chez l'Enfant*, *62–63*, 115–128.

Stanovich, K. E. (1986). Matthew effects in reading: Some consequences of individual differences in the acquisition of literacy. *Reading Research Quarterly*, *21*, 360–407.

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

Swanson, H. L. (1999). Reading comprehension and working memory in learning-disabled readers: Is the phonological loop more important than the executive system? *Journal of Experimental Child Psychology*, *72*, 1–31.

Swanson, H. L., Kehler, P., & Jerman, O. (2010). Working memory, strategy knowledge, and strategy instruction in children with reading disabilities. *Journal of Learning Disabilities*, *43*, 24–47.

Thomson, M. (1999). Subtypes of dyslexia: A teaching artefact? *Dyslexia*, *5*, 127–137.

Thomson, M. (2003). Monitoring dyslexics' intelligence and attainments: A follow-up study. *Dyslexia*, *9*, 3–17.

Vargo, F. E., Grosser, G. S., & Spafford, C. S. (1995). Digit span and other WISC-R scores in the diagnosis of dyslexia in children. *Perceptual and Motor Skills*, *80*, 1219–1229.

Vellutino, F. R., Fletcher, J. M., Snowling, M. J., & Scanlon, D. M. (2004). Specific reading disabilities (dyslexia): What have we learned in the past four decades? *Journal of Child Psychology and Psychiatry*, *45*, 2–40.

Watkins, M. W., Kush, J. C., & Glutting, J. J. (1997). Discriminant and predictive validity of the WISC-III ACID profile among children with learning disabilities. *Psychology in the Schools*, *34*, 309–319.

Wechsler, D. (1981). *WISC-R. Echelle d'intelligence de Wechsler pour enfants—édition Révisée.* Paris, France: ECPA.

Wechsler, D. (1996). *WISC-III. Echelle d'intelligence de Wechsler pour enfants—Troisième édition.* Paris, France: ECPA.

Wechsler, D. (2005). *WISC-IV. Echelle d'intelligence de Wechsler pour enfants—Quatrième édition.* Paris, France: ECPA.

Whitehouse, C. C. (1983). Analysis of WISC-R coding performance of normal and dyslexics readers. *Perceptual and Motor Skills*, *57*, 951–960.

Wolf, M., & Bowers, P. G. (1999). The double-deficit hypothesis for the developmental dyslexias. *Journal of Educational Psychology*, *91*, 415–438.

About the Authors

Maryse De Clercq–Quaegebeur is a psychologist specialized in neuropsychology, having a clinical practice and a searching activity in the Regional Reference Center for Learning Disabilities Diagnosis (CRDTA), in Lille Regional and Universitary Hospital Center (CHRU). Her current interests include learning disabilities (dyslexia and dyscalculia).

Séverine Casalis, PhD, is a professor of cognitive psychology, in the URECA Laboratory, University of North France. Her research interests include learning to read (linguistic awareness, morphology, orthography) and developmental dyslexia.

Marie-Pierre Lemaitre, PhD, is a neuropediatrist coordinating the CRDTA. Her current interests include learning disabilities and neurodevelopmental diseases.

Béatrice Bourgois, PhD, is a neuropediatrist working in the CRDTA and in the Urgency Paediatrics Service in Roubaix Hospital Center. She made an epidemiologic study in the CRDTA. Her current interests include neurodevelopmental diseases and learning disabilities diagnosis.

Marie Getto is a student in neuropsychology, interested in dyslexic children.

Louis Vallee, MD, is a professor of pediatrics in the University of North France, leader of the service of neuropediatrics in Lille, CHRU. His current interests are neurodevelopmental diseases, epileptologia, learning disabilities.