Academic Underachievement in ADHD Subtypes

Richard M. Marshall, George W. Hynd, Michael J. Handwerk, and Josh Hall

Abstract

Although a relationship between attention-deficit/hyperactivity disorder (ADHD) and academic underachievement has been widely reported, the nature of this relationship has not been specified. The present investigation addresses this relationship directly by comparing 24 students (20 males and 4 females) with ADHD and 20 students (15 males and 5 females) with attention-deficit disorder without hyperactivity (ADD/noH) referred to a university-based diagnostic clinic for comprehensive neuropsychological assessment. The students ranged in age from 6 years 0 months to 12 years 10 months. Consistent with previous reports, this study found that math achievement test scores for students with ADD/noH were significantly lower than those for students with ADHD. These findings support previous research suggesting the ADD/noH may represent a distinct ADD subtype. It is hypothesized that inattention interferes with students' ability to master abstract symbol systems, especially in the acquisition of basic arithmetic skills in the primary grades.

The relationship between attention-deficit/hyperactivity disorder (ADHD) and academic underachievement has long been acknowledged. Attempts to explain "minimal brain damage" (as the diagnosis was originally named) included "learning disorders" as a primary characteristic (Lehtinen, 1955). A decade later, the U.S. government tried to clarify the disparate viewpoints regarding the diagnosis. Although its report listed 99 characteristics associated with this disorder, academic deficits remained one of the 10 most commonly mentioned features (Clements, 1966).

ADHD (or Hyperkinetic Reaction of Childhood and Adolescence, as it was once termed) achieved the status of an independent diagnosis in the second edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM II; American Psychiatric Association, 1968). Specific diagnostic criteria, however, were not provided. Despite changes in nomenclature and the inclusion of specific diagnostic criteria in subsequent editions of the DSM, the high co-occurrence of learning problems among students with this diagnosis remained a recurring theme.

In DSM-III (American Psychiatric Association, 1980), inattention displaced hyperkinesis as the disorder's primary symptom, and two subtypes were specified: ADHD and Attention Deficit Disorder without Hyperactivity (ADD/noH). In addition to efforts aimed at establishing the precise nature and extent of overlap between ADD and learning problems, researchers were also trying to determine ways in which ADHD and ADD/noH might be differentiated. Lahey and his colleagues conducted a series of studies aimed at comparing ADD subtypes. An analysis of teacher ratings (Lahey, Pelham, et al., 1988; Lahey, Schaughency, Frame, & Strauss, 1985) and parent and child interviews (Lahey, Piacentini, et al., 1988; Lahey, Schaughency, Hynd, Carlson, & Nieves, 1987; Walker, Lahey, Hynd, & Frame, 1987) indicated that students with ADHD were aggressive, guiltless, and unpopular, whereas students with ADD/noH were shy, anxious, socially withdrawn, and moderately unpopular. Both groups also performed poorly in school.

In what may be the first direct comparison of the cognitive test performances of the two ADHD groups, Carlson, Lahey, and Neeper (1986) compared students with ADHD with a mean age of 10 years to students with ADD/noH on a battery of standardized intelligence and academic tests. Using Full Scale IQ as a covariate, an analysis of covariance revealed significant differences in scores on the Reading, Spelling, and Math subtests of the Basic Achievement Skills Individual Screener (BASIS) between ADD groups and a non-ADD control group. Although no significant differences between students with ADHD and children with ADD/noH were found on Math, Reading, or Spelling subtests scores, children with ADD/noH scored significantly lower than controls on the Math subtest. Although the students with ADHD had significantly lower Full Scale IQ and Verbal IQ scores than the students with ADD/noH and the nondiagnosed students, their achievement scores did not differ significantly from those of the participants with ADD/noH. By contrast, students with ADD/noH were comparable to the nondiagnosed students on IQ, but their math achievement scores were significantly lower than

the controls'. These results are important because they are the first to suggest that, despite higher IQ scores, students with ADD/noH are at higher risk than students with ADHD for academic problems, particularly in math achievement.

Additional evidence for specific academic deficits associated with ADD/noH was provided by Hynd et al. (1991), who compared students with ADHD to students with ADD/noH. In previous studies, significant differences in IQ scores sometimes separated these two groups. In the Hynd et al. study, no significant IQ differences were found between the groups. Statistical comparisons indicated that the ADD/noH group scored lower than the ADHD group in math, spelling, and reading, but significant differences were reported only for the math subtest. It is also worth noting that 60% of the ADD/noH group received an Axis II diagnosis of Developmental Reading Disorder or Developmental Arithmetic Disorder, whereas none of the students in the ADHD group received such a diagnosis.

Accardo, Blondis, and Whitman (1990) also used DSM-III criteria to examine the relationship between ADD and learning disabilities (LD). In their sample of 614 clinic-referred children, 68.7% were diagnosed as ADD. Of that group, 66.8% were diagnosed with ADHD, and the remainder were diagnosed with ADD/noH. The authors also pointed out that, consistent with other studies, there was a significant difference in the incidence of diagnosed LD in the ADHD group (67.7%) versus the nonhyperactive group (85.7%).

Epstein, Shaywitz, Shaywitz, and Woolston (1991) reached the same conclusion. In their review of the relationship between ADD and LD, they cited a number of studies that demonstrated significant differences in academic performance between students with ADHD and those with ADD/noH. They concluded that "there is accumulating evidence to suggest that children with ADD/noH are at significant risk for academic failure" (p. 79).

One of the unfortunate consequences of replacing the dichotomous categorization system of DSM-III with the nonmothetic scheme for ADHD adopted in DSM-III-R (American Psychiatric Association, 1987) was a reduction in the number of studies that sought to differentiate ADHD from ADD/noH. However, it must be noted that, DSM-III-R notwithstanding, researchers continue to find evidence supporting two ADHD subtypes. For example, Barkley, DuPaul, and McMurray (1990) provided an empirical validation of ADHD and ADD/noH subtypes using parent interviews, parent and teacher behavior ratings, and psychological tests. With these measures, Barkley et al. were able to distinguish three groups: ADHD, ADD/noH, and LD. Although the three groups did not differ significantly from each other on the Reading, Spelling, and Arithmetic subtests of the Wide Range Achievement Test–Revised (WRAT-R), the scores of all three groups were lower than those of a nondiagnosed control group. The authors also reported that the children with ADHD were more likely to be placed in BD classes, whereas the children with ADD/noH were more likely to be in LD classes.

Other articles appearing since the publication of DSM-III-R also continue to support a DSM-III subtyping classification system (Epstein et al., 1991; Lahey & Carlson, 1991; McKinney, Montague, & Hocutt, 1993; Riccio, Hynd, Cohen, & Gonzalez, 1993; B. Shaywitz & S. Shaywitz, 1991; S. Shaywitz & B. Shaywitz, 1991). Most of these investigators have argued that the ADHD and ADD/noH dichotomy more accurately reflects the disorder's characteristics and comorbid conditions (B. Shaywitz & S. Shaywitz, 1991; S. Shaywitz & B. Shaywitz, 1991) and associated learning problems (Epstein et al., 1991; McKinney et al., 1993).

To date, much of the research correlation deficits in attention and learning disorders has focused on reading disabilities (e.g., Ackerman & Dykman, 1990; August & Garfinkel, 1990; Dykman & Ackerman, 1991; Felton & Wood, 1989). However, there is accumulating evidence suggesting that ADD also places students at increased risk for deficits in arithmetic. Although little is known about the relationship between ADD and math performance, there is increasing evidence that students with ADHD and ADD/noH experience higher rates of arithmetic deficits than their nondisabled peers (Nussbaum, Grant, Roman, Poole, & Bigler, 1990; Semrud-Clikeman et al., 1992; Zentall, 1993). Moreover, there is evidence suggesting that students with ADD/noH may be more impaired in arithmetic than students with ADHD. As noted earlier, this possibility was first raised by Carlson et al. (1986), who reported that their ADD/noH group performed worse than a nondisabled group on a math achievement test, despite comparable IQ scores. Using the same achievement test, Hynd et al. (1991) reported that students with ADD/noH scored significantly lower than students with ADHD.

Zentall (1993) reported that math computation is the area in which students with ADHD are most likely to show diminished performance. Until recently, efforts to differentiate ADHD subtypes from ADD/noH subtypes on the basis of academic performance failed to reveal group differences, and it was assumed that the two groups had similar academic problems. However, in studies using the BASIS rather than the WRAT or the WRAT-R, student with ADD/noH have been found to perform less well than their nondisabled peers (Carlson et al., 1986) and students with ADHD (Hynd et al., 1991).

Determining that ADHD and ADD/noH can be differentiated on the basis of incidence rate and type of academic underachievement would provide additional support for differentiating ADHD subtypes. At the same time, such differentiation might inform us as to how inattention, impulsivity, and hyperactivity are related to specific kinds of academic impairment (McKinney et al., 1993; B. Shaywitz & S. Shaywitz, 1991).

Method

Participants

Participants for the study were selected from 182 school-age children referred to a university-based neuropsychology clinic that offers diagnostic services primarily to children and adolescents with learning disorders and behavior problems. These participants ranged in age from 6 years 0 months to 12 years 10 months. All had Wechsler Intelligence Scale for Children–Revised or Wechsler Intelligence Scale for Children–Third Edition FSIQ scores greater than or equal to 85. Students with sensory impairments, a history of neurological impairment, epilepsy, or closed-head injury were excluded.

Cinical Diagnoses

Clinical diagnoses were based on a multi-informant, multimodal procedure consisting of parent interviews and rating scales, teacher rating scales, student test results and self-reports, and examiner observations during the administration of the psychometric test battery. Diagnostic decisions were based on criteria for childhood disorders in DSM-III and DSM-III-R. To enhance reliability all diagnostic decisions were made by two psychologists who examined the data independently. Disagreements regarding diagnoses were resolved through discussion. The interdiagnostician reliabilities reported by Walker et al. (1987) yielded Cohen's kappa values from .77 to 1.00. All were above the .70 criterion, an acceptable criterion for reliability (Spitzer, Cohen, Fleiss, & Endicott, 1967). On the basis of these procedures, 24 students (20 males and 4 females) met DSM-III criteria for ADHD, and 20 students (15 boys and 5 girls) met criteria for ADD/noH. In addition to differentiating ADHD from ADD/noH, the Structured Interview for the Diagnostic Assessment of Children (SIDAC) was also used to specify co-occurring childhood psychopathological disorders. An updated version of the Schedule for Affective Disorders and Schizophrenia for School-Age Children; Puig-Antich & Chambers, 1978), the SIDAC includes questions pertaining to symptoms for all DSM-III and DSM-III-R diagnoses.

Dependent Measures

Five measures of academic achievement were used to compare the reading and math performance of the groups. These included the Reading and Mathematics subtests of the BASIS (Psychological Corporation, 1983); the Arithmetic subtest of the WRAT-R (Jastak & Jastak, 1987); and the Passage Comprehension subtest and Reading Comprehension Cluster of the Woodcock Reading Mastery Test–Revised (Woodcock, 1987).

Means and standard deviations for demographic and psychometric data for each group are presented in Table 1.

Results

Prior to comparing the groups' academic performance measures, the authors computed analyses of variance on the age, Full Scale IQ, Verbal IQ, and Performance IQ of the two groups. As Table 2 illustrates, no significant differences existed between the groups on age, FSIQ, or Verbal IQ. A significant difference between the groups was noted on Performance IQ, where $F(1.42) = 4.134$, $p < .048$. Some studies comparing ADHD and ADD/noH have reported FSIQ differences between the groups. Having determined that the present groups did not differ on FSIQ, the decision to apply analysis-of-covariance procedures based on IQ was rejected.

Results of an analysis of variance comparing group means of academic achievement test scores are contained in Table 3. Students with missing scores were excluded from these analyses, leaving 18 students in each group. Of five analyses, significant differences were found on the BASIS Math subtest score, where $F(1,34) = 4.9807$, $p < .032$.

The number and corresponding percentages of participants with co-occurring psychiatric diagnoses are given in Table 4. Although inadequate cell sizes prevented the computation of formal statistical procedures, the types of comorbid psychopathology associated with each subtype suggest that the groups identified for this study accurately reflect the two ADD subtypes. For example, all of the students with externalizing disorders (Conduct

TABLE 1
Demographic and Psychometric Data

Variable	ADHD		ADD/noH	
	M	*SD*	*M*	*SD*
CA (months)	121.875	(29.538)	126.400	(29.316)
Intelligence				
Verbal IQ	106.375	(13.780)	108.100	(15.620)
Performance IQ	106.792	(14.539)	98.400	(12.445)
Full Scale IQ	107.042	(13.307)	104.050	(13.141)
Achievement				
BASIS Reading	98.944	(18.142)	98.222	(16.178)
BASIS Math	101.944	(13.880)	92.056	(12.680)
WRAT-R Arithmetic	92.000	(14.900)	87.813	(13.790)
WRMT-R PC	95.263	(14.828)	92.890	(15.751)
WRMT-R RCC	98.474	(16.078)	98.118	(17.011)

Note. CA = chronological age; BASIS = Basic Achievement Skills Individual Screener; WRAT-R = Wide Range Achievement Test–Revised; WRMT-R PC = Woodcock Reading Mastery Test–Revised, Passage Comprehension subtest; WRMT-R RCC = Woodcock Reading Mastery Test–Revised, Reading Comprehension Cluster.

TABLE 2
Analyses of Variance for Age and IQ

Variable	SS	*F* ratio	*p*
Age	223.3705	.2578	.6143
FSIQ	97.6371	.5576	.4594
VIQ	32.4614	.1514	.6991
PIQ	768.2189	4.1340	.0484*

Note. FSIQ = Full Scale IQ; VIQ = Verbal IQ; PIQ = Performance IQ.
*p < .05.

Disorder, Oppositional Defiant Disorder) also had diagnoses of ADHD. Whereas 21% of students with ADHD and co-occurring internalizing disorders (Dysthymia, Separation Anxiety Disorder), 50% of students with ADD/noH had internalizing disorders.

In addition to such predictable behavioral differences, it is also worth noting that the ADD/noH group had more than twice as many Developmental Disorders (i.e., learning disabilities) as the ADHD group. Results of a chi-square procedure comparing the number of participants in each group with co-occurring learning disabilities were significant; the students with ADD/noH had significantly more LD than the students with ADD/H, $\chi^2(1, N = 44) = 4.01, p < .05$.

Discussion

This study's principal finding was that math achievement in students with ADD/noH was significantly lower than for students with ADHD. There are two principal implications in this finding. The first relates to diagnostic classification; the second involves educational issues.

Diagnostic Classification

With regard to classification, the finding that students with ADD/noH performed more poorly in math was consistent with previous research by Carlson et al. (1986) and Hynd et al. (1991), who also reported poorer math performance in students with ADD/noH. If subsequent studies continue to document differential performance on math tests, such differences might provide additional external validity for ADHD subtyping. Data from carefully controlled comparisons of academic achievement would supplement recent investigations that support an ADHD subtype classification scheme (August & Garkinkel, 1989, 1990; Barkley et al., 1990).

The search for differentiating characteristics is not without consequences. As Rutter (1983) pointed out, there are criteria to be met in establishing a differential classification of disorders. These criteria include that the disorders are definable, that their differentiation leads to treatment, that their validity and reliability can be evaluated, and that they discriminate those with the disorder from nondisabled samples. To distinguish ADHD from ADD/noH subgroups on the basis of differential academic achievement satisfies the third and fourth criteria.

A more favorable climate for differentiating ADHD and ADD/noH is provided in DSM-IV (American Psychiatric Association, 1994). The new system contains three ADHD subtypes: ADHD, Predominantly Inattentive Type; ADHD, Predominantly Hyperactive–Implusive Type; and ADHD, Combined Type. In this scheme, the Predominantly Inattentive Type seems to represent a return, of sorts, to the ADD/noH subtype of DSM-III. It also replaces Undifferentiated Attention Deficit Disorder in the DSM-III-R and in that regard represents a bona fide diagnostic category. By differentiating ADHD into subtypes, DSM-IV encourages researchers to identify dimensions on which the three subtypes differ.

The relationship between ADHD and math disability is, admittedly, a tentative one, prompting two questions. Is there sufficient evidence to support the proposed connection between ADD/noH and math achievement? And, if so, why is this relationship so underreported?

In response to the first question, evidence in support of a connection has been accumulating. The previously mentioned studies by Carlson et al. (1986) and Hynd et al. (1991) were specifically designed to directly compare the academic achievement of ADHD and ADD/noH subtypes. In both, the data suggested that students with ADD/noH performed more poorly than students with ADHD (Hynd et al., 1991) and nondisabled students (Carlson et al., 1986).

Though less direct, other evidence also suggests a connection. For example, Dykman and his colleagues reported that although both students with ADHD and students with ADD/noH showed increased rates of reading disabilities (RD) and math disabilities (MD), MD appeared more often in students with ADD/noH (Ackerman, Anhalt, Dykman, & Holcomb, 1986). Those researchers attributed specific math deficits to the failure of participants with ADD/noH to achieve automaticity in number facts. Whether this inability was due to some underlying cognitive deficit or to a lack of repetition (because students eschewed repetitive drill) is unresolved.

The answer to the second question (Why is the relationship between ADD/noH and MD so underreported?) is straightforward. The relationship is underreported because it is underinvestigated. Except for the 7 years between the publication of DSM-III and the publication of DSM-III-R, ADHD's defining characteristic has been hyperactivity. Prior to 1980, researchers tried to delineate the characteristics of Hyperkinetic Reaction of Childhood and Adolescence. Since 1987, the emphasis has been on ADHD, wherein hyperactivity was the main symptom. In the main, therefore, the history of this disorder is the history of hyperactivity.

Research conducted prior to 1980 had established that students with hyperactivity experienced high rates of school problems (Cantwell & Satterfield, 1978) and learning disabilities (Lambert & Sandoval, 1980). And al-

though inattention was suggested by some as a cause of learning problems (e.g., Keogh, 1971), the focus of these studies was clearly on the correlation between hyperactivity and learning problems. Although researchers began to implicate inattention as a primary symptom in the early 1970s (Douglas, 1972), few reasons could be found to investigate the specific relationship between inattention and academic achievement in the absence of hyperactivity.

The publication of DSM-III, however, provided the impetus for a rapid increase in studies seeking to validate its classification system. In fact, much of the literature addressing academic achievement in general and math achievement in particular was undertaken to compare the characteristics of ADHD and ADD/noH subgroups on various dimensions. Thus, it was not until 1980 that inattention as it related to academic achievement was granted the status of a mainstream mental health and educational issue. Despite the elevated status of ADD/noH as a distinct ADD subtype, two factors prevented the relationship between ADD/noH and academic achievement from becoming a major research focus. First, compared to ADHD, the diagnosis of ADD/noH was infrequently made. In studies conducted since 1980, the total number of subjects meeting the DSM-III criteria for ADD/noH was 222 (Lahey & Carlson, 1991). Second, much of the validity research conducted on DSM-III and DSM-III-R has been devoted to behavioral and emotional variables or to leaning disabilities in general. For example, although Lahey and colleagues undertook a series of studies that compared participants with ADHD and ADD/noH on behavioral and emotional variables, only one specifically addressed academic performance. In fact, the study by Carlson et al. (1986) was the first direct comparison of cognitive abilities in ADHD and ADD/noH subgroups. By 1991, eight studies directly comparing the cognitive performance of the two groups had been published (Lahey & Carlson, 1991).

TABLE 3
Analyses of Variance for Academic Achievement Tests

Test	SS	*F* ratio	*p*
BASIS Math	880.111	4.9807	.0323*
BASIS Reading	4.0556	.0159	.9004
WRAT-R Math	148.5331	.7173	.4033
WRMT-R PC	52.1056	.2231	.6396
WRMT-R RCC	1.1373	.0042	.9489

Note. BASIS = Basic Achievement Skills Individual Screener; WRMT-R PC = Passage Comprehensive subtest of the Woodcock Reading Mastery Test–Revised; WRMT-R RCC = Reading Comprehension Cluster of the Woodcock Reading Mastery Test–Revised.
*$p < .05$.

TABLE 4
DSM-III and DSM-III-R Diagnoses Associated with ADHD and ADD/noH

Diagnosis	ADHD (%)[a]	ADD/noH (%)[b]
Developmental disorder		
Arithmetic	4 (16)	11 (39)
Reading	3 (13)	8 (29)
Articulation	1 (4)	0 (0)
Expressive Writing	0 (0)	1 (4)
Expressive Language	1 (4)	0 (0)
Externalizing disorders		
Conduct Disorder	6 (25)	0 (0)
Oppositional Defiant Disorder	5 (21)	0 (0)
Internalizing disorders		
Major Depression	2 (8)	1 (4)
Dysthymia	1 (4)	4 (14)
Overanxious Disorder	0 (0)	1 (4)
Separation Anxiety Disorder	1 (4)	3 (11)
Avoidant Disorder	0 (0)	1 (4)

[a]Indicates percentage of total number of each co-diagnosis for each group.

Educational Issues

That students with ADD/noH may have increased rates of learning problems in general and increased rates of math deficits in particular has important educational implications. The academic difficulties encountered by students with hyperactivity have been documented both anecdotally and experimentally for over four decades. A major disadvantage of much of this research (especially research undertaken prior to 1980) is that it did not attempt to determine whether the arithmetic errors made by students with ADHD could be differentiated from errors made by students with ADD/noH. As noted previously, the study of ADHD has essentially been an investigation and elucidation of hyperactivity. In contrast, little is known about ADD/noH—an unfortunate circumstance, considering the students with ADD/noH may experience unique cognitive, academic, and social–emotional difficulties that, if

studied, might help to specify the relationship between ADHD and academic difficulties.

It seems prudent to agree with Ackerman et al. (1986) that students with ADHD should at least be screened for various learning disabilities. Moreover, for students doing poorly in math, inattention should be ruled out as a causal factor. Conversely, it seems judicious to monitor the math performance of students who have or who are suspected of having attention problems (especially in the absence of hyperactivity) as they proceed through the grades. Zentall (1990) reported that 53% of the children with LD in the study were also rated by their teachers as being more impulsive and inattentive (but not hyperactive), lending additional support to the argument that students with ADD/noH experience more difficulties mastering math concepts than do students with ADHD.

An interesting and recurring aspect of the ADD/noH and math deficit connection is that the math deficits are more pronounced in older than younger elementary school students, as noted by Ackerman et al. (1986). Nussbaum et al. (1990) also reported that older children with ADD are more likely to have math LD (as defined by a 15-point discrepancy between IQ and math achievement). In both studies, the age factor was thought to reflect a lack of acquisition of new skills, possibly related to cognitive deficits that interfered with the gradual accumulation of arithmetic computation skills (Rourke, 1993; Zentall & Ferkis, 1993).

Although some studies have reported few academic or cognitive differences between ADHD and ADD/noH subgroups (e.g., Epstein et al., 1991), two common features of such studies are worth noting. First, the most commonly reported measure of academic achievement is the WRAT or the WRAT-R, and although this test is considered a valid measure for comparing the academic achievement of nondisabled and clinical samples, it may not possess sufficient sensitivity for identifying differences between two clinical populations.

Second, math deficit is most often defined as a score below a certain level, typically more than 1 standard deviation below the mean, or below measured IQ. All students scoring below that level are considered deficient in math. Recently, however, researchers have begun to acknowledge that the *type* of errors committed further differentiates students with MD. As Rourke (1993) has pointed out, it is not sufficient to know that two groups of students scored below a certain level on the same math achievement test. Error analysis indicates that error type suggests different underlying disorders even within groups of students with MD. These error patterns correlate not only with neuropsychological test results that reflect right- and left-hemisphere processing deficits but also with deficits in computation and comprehension (Zentall & Ferkis, 1993).

Efforts to correlate cognitive deficits, inattention, and academic difficulties are not new, but more specific subtyping of ADHD provides more informative correlations. McGee and Share (1988), for example, stated that the cognitive tasks in which individuals with ADHD show deficiency (naming, perceptual speed, and speed of cognitive processing) also predict reading disability. Stolzenberg and Cherkes-Julkowski (1991) expressed the view that children with ADD/noH encounter difficulties in reading decoding and math computation because attention-based working memory problems make it difficult for them to learn the arbitrary symbol systems involved in reading and math. Likewise, Zentall and Ferkis (1993) argued that poor cognitive *style* (inattention, disorganization) is associated with math computation deficits, whereas decreased cognitive *ability* (IQ and memory) and reading ability are correlated with decreased comprehension and problem solving.

The important educational implication of all of this is that for students with ADD/noH, cognitive deficits underlie learning disabilities. The educational dilemma that is created is that if, as Mayer (1993) and others advocate, students with learning disabilities (including math disabilities) need to learn to use cognitive and metacognitive strategies, educators may be asking students with ADD/noH to use their primary deficit (in cognitive strategies) to overcome their academic difficulties. If, as the preceding paragraph implies, attention-based working memory deficits are causing academic difficulties, it seems unlikely that the same deficits would serve as the solution to these students' academic problems.

In addition to these practical implications, it is useful to consider several underlying theoretical issues. That ADHD and reading disabilities are associated has been reasonably well established (August & Garfinkel, 1990; Dykman & Ackerman, 1991). Dykman and Ackerman, for example, reported that over half of their clinic-referred ADD sample met criteria for specific reading disability. A number of carefully constructed prospective studies provide a detailed analysis of various aspects of the relationship between ADD and RD (Epstein et al., 1991). Although far more is known about the relationship between ADHD and RD, it seems worth considering that if RD represents the verbal LD associated with ADHD, then MD may represent its nonverbal analog.

Although the nature of the relationship between inattention and math disabilities has not been specified, there is accumulating evidence from various sources that MD may be differentially related to ADD/noH. Two possible links between inattention and math disabilities are discussed here. First, it may be that ADD/noH represents a specific type of attentional disorder that affects math performance in some unique way. In a series of studies conducted in the 1980s, Lahey and his colleagues showed that ADHD and ADD/noH had distinct behavioral characteristics (Lahey, Pelham, et al., 1988; Lahey, Piacentini, et al., 1988; Lahey et al., 1985; Lahey et al., 1987).

Given their findings, it does not seem unreasonable to suggest that cognitive differences also characterize the two subtypes of inattention. Support for this position was provided by Goodyear and Hynd (1992), who advised that one consider "the possibility that ADD/noH is a more attention/cognitive/anxious type of disorder in contrast to the more attention/behavior/impulsive aspects of ADD/H" (p. 289). More specifically, Rourke (1989) argued that ADD/noH may represent a type of inattention that accompanies nonverbal learning disabilities, of which MD are a subset.

Behavioral comparisons of the two groups demonstrate that children with ADHD have co-occurring externalizing disorders and that children with ADD/noH have co-occurring internalizing disorders. At a conceptual level, it seems reasonable to assume that differential academic or cognitive processing patterns also distinguish the two groups. Research should continue to focus on specifying these processes, despite the fact that methodological problems make it more difficult to specify covert academic processing than overt behavioral characteristics. In this way, more will become known about the unique constellation of abilities and deficits that distinguish ADHD subtypes.

There are several limitations to the present study. First, students in both groups were from a clinic-referred population. Making and keeping clinic appointments, completing all clinic forms, and assuming ultimate financial responsibility for clinic visits are obligations that many parents are unable or unwilling to meet. Therefore, results of this study may not generalize to students without the financial means and parental support demanded by the clinic process. Second, because all students were referred for neuropsychological evaluation, the question remains whether students with ADHD who are not referred for comprehensive evaluation exhibit similar performance differences. To answer this question, the authors are replicating the present study on a school-referred population.

Third, variables other than group membership (e.g., test selection) could explain math test performance differences. The only studies reporting math achievement test differences between the groups used the BASIS, and explanations for this remain speculative. Prospective studies using a variety of instruments could address this question more fully. It is also possible that although some studies report no significant differences in arithmetic test performance, error type differentiates students with ADHD and ADD/noH. To address this question, the authors are currently undertaking an analysis of the types of errors made by the two groups of students in this study.

ABOUT THE AUTHORS

Richard M. Marshall, *PhD, is an assistant professor of educational psychology at The University of Texas in Austin and a member of the school psychology faculty.* ***George W. Hynd,*** *EdD, is a research professor of special education and psychology and a member of the school psychology faculty at The University of Georgia.* ***Michael J. Handwerk*** *is a doctoral student in educational psychology at The University of Texas in Austin.* ***Josh Hall,*** *PhD, is an assistant professor of educational psychology at Ball State University. Address: Richard M. Marshall, Department of Educational Psychology, EDB 504, The University of Texas, Austin, TX 78712.*

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