Learning Disabilities and ADHD:
Overlapping Spectrum Disorders

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Abstract

Clinical and psychoeducational data were analyzed for 119 children ages 8 to 16 years who were evaluated in a child diagnostic clinic. A learning disability (LD) was present in 70% of the children with attention-deficit/hyperactivity disorder (ADHD), with a learning disability in written expression two times more common (65%) than a learning disability in reading, math, or spelling. Children with LD and ADHD had more severe learning problems than children who had LD but no ADHD, and the former also had more severe attention problems than children who had ADHD but no LD. Further, children with ADHD but no LD had some degree of learning problem, and children with LD but no ADHD had some degree of attention problem. Results suggest that learning and attention problems are on a continuum, are interrelated, and usually coexist.

Previous research has indicated high comorbidity for learning disabilities (LD) and attention-deficit/hyperactivity disorder (ADHD) in children. In referred samples of children with ADHD, estimates of the prevalence of LD ranged from 15% to 50% for reading (August & Garfinkel, 1990; Barkley, 1990; Lambert & Sandoval, 1980; Livingston, Dykman, & Ackerman, 1990; Semrud-Clikeman et al., 1992), to 24% to 60% for math (Barkley, 1990; Lambert & Sandoval, 1980; Semrud-Clikeman et al., 1992), to 24% to 60% for spelling (Barkley, 1990). Overall, according to Barkley (1994), 25% to 50% of children with ADHD have LD.

A review of studies citing prevalence rates for LD in children with ADHD revealed many methodological inconsistencies and problems. According to Sattler (1988, p. 607), a discrepancy between IQ and achievement test scores is the most conventional and widely used indicator of LD. However, the definition of LD varied from study to study, and individual discrepancy scores were not always used in the determination of LD (e.g., Graham, 1990; Korkman & Pesonen, 1994; Robins, 1992).

According to S. E. Shaywitz and Shaywitz (1993), it is best to use a regression equation when calculating the IQ–achievement discrepancy, otherwise children with high IQs are overidentified as having LD and children with low IQs are underidentified as having LD. Similarly, the Wechsler Individual Achievement Test (WIAT) manual (Psychological Corp., 1992) recommends using the regression-based predicted-achievement method (versus the simple-difference method) to diagnose LD "because of the importance of eliminating potential bias in identification of learning disabled children" (p. 191). Although the LD/ADHD prevalence studies reviewed did use an IQ–achievement discrepancy as all or part of the definition of LD, none used a regression equation (August & Garfinkel, 1990; Barkley, 1990; Lambert & Sandoval, 1980; Livingston et al., 1990; Semrud-Clikeman et al., 1992).

A major limitation of research investigating the prevalence of LD in children with ADHD is that none of the studies assessed children for LD in written expression. It has been recognized for quite some time that children with LD frequently have difficulty with writing (Bruck, 1985; Graham, 1990; Griffey, 1986; Keefe & Candler, 1989; Kerchner & Kistinger, 1984; Poplin, Gray, Larsen, Banikowski, & Mehring, 1980). Writing problems are also relatively common in the general population. Hooper et al. (1993) reported that 20% to 51% of 1,274 students in three middle schools scored 1 standard deviation or more below the mean on the spontaneous writing sample from the Test of Written Language–2 (Hammill & Larsen, 1988). Hooper et al. (1993) concluded that school psychologists should "become more aware of the significant number of students who may be experiencing writing output problems" (p. 620). A common practice in LD prevalence studies is to use the Wide Range Achievement Test–Revised (Jastak & Jastak, 1985), which provides an assessment of basic reading (decoding of single words), math, and spelling but not an assessment of composition, written expression skills, or reading comprehension. In some studies (e.g., Lambert & Sandoval, 1980; Semrud-Clikeman et al., 1992) only reading and math subtests were used to determine LD; therefore, children with learning disabilities in written expression but

not reading or math were incorrectly classified as not having LD.

One purpose of our study was to rectify previous methodological problems and investigate the comorbidity of learning disabilities with ADHD by using current and comprehensive IQ and achievement tests. All children in the study were administered the Wechsler Intelligence Scale for Children–III (WISC-III; Wechsler, 1991) and the WIAT. The WIAT was chosen because scores are derived from the same normative sample as the WISC-III. Therefore, scores on the WISC-III and WIAT are directly comparable, which is not possible using other measures of academic achievement. All major academic areas were assessed, including basic reading, reading comprehension, math, spelling, and written expression. The WIAT Written Expression subtest is comprehensive and analyzes compositional writing skills. The child's composition is scored for ideas and development, organization, vocabulary, sentence structure, grammar, capitalization, and punctuation. Further, our study included a contrast group of referred children without ADHD, so that differences in LD types and frequencies in clinical children with and without ADHD could be determined. Last, differences in the magnitude of learning problems between children in four diagnostic subgroups (ADHD and LD, ADHD without LD, LD without ADHD, and no ADHD or LD) were analyzed to determine if children with ADHD had some degree of learning problem, even if they did not meet the diagnostic criteria for LD.

In addition to investigating learning problems in children with ADHD, our study assessed attention problems in children with LD. Previous research (Mayes, Calhoun, & Crowell, 1998a, 1998b) has suggested that children with LD have difficulty with attention even if they do not meet the diagnostic criteria for ADHD. This is supported by studies showing that children who have LD but not ADHD have attention deficits as indicated by teacher rating scales (Barkley & Grodzinsky, 1994) and psychometric measures of attention, such as continuous performance tests (Dainer et al., 1981; Robins, 1992; Swanson, 1981, 1983; Tarnowski, Prinz, & Nay, 1986). However, other continuous performance studies have failed to show attention problems in children with LD (Aylward, Verhulst, & Bell; 1990; Barkley, Grodzinsky, & DuPaul, 1992; Samuels & Miller, 1985). Our study addressed these equivocal findings by using two independent measures of attention to quantify attention problems in the four diagnostic subgroups: LD and ADHD, LD without ADHD, ADHD without LD, and no LD or ADHD.

Method

Procedure and Inclusion Criteria

The study involved children 8 to 16 years of age referred to diagnostic clinics at a university-affiliated department of psychiatry and a rehabilitation center. Most children were referred because of learning, attention, mood, and/or behavior problems. All children in the study underwent lengthy clinical evaluations by a psychologist and by a child psychiatrist or developmental pediatrician. The psychological evaluation included the administration of the WISC-III, the WIAT, and a computerized continuous performance test (Gordon, 1983); a child interview using a standardized self-report scale developed for the clinics; clinical observations of the child during the evaluation; an analysis of parent and teacher questionnaires and rating scale data from the Pediatric Behavior Scale (Lindgren & Koeppl, 1987) or the Child Behavior Checklist and Teacher's Report Form (Achenbach, 1991a, 1991b); and a review of historical data, including school records from kindergarten to the present, previous evaluations, and the child's developmental history. The psychiatric and pediatric evaluations involved a semistructured interview with the parents and with the child (including an assessment of the child's history and current symptoms), clinical observations of the child, a review of records, and an analysis of the rating scales and questionnaires completed by the parents and teachers. Diagnoses were based on criteria in the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV*; American Psychiatric Association, 1994). If a consensus regarding the child's diagnosis was not reached between the psychologist and the psychiatrist or pediatrician, the child was not included in the study.

All children evaluated in the clinics were eligible for the study if (a) they earned a WISC-III Full-Scale IQ (FSIQ) of 80 or above, (b) they were administered the WIAT Basic Reading, Reading Comprehension, Numerical Operations, Spelling, and Written Expression subtests, (c) they did not have psychosis, autism/pervasive developmental disorder, bipolar disorder, significant hearing or visual loss, or frank neurological impairment (e.g., spina bifida, cerebral palsy, or closed head injury), and (d) there was a definitive *DSM-IV* diagnosis agreed upon by the psychologist and psychiatrist or pediatrician. Further, children with an attention deficit without impulsivity and without hyperactivity were excluded so that children in the ADHD subgroup all had the ADHD combined type.

A diagnosis of LD was made if one or more of the WIAT subtest scores was significantly lower ($p < .05$) than predicted based on the FSIQ, using the procedure specified in the WIAT manual. This is consistent with educational guidelines in the authors' state that define LD as a severe discrepancy between intelligence and academic achievement in children who have an IQ of 80 or higher (Pennsylvania Department of Education, 1994). All test data were independently rescored by a second psychologist, and discrepancies were discussed and resolved by the two psychologists.

Participants

The number of children meeting the criteria for inclusion in the study was 119. Mean age was 11.1 years (range 8 to 16) and mean FSIQ was 103.9 (range 81 to 144). The male-to-female ratio was 93:26, and 114 of the children were White. Professional or managerial positions were held by 42.6% of mothers and 43.0% of fathers. For mothers, 54.3% had an education beyond high school; for fathers it was 54.5%. In the total sample, 61.3% of the children met the criterion for LD, and 72.3% met the *DSM-IV* criteria for ADHD combined type. For the remaining children who did not have ADHD, 11.8% had no major *DSM-IV* mood or behavior disorder, 10.1% had a mood disorder alone (e.g., anxiety or depression), 5.9% had a mood and behavior disorder, and 0% had only a behavior disorder (e.g., oppositional defiant or conduct disorder).

Instruments

Data analyzed in the study were derived from the WISC-III (FSIQ and Freedom from Distractibility, Verbal Comprehension, and Perceptual Organization Index scores), the WIAT, and the Gordon Diagnostic System (GDS; Gordon, 1983). The GDS is a portable, electronic, continuous performance test designed to measure attention. Studies have shown significant GDS differences between children with and without ADHD (Barkley, DuPaul, & McMurray, 1990; Barkley & Grodzinsky, 1994; Barkley et al., 1992; Gordon, 1979; Gordon & McClure, 1983; Grodzinsky & Barkley, 1999; Grodzinsky & Diamond, 1992; Mariani & Barkley, 1997; Mayes, Calhoun, & Crowell, 1998c; McClure & Gordon, 1984). Significant congruence between the GDS and other measures of attention (such as performance tests, rating scales, behavioral observations, and clinical diagnoses) has also been demonstrated (Barkley 1991; Fischer, Newby, & Gordon, 1995; Gordon, DiNiro, Mettelman, & Tallmadge, 1989; Gordon & McClure, 1983; Gordon & Mettelman, 1987; Loge, Staton, & Beatty, 1990; Mayes et al., 1998c; Mayes & Calhoun, 1998; McClure & Gordon, 1984). Recent research (Mayes et al., 1998c) suggested that the highest accuracy rate for diagnosing children with and without ADHD was achieved when the GDS composite standard score was compared to the child's IQ (i.e., IQ–GDS difference score). In the present study, both the IQ–GDS difference score and the IQ–FDI (Freedom from Distractibility Index) difference score were used as measures of attention. A study by the authors (Mayes et al., 1998a) showed that IQ–FDI differed significantly between children with and without ADHD in a sample of 194 referred children, and the study provided support for interpreting the FDI as a measure of attention.

Data Analyses

Differences in LD frequencies between children with and without ADHD were analyzed using a chi square or, for cell frequencies less than 5, Fisher's exact probability estimate. The sign or binomial test was used to determine the significance of the pattern of differences in WIAT subtest scores between children with and without ADHD and with and without LD. Pearson product-moment correlation coefficients were calculated to investigate the relationship between the IQ–WIAT discrepancy score (using the mean of the WIAT reading, writing, and math scores) and an attention deficit as indicated by the IQ–FDI and IQ–GDS discrepancy scores. Differences among the four ADHD/LD subgroups on the IQ–WIAT, IQ–GDS, IQ–FDI, IQ–VCI (Verbal Comprehension Index), and IQ–POI (Perceptual Organization Index) discrepancy scores were investigated using a one-way analysis of variance (ANOVA). A 2×2 ANOVA was used to determine the main and interaction effects of ADHD and LD on the discrepancy scores. Age and IQ were entered as covariates in the ANOVAs because of some significant differences in age ($F = 7.41$, $p < .0001$) and IQ ($F = 3.84$, $p = .012$) among the four ADHD/LD subgroups. To indicate the magnitude of effect or strength of relationship between ADHD/LD diagnoses and the five study variables (IQ–WIAT, IQ–GDS, IQ–FDI, IQ–VCI, and IQ–POI), an adjusted R^2 was calculated. One-tailed tests of significance were used for learning and attention data in the ADHD and LD groups because we hypothesized that children with LD have attention problems and children with ADHD have learning problems. All other tests of significance were two-tailed.

Results

LD Frequency in Children With and Without ADHD

The presence of one or more type of LD was more common in the 86 children with ADHD (69.8%) than in the 33 children without ADHD (39.4%), $\chi^2 = 9.28$, $p = .001$. This was primarily because of the disproportionate number of children with LD in written expression (ADHD, 65.1%; without ADHD, 27.3%, $\chi^2 = 13.78$, $p = .0001$) and spelling (ADHD, 30.2%; without ADHD, 6.1%, Fisher = 8.45, $p = .002$). Although learning disabilities in math (numerical operations) and reading (basic reading or reading comprehension) were more prevalent in children with ADHD than in children without ADHD, the differences in frequencies were not significant, $\chi^2 = 2.08$, $p = .075$, and $\chi^2 = 0.39$, $p = .267$, respectively.

LD Prevalence and Types

For the 86 children with ADHD, 26.7% had an LD in basic reading or reading comprehension, 31.4% had an LD in numerical operations, and 30.2% had an LD in spelling. In contrast, more than twice as many (65.1%) had an LD in written expression. The proportion of children with an LD in basic reading (19.8%) was equal to that for reading comprehension (19.8%). Among children with ADHD, 69.8% had an LD in

one or more areas. Conversely, 82.2% of the 73 children with an LD had ADHD.

IQ–Achievement Discrepancies

Children with ADHD who did not meet the criterion for LD in any area (n = 26) performed more poorly relative to IQ on all the WIAT subtests than did the 20 children without ADHD who also did not meet the LD criterion (see Table 1). Similarly, children who had LD and ADHD (n = 60) performed less well on the WIAT subtests relative to IQ than did the 13 children who had LD and no ADHD. This pattern of poorer performance was statistically significant (sign test, p = .001).

ADHD and LD Impact on Learning and Attention

The disparity between IQ and the mean of the WIAT subtest scores differed significantly among some of the ADHD/LD subgroups, F = 43.34, p < .0001, adjusted R^2 = .66. Children with LD and ADHD (n = 60) had the poorest WIAT performance relative to IQ, followed by the LD without ADHD group (n = 13), and then the ADHD without LD group (n = 26). Children with neither LD nor ADHD (n = 20) showed the opposite pattern and scored somewhat above IQ on the WIAT. Similarly, attention problems, as indicated by the disparity between IQ and FDI, differed significantly for some of the ADHD/LD subgroups, F = 12.66, p < .0001, adjusted R^2 = .37. Children with ADHD and LD performed least well with the greatest discrepancy between IQ and FDI, followed by the ADHD without LD group, and then the LD without ADHD group. Children with neither LD nor ADHD had the reverse pattern, with a higher mean FDI than IQ. This pattern was again found for the four ADHD/LD groups when attention scores on the GDS were compared to IQ, F = 9.87, p < .0001, adjusted R^2 = .28.

Figure 1 depicts the influence of ADHD and LD on measures of attention and learning. For all three variables (IQ–WIAT, IQ–FDI, and IQ–GDS), ADHD and LD had significant main effects (see Table 2) but no significant interaction effects because the effects of LD and ADHD on learning and attention problems were additive. Further, a significant and positive correlation was found between the IQ–WIAT discrepancy score and both IQ–FDI, r = .63, p < .0001, and IQ–GDS, r = .45, p < .0001.

ADHD and LD Impact on Other Cognitive Measures

Although the presence of ADHD and LD had a consistent impact on mea-

TABLE 1
Mean IQ and WIAT Standard Scores for ADHD/LD Subgroups

Subgroup	*n*	IQ	WIAT				
			BR	RC	NO	S	WE
ADHD without LD	26	104.8	102.3	105.0	104.1	101.7	97.0
No ADHD or LD	20	97.5	104.4	103.0	98.4	101.4	100.5
LD with ADHD	60	107.0	93.7	98.8	90.8	89.2	81.1
LD without ADHD	13	97.8	91.2	93.8	86.2	89.0	82.6

Note. WIAT = Wechsler Individual Achievement Test (Psychological Corp., 1992); BR = basic reading; RC = reading comprehension; NO = numerical operations; S = spelling; and WE = written expression.

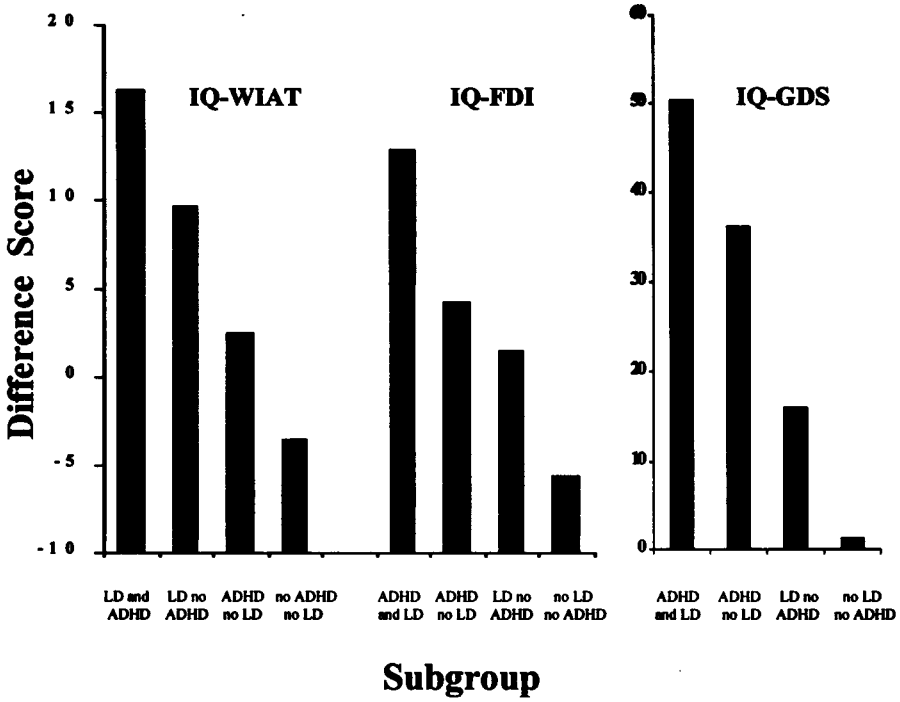

FIGURE 1. Mean IQ–WIAT, IQ–FDI, and IQ–GDS difference scores for the ADHD/LD subgroups (WIAT = Wechsler Individual Achievement Test [Psychological Corp., 1992]; FDI = Freedom from Disability Index [Wechsler, 1991]; GDS = Gordon Diagnostic System [Gordon, 1983]).

sures of learning and attention, this was not the case for measures of verbal and nonverbal reasoning, as shown in Figure 2. The difference between IQ and the Verbal Comprehension Index score and the difference between IQ and the Perceptual Organization Index score was close to 0 (± 4 points) for all of the four ADHD/LD groups. Differences among the four ADHD/LD groups were nonsignificant for the Verbal Comprehension Index, $F = 1.01$, $p = .781$, adjusted $R^2 = .005$. For the Perceptual Organization Index, only the groups with the two extreme scores (ADHD without LD and ADHD with LD) differed significantly, $F = 6.53$, $p < .001$, adjusted $R^2 = .18$.

Discussion

The intent of our study was to investigate the relationship between attention and learning problems in a typical sample of children referred to a child diagnostic clinic. Our base rate for ADHD (72.3%) is similar to that reported for other clinics serving the same type of population (Edwards, 1998). Although our sample may be representative of other clinical groups, our results are not necessarily applicable to nonreferred children.

Our study showed that referred children with ADHD had a significantly greater frequency of LD than children without ADHD. LD frequencies in reading, math, and spelling in children with ADHD were consistent with prior research. The prevalence of LD in each of these areas was close to one third. However, the overall prevalence for LD doubled (70%) when written expression was included in the assessment. According to federal guidelines (Education of the Handicapped Act, 1977), a child may have LD in written expression. In spite of such guidelines, written expression was neglected in previous studies investigating learning disabilities in children with ADHD, resulting in an underestimation of LD in these children. Our findings, in combination with a high incidence of writing problems among schoolchildren in general (Hooper et al., 1993) and among children with LD (Bruck, 1985; Graham, 1990; Griffey, 1986; Keefe & Candler, 1989; Kerchner & Kistinger, 1984; Poplin et al., 1980), cast doubt on statements made by some authors that a reading disability is the most common type of LD (B. A. Shaywitz et al., 1995; S. E. Shaywitz & Shaywitz, 1993).

TABLE 2
Main and Interaction Effects of ADHD and LD on Learning and Attention Scores

	Main effect					
	ADHD		LD		Interaction effect of ADHD and LD	
Variable	*F*	*p*	*F*	*p*	*F*	*p*
IQ–WIAT	3.94	< .049	87.79	< .0001	**0.00**	**.967**
IQ–FDI	12.86	< .0001	11.40	= .001	**0.03**	**.865**
IQ–GDS	14.28	< .0001	5.76	= .018	0.00	.954

Note. IQ–WIAT = IQ–Wechsler Individual Achievement Test (Psychological Corp., 1992) difference score; IQ–FDI = IQ–Freedom from Distractibility Index (Wechsler, 1991) difference score; IQ–GDS = IQ–Gordon Diagnostic System (Gordon, 1983) difference score.

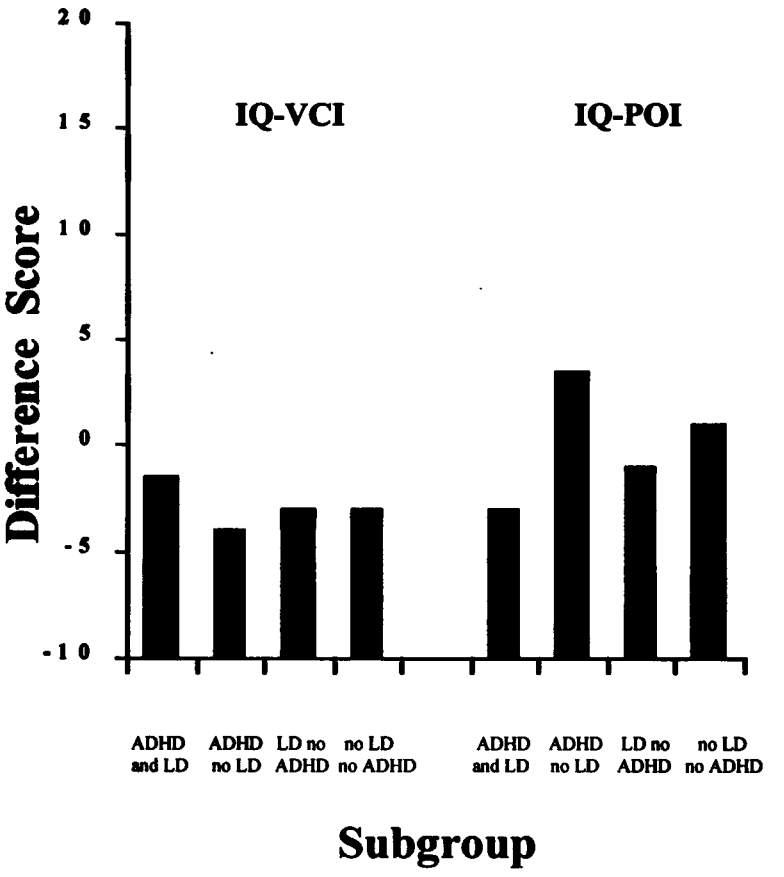

FIGURE 2. Mean IQ–Verbal Comprehension Index (VCI; Wechsler, 1991) and IQ–Perceptual Organization Index (POI; Wechsler, 1991) difference scores for the ADHD/LD subgroups.

Given that 65% of our children with ADHD had LD in written expression, it is important for psychologists to assess written expression when evaluating a child for ADHD or LD. This is particularly important considering that—of all the LD types—LD in written expression may be the most amenable to compensatory adaptations. Research has shown that children with writing disabilities can benefit from the use of word processors and spell checkers (Glazer & Curry, 1988; Griffey, 1986; Keefe & Candler, 1989; Kerchner & Kistinger, 1984; McNaughton, Hughes, & Ofiesh, 1997), oral or dictated performance (Glazer & Curry, 1988; Lane & Lewandowski, 1994; MacArthur & Graham, 1987), and production prompts and additional time for written assignments (Graham, 1990).

Our findings suggest that problems with attention and with academic achievement are found for both children with ADHD and children with LD, although the problems differ in degree, as would be expected. The correlations between the IQ–WIAT discrepancy score and both attention measures (IQ–FDI and IQ–GDS) were significant and positive, indicating that as attention problems increased, so did academic problems, and vice versa.

When the WIAT mean was compared with IQ, results demonstrated that children with LD and ADHD had the greatest problem with learning, followed in order by children with LD and no ADHD, children with ADHD and no LD, and children with neither LD nor ADHD. These findings demonstrated that

1. among the children who did not have a learning disability, children with ADHD had more learning problems than children without ADHD, indicating that children with ADHD had some difficulty with learning even though they did not meet the criteria for LD;
2. among children who had LD, learning problems were greater for children with ADHD than for children without ADHD, suggesting that the presence of ADHD intensified learning problems in children who had LD; and
3. the referred children without LD and without ADHD had no learning problems, and their mean WIAT score was slightly above their IQ.

A similar pattern was found for the discrepancy between IQ and performance on two independent measures of attention (IQ–FDI and IQ–GDS). This time, as expected, children with ADHD and LD had the greatest attention problems, followed by children with ADHD and no LD, children with LD and no ADHD, and, last, children with no LD and no ADHD. Again, there were three findings:

1. among children who did not have ADHD, children with LD had problems with attention compared to children without LD, indicating that the children with LD had some attention problems even though they did not meet the diagnostic criteria for ADHD;
2. among children who had ADHD, children with LD had more problems with attention than children without LD, indicating that the presence of LD intensified attention problems in children with ADHD; and
3. the referred children without ADHD and without LD had no attention problems, and the discrepancy between their IQ and attention scores was approximately zero. This last group included children who had mood or behavior disorders (e.g., anxiety disorder, depression, and oppositional defiant disorder), which contradicts the common belief that an attention deficit is a nonspecific symptom of psychiatric disorders in children (Hall, Halperin, Schwartz, & Newcorn, 1997; Halperin, Matier, Bedi, Sharma, & Newcorn, 1992).

Overall, our results indicated that attention and learning problems are interrelated and usually coexist, although they differ by degree, depending on the child's ADHD or LD diagnosis. These findings do not simply reflect a uniform and consistent effect of ADHD and LD on all psychometric or ability test scores. The impact of ADHD and LD on measures of attention and learning was not duplicated on measures of verbal ability (IQ–VCI) or visual–motor ability (IQ–POI). These two variables each accounted for very little (0.5% and 18%, respectively) of the variance among the four ADHD/LD subgroups, whereas measures of learning and attention (IQ–WIAT, IQ–FDI, and IQ–GDS) accounted for sizable proportions of the variance (66%, 37%, and 28%, respectively). Psychologists and other educational and mental health professionals should be aware that attention and learning problems are on a continuum (and not simply present or absent) and that they usually occur together. If a child does not meet diagnostic criteria for ADHD or LD, the child may still have some degree of attention or learning problems that may require intervention.

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