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Clinical Validity and Interpretation of the Gordon Diagnostic System in ADHD Assessments

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ABSTRACT

Gordon Diagnostic System (GDS) data were analyzed for 165 referred children with ADHD combined type and 46 referred children without ADHD, 6 – 16 years of age. Results showed significant differences between children with and without ADHD on the GDS standard scores and the IQ-GDS differences scores. Using a GDS composite standard score of 13 points or more below IQ to classify children as having ADHD resulted in the highest diagnostic accuracy (86%), with positive predictive power equal to 91%, and negative predictive power 67%. Results for the GDS compared favorably with those reported for other continuous performance tests. The findings lend support to the GDS as a clinically useful component of an ADHD evaluation.

The clinical utility of a continuous performance test (CPT) in the diagnosis of attention deficit hyperactivity disorder (ADHD) is the subject of much controversy. Some studies have reported high degrees of accuracy (sensitivity and specificity) in identifying children with and without ADHD using CPTs (Conners, 1994; Edwards, 1998; Forbes, 1998; Greenberg, 1992; Sandford, Fine, & Goldman, 1995). However, another study (McGee, Clark, & Symons, 2000) was not as positive, and recently published practice parameters (Dulcan and the Work Group on Quality Issues, 1997) stated that CPTs are not useful in ADHD assessments because of 'low sensitivity and specificity' (p. 87S). Clearly, more research is needed to assess the clinical utility of CPTs.

The Gordon Diagnostic System (GDS, Gordon, 1983) is the first commercially available CPT for clinical use. Studies have shown significant agreement between GDS subtest scores and other indicators of ADHD, including behavior rating scales, performance tests, clinical diagnoses, and behavioral observations (Barkley, 1991; Fischer, Newby, & Gordon, 1995; Gordon, DiNiro, Mettelman, & Tallmadge, 1989; Gordon, Mammen, DiNiro, & Mettelman, 1989; Gordon & McClure, 1983; Gordon & Mettelman, 1987; Loge, Staton, & Beatty, 1990; McClure & Gordon, 1984). Significant GDS differences between children with and without ADHD have also been demonstrated (Barkley, DuPaul, & McMurray, 1990; Barkley & Grodzinsky, 1994; Barkley, Grodzinsky, & DuPaul, 1992; Gordon, 1979; Gordon & McClure, 1983; Grodzinsky & Barkley, in press; Grodzinsky & Diamond, 1992; Mariani & Barkley, 1997; McClure & Gordon, 1984). However, most GDS research has focused on the validity of portions of the GDS (particularly the Vigilance subtest) without assessing the diagnostic accuracy of the GDS in its entirety. The purpose of our study was to determine the best way to use GDS findings to identify clinical children with ADHD combined type and clinical children without any type of ADHD.

We also planned to assess the influence of IQ on the interpretation of GDS scores. Numerous studies found a significant positive relationship between IQ and GDS performance (Aylward, Bell, & Gordon,

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1995; Aylward, Verhulst, & Bell, 1990; Gordon, McClure, & Aylward, 1996; Gordon, Thomason, & Cooper, 1990; Grant, Ilai, Nussbaum, & Bigler, 1990; Trommer, Hoeppner, Lorber, & Armstrong, 1988). This raises the question of whether GDS scores should be interpreted relative to IQ instead of the norm to assess an attention deficit (similar to analyzing academic achievement test scores relative to IQ to assess a learning disability). To investigate this in our study, we subtracted each child's GDS composite score from the child's IQ to obtain a simple difference or discrepancy score.

Although, the most common method of diagnosing a learning disability or LD is to use an IQ-academic achievement discrepancy score (Sattler, 1988), there are potential drawbacks of this approach. A simple discrepancy score (versus that based on a regression equation) overidentifies LD in children with high IQs and underidentifies LD in children with low IQs (Shaywitz & Shaywitz, 1993). Other limitations of a discrepancy score are lack of classification stability over time, arbitrary cutpoints, and failure to identify learning problems in children whose low achievement is not discrepant from IQ (Fletcher et al., 1998). We chose the simple discrepancy method instead of more complicated calculations (e.g., the z-score formula described by Reynolds, 1981, which entails multiple computations using the obtained scores, means, standard deviations, and reliability coefficients for the two tests), because we wanted to determine the validity of a clinically simple and quick means of controlling for IQ that would be easy for psychologists to calculate and use. The overall goal of our study was to determine the best combination of GDS scores and method of interpretation (IQ- versus norm-referenced) to maximize diagnostic accuracy for clinical children with ADHD combined type and clinical children without ADHD.

METHOD

Procedure

Evaluation

The study involved children 6–16 years of age consecutively referred over the past 10 years to our child diagnostic clinic for learning, attention, and/or behavior problems at a university-affiliated hospital. All children underwent comprehensive evaluations by two clinicians: a licensed psychologist and a physician (either a child psychiatrist or a developmental pediatrician). Evaluations employed multiple methods and sources of information. Components of the psychological evaluation were: (a) analysis of teacher and parent questionnaires and rating scale data from the Pediatric Behavior Scale (Lindgren & Koeppl, 1987); (b) administration of the Wechsler Intelligence Scale for Children – Third Edition (WISC-III, Wechsler, 1991), Wechsler Individual Achievement Test (WIAT, the Psychological Corporation, 1992), and GDS (with all children completing the entire GDS); (c) child interview using a self-report scale developed for the clinics; (d) clinical observations of the child during testing; and (e) review of historical data (the child's developmental history, school records from kindergarten to the present, and previous evaluations). Components of the psychiatric or developmental pediatric evaluations were: (a) semistructured interviews with the child and with the parents (including an assessment of the child's history and current symptoms); (b) clinical observations of the child; (c) review of records; and (d) analysis of the questionnaires and rating scales completed by the parents and teachers.

Diagnosis

In order to enhance diagnostic reliability and accuracy, only children diagnosed with ADHD combined type by both the psychologist and the physician (i.e., the child psychiatrist or developmental pediatrician) were included in the ADHD group and only children considered not to have any type of ADHD by both the psychologist and the physician were included in the nonADHD clinical control group. Diagnoses were made using the 18 DSM-IV criteria for ADHD combined type. The diagnostic decision was based on information obtained from multiple sources including: parent and teacher responses on the Pediatric Behavior Scale (PBS), parent and child interviews, observations of the child, and review of school and clinical records. The 165 PBS items include items that correspond to the 18 DSM-IV criteria for ADHD. The PBS assesses multiple psychological problems, including ADHD; oppositional, aggressive, and explosive behavior; anxiety; depression; social problems; somatic complaints; deviant behavior; and learning or developmental problems. PBS items are rated by the parent and teacher on a 4-point scale from 'not at all' to 'just a little' to 'often' to 'very often.' In our study, children with ADHD combined type earned a mean rating by mothers of 'often' on the DSM-IV ADHD items, versus 'just a little' for referred children without ADHD, $F(2,198) = 24.74$, $p < .0001$, $d = 0.79$. Similarly, the mean PBS teacher rating for the DSM-IV ADHD items was 'often' for children in our ADHD group and 'just a little' for clinical children without ADHD, $F(2,167) = 42.14$, $p < .0001$, $d = 1.29$.

Inclusion criteria
Children evaluated in the clinics were included in the study if they: (a) earned a WISC-III Full Scale IQ (FSIQ) of 70 or above, (b) did not have psychosis, autism / pervasive developmental disorder, bipolar disorder, significant hearing or visual loss, or neurological conditions, such as spina bifida, cerebral palsy, or closed head injury, and (c) were not taking medication to treat ADHD at the time of the evaluation. Parents of children treated with stimulants were asked not to give the child medication before testing on the day of evaluation. Further, children with an attention deficit without hyperactivity or impulsivity were not eligible for the study so that the ADHD subgroup consisted only of children with ADHD combined type.

Sample
The number of children meeting inclusion criteria was 211. Of these, 165 had a DSM-IV diagnosis of ADHD combined type. Sample characteristics are presented in Table 1. A learning disability (LD) was defined as a significant discrepancy ($p < .05$) between reading, math, or written expression WIAT subtest scores and the score predicted based on the child's WISC-III FSIQ using the regression-based formula recommended in the WIAT manual. The discrepancy definition of LD was chosen because it is the most conventional and widely used indicator of LD (Sattler, 1988). Only children 8 years of age or older were included in the LD analyses, because the WIAT written expression subtest cannot be administered to younger children.

Instrument
The GDS is a portable, computerized continuous performance test normed on 1,266 4–16 year olds (Gordon & Mettelman, 1988). The GDS has three subtests (Delay, Vigilance, and Distractibility) designed to assess inattention and impulsivity. For the 8-min Delay task, the child is instructed to earn as many points as possible by pushing the response button. The child is told to wait before pushing the button again, otherwise a point will not be earned. Points are displayed on the screen, and the child must determine how long to wait to earn a point. The Delay task is programmed using a differential reinforcement of low rate responding (DRL) 6-s schedule, so that the child earns a point each time

Table 1. Sample Characteristics.

	ADHD (n = 165)			nonADHD (n = 46)				
	M	(SD)	Range	M	(SD)	Range	t	$p <$
Age (Yrs)	9.32	(2.61)	6–16	11.61	(2.89)	7–16	5.15	.0001
FSIQ	104.84	(14.20)	71–145	99.87	(10.84)	83–127	2.20	.03

	Percentage	Percentage	χ^2	$p<$
Male	81	63	5.28	.05
White	96	93	0.06	n.s.
Mood/behavior disorder[a]	39	70	12.53	.01
Learning disability	70	38	9.52	.01
Education beyond high school				
Mother	55	58	0.02	n.s.
Father	47	61	1.20	n.s.
Mother professional[b]	35	49	1.79	n.s.
Father professional	42	52	0.60	n.s.

[a] The most common mood and behavior disorders were oppositional defiant disorder, depression, anxiety disorder, adjustment disorder, and parent-child relational problem.
[b] Employed in a professional or managerial position.

he / she waits a minimum of 6-s. The Delay task is construed as a measure of the child's ability to inhibit impulsive responding. The Delay task yields an 'efficiency ratio,' or percentage of correct responses (number of points earned divided by total number of responses). According to the GDS manual (Gordon et al., 1996), the efficiency ratio is the 'best single Delay Task indicator of the level of impulsivity demonstrated by a subject' (p. 54).

The 9-min Vigilance task is based on the standard CPT paradigm. Single digits are randomly displayed one at a time in the center column on the screen. The child is told to press the button when a '1' is immediately followed by a '9.' This task yields two major scores (omission and commission errors) and assesses the child's ability to sustain attention, respond correctly, and inhibit incorrect responding.

On the 9-min Distractibility task, single digits randomly appear one at a time in all three columns on the GDS display screen. This time, the child is instructed to push the button when a '1' is followed by a '9' in the center column and to ignore the numbers to the right and left. The Distractibility task yields two main scores (omission and commission errors) and assesses the child's ability to screen out extraneous stimuli while responding correctly and inhibiting incorrect responding.

In the present study, eight GDS scores were used: (1) Delay (efficiency ratio or percentage of correct responses), (2) Vigilance Omissions, which is the number of 1/ 9 targets missed or the highest possible score (45) minus the number correct, (3) Vigilance Commissions (the number of commission errors or incorrect responses), (4) Vigilance composite (the average of the omission and commission scores), (5) Distractibility Omissions, (6) Distractibility Commissions, (7) Distractibility composite, and (8) GDS composite (the average of the scores for Delay, Vigilance composite, and Distractibility composite). To generate these scores, GDS raw scores were transformed into standard scores with a mean of 100 and standard deviation of 15 using the age norms reported in the GDS manual.

Data Analyses

Pearson correlation coefficients were used to investigate the linear relationship between IQ and the GDS composite score. The significance of differences between the eight GDS standard scores and the eight IQ-GDS discrepancy scores for children with and without ADHD was determined with general factorial analysis of variance with age as a covariate, to control for significant age differences between the two groups. Effect sizes (Cohen's *d*) were also calculated. The sign test was applied to compare the discriminative power of the GDS standard scores versus the IQ-GDS discrepancy scores. Chi-square with a Yates continuity correction was calculated to determine if classification accuracies differed significantly using the GDS composite versus the IQ-GDS composite discrepancy score. The impact of level of intelligence and the presence of a learning disability was analyzed for subgroups of children divided on these dimensions. A .01 significance level and two-tailed tests were used for all statistical analyses because of the large number of comparisons made.

Frequency data for the GDS composite standard score and IQ-GDS composite discrepancy score were analyzed to determine the cut-off score which was most accurate in differentiating between the ADHD and nonADHD groups and which yielded values for sensitivity and specificity that were relatively equal and were meaningfully above the ADHD and nonADHD sample base rates (78 and 22%, respectively). An ADHD base rate percentage in the mid to upper 70s is typical for samples of children referred to clinics similar to ours (Edwards, 1998).

The sample was divided into children who earned a normal versus abnormal GDS composite score (both relative to the norm and to IQ) in order to calculate the positive predictive power (PPP) and negative predictive power (NPP). PPP is defined as the percentage of children who had ADHD in the group of children who earned abnormal GDS scores, and NPP is the percentage of children who did not have ADHD in the group of children who earned normal GDS scores (Barkley, 1996). According to Barkley (1996), PPP and NPP are clinically more meaningful than sensitivity and specificity because they are consistent with clinical practice. In other words, clinicians obtain clinical data and then make a diagnosis, as opposed to being given a diagnosis and then determining if the clinical data are consistent with the diagnosis.

RESULTS

Relationship Between IQ and GDS Scores

For children with ADHD combined type, IQ correlated positively and significantly with the GDS composite ($r = .34$, $p < .0001$). In the nonADHD group, the correlation was nonsignificant ($r = -.01$).

GDS Scores for Children With and Without ADHD

As shown in Table 2, children with versus without ADHD differed significantly from each other on all of the GDS standard scores and IQ-GDS discrepancy scores, covarying age. For each of the GDS scores, the IQ-GDS discrepancy scores yielded greater effect sizes between children with and without ADHD than the corresponding GDS standard scores (Sign test $p < .01$). Of all the GDS scores, IQ minus the GDS composite resulted in the most significant difference between children with and without ADHD and the highest effect size.

GDS Composite Cut-off Scores

Scoring the GDS composite relative to IQ tended to be somewhat (7%) more accurate overall than scoring the GDS composite relative to the norm. This trend fell just short of statistical significancce, ($\chi^2 = 2.77$, $p > .05$. Using a 13-point or greater discrepancy between IQ and the GDS composite to classify children as having ADHD combined type resulted in the highest accuracy rate (86%), with a sensitivity of 90% and specificity of 70%. The best ADHD cutpoint for the GDS composite alone was a standard score less than 90 (79% classification accuracy).

Positive and Negative Predictive Power

Of the 153 children who earned an abnormal GDS composite standard score (below 90), 90% had a diagnosis of ADHD (positive predictive power or PPP). Of the 58 children whose GDS composite score was normal, 52% did not have ADHD (negative predictive power or NPP). PPP was 91% (149/163) when IQ minus the GDS composite was 13 points or greater, and NPP was 67% (32/48).

Learning Disability

Within the total group of children who had a learning disability (LD), the IQ-GDS composite discrepancy score differed significantly between children with and without ADHD, $F\ (2,79) = 7.08$, $p < .01$, $d = .89$. This was also true in the nonLD group, $F(2,48) = 20.34$, $p < .0001$, $d = 1.36$. The mean GDS composite standard score for clinical children without ADHD (90.80) was below the normal mean of 100 and near the ADHD cutpoint of 90. When children with LD were eliminated from the nonADHD group, the GDS mean composite increased to 95.06 (*SD* 12.33), and IQ minus the GDS composite decreased from 9.07 to 3.22 (*SD* 19.04).

Table 2. Differences in GDS Standard Scores and IQ-GDS Discrepancy Scores Between Children With and Without ADHD.

	ADHD ($n = 165$)		NonADHD ($n = 46$)				
	M	(*SD*)	*M*	(*SD*)	*F*	$p <$	d^a
Delay	59.40	(30.32)	80.73	(27.29)	18.71	.0001	.69
Vigilance omissions	79.64	(35.42)	98.68	(17.61)	12.25	.001	.57
Vigilance commissions	49.84	(82.33)	97.66	(26.80)	9.86	.01	.63
Vigilance composite	64.74	(52.16)	98.17	(20.33)	13.40	.001	.68
Distractibility omissions	83.46	(20.29)	98.04	(16.61)	8.50	.01	.71
Distractibility commissions	32.28	(84.92)	88.97	(47.97)	12.19	.001	.69
Distractibility composite	57.87	(47.53)	93.50	(28.78)	14.08	.001	.77
GDS composite	60.67	(32.85)	90.80	(19.07)	26.09	.0001	.92
IQ-Delay	45.44	(32.02)	19.14	(33.11)	22.78	.0001	.77
IQ-Vigilance omissions	25.20	(33.23)	1.19	(17.75)	20.70	.0001	.75
IQ-Vigilance commissions	55.00	(79.67)	2.21	(27.12)	12.99	.001	.71
IQ-Vigilance composite	40.10	(49.30)	1.70	(20.60)	19.73	.0001	.81
IQ-Distractibility omissions	21.38	(21.04)	1.83	(20.25)	16.18	.001	.88
IQ-Distractibility commissions	72.56	(82.63)	10.90	(46.63)	15.47	.001	.77
IQ-Distractibility composite	46.97	(45.64)	6.37	(28.85)	20.42	.0001	.89
IQ-GDS composite	44.17	(30.97)	9.07	(22.04)	38.47	.0001	1.08

[a] Effect sizes: .2 : small, .5 : medium, and .8 : large (Cohen, 1988).

DISCUSSION

Highly significant differences with medium to large effect sizes were found between children with and without ADHD on the GDS standard scores and the IQ-GDS difference scores for all of the GDS subtests and the GDS composite. The IQ-GDS discrepancy scores yielded greater effect sizes than the GDS standard scores. The IQ-GDS composite discrepancy score resulted in the largest effect size and the most significant difference between children with and without ADHD (probably because the composite score is more reliable than the individual subtest scores). The IQ-GDS composite discrepancy score also demonstrated a (statistically not significant) trend to yield somewhat higher accuracy in classifying children with and without ADHD than the GDS composite score alone.

Even though comparing GDS scores with IQ fared somewhat better than comparing GDS scores with the norm, the GDS composite standard score alone differed very significantly for children with and without ADHD. Therefore, when a child's IQ is not available, the GDS composite is still clinically useful because of its high diagnostic accuracy. The GDS composite cutpoint for ADHD that was most accurate (79%) was a standard score below 90 (which corresponds to a percentile of 25). This is consistent with the GDS Interpretive Guide (Gordon et al., 1996), which states that "scores that are above the twenty-fifth percentile are classified as normal" (p. 32).

The difference in classification accuracy using the GDS composite versus the IQ-GDS composite discrepancy score (79 and 86%, respectively) approximated but did not achieve statistical significance ($p > .05$). Positive predictive power for the GDS composite and IQ-GDS composite discrepancy score was similar (90 and 91%, respectively). However, negative predictive power was lower for the GDS composite (52%) than for the IQ-GDS composite discrepancy score (67%). Therefore, children who earned normal scores (GDS composite $\geq$ 90 or IQ-GDS composite $<$ 13) were more likely to be correctly classified as not having ADHD using the IQ-GDS composite discrepancy score than the GDS composite score. This may have practical and clinical significance in situations where it is critical to minimize the risk of misclassifying children who do not have ADHD.

Children with and without ADHD were identified with 86% accuracy (sensitivity 90% and specificity 70%). These results contradict recently published practice parameters by the American Academy of Child and Adolescent Psychiatry (Dulcan and the Work Group on Quality Issues, 1997), stating that CPTs 'generally are not useful in diagnosis because they suffer from low specificity and sensitivity' (p. 87S). Dulcan et al. (1997) referenced this statement with two old studies while neglecting newer research to the contrary (Corman, 1998). Our accuracy rates for the GDS compare favorably with those for other CPTs. For example, Edwards (1998) found that the Intermediate Visual and Auditory Continuous Performance Test (IVA CPT, Sandford & Turner, 1995) yielded 71% sensitivity and 64% specificity for a referred sample of children diagnosed with and without ADHD. Results were somewhat higher for the Test of Variables of Attention (TOVA) for clinical children with and without ADHD (sensitivity 80%, specificity 72%). When CPTs are used to differentiate between children with ADHD and nonreferred normal controls, accuracy rates are even higher (DuPaul, Anastopoulos, Shelton, Guevremont, & Metevia, 1992; Gordon et al., 1996; Halperin, Matier, Bedi, Sharma, & Newcorn, 1992). For example, when children with ADHD were compared with normal controls, the Conners' Continuous Performance Test had sensitivity and specificity values of 92 and 86% (Conners, 1994). The TOVA had a reported sensitivity of 89% and specificity of 90% (Greenberg, 1992), and sensitivity and specificity for the IVA CPT in a study in preparation were 92 and 90% (Sandford et al., 1995).

Diagnostic accuracy using the GDS was higher in our study than in studies of children evaluated in Barkley's ADHD clinic (Barkley & Grodzinsky, 1994; DuPaul et al., 1992; Grodzinsky & Barkley, in press). The lower accuracy reported by these studies may be in part because only one GDS subtest (Vigilance) was used, the scores were not interpreted relative to the child's IQ, the sample sizes were small, and the ADHD cutpoint chosen for the Vigilance subtest was very conservative (children scoring in the lower seventh percentile) and not the 25th percentile as recommended in the GDS manual (Gordon et al., 1996, p. 32). In contrast, our study established an optimal ADHD cutpoint for the IQ-GDS composite discrepancy score which maximized sensitivity and specificity.

Consistent with previous research, IQ correlated significantly and positively with the GDS composite in the ADHD group, explaining 12% of the variance. This, together with the finding that the IQ-GDS composite discrepancy score was the most accurate of the GDS scores in identifying children with and without ADHD, suggests that the best clinical practice is to use the GDS composite and score it relative to the child's IQ. In school psychological evaluations and most hospital- and community-based clinics, the WISC-III is routinely administered to children referred for diagnostic evaluations. Therefore, the child's IQ is often available to the clinician. In addition, current research using the WISC-III and WIAT shows that 70% of referred children with ADHD have a learning disability in reading, math, and/or written expression (Mayes, Calhoun, & Crowell, 2000). This percentage is higher than that reported in earlier studies because no previous prevalence study included an assessment of written expression, which is the most common type of LD in children with ADHD. Given this high incidence, it is advisable that children referred for an ADHD evaluation also be tested for a learning disability. This would entail IQ and academic achievement testing, which would also make it possible to compare the child's GDS score with IQ.

Referred children with ADHD in our study had a mean composite score on the GDS (61) that was far below the normal mean of 100 and far below the child's IQ (mean for IQ minus the GDS composite = 44). Even though these scores were significantly better in the nonADHD group, clinical children without ADHD still scored lower than the normal mean (GDS composite = 91) and lower than IQ (IQ minus the GDS composite = 9). However, when children with a learning disability (LD) were eliminated from the nonADHD clinical group, the GDS composite increased to 95 and IQ minus the GDS composite decreased to a mere 3 points. This is consistent with previous research showing that children who have a learning disability without ADHD earn low scores on psychometric measures of attention (Barkley & Grodzinsky, 1994; Dainer et al., 1981; Mayes, Calhoun, & Crowell, 1998; Robins, 1992; Swanson, 1981, 1983; Tarnowski, Prinz, & Nay, 1986). Similarly, a recent study (Mayes et al., 2000) showed that children without ADHD who had LD scored lower relative to IQ on both the GDS composite and the WISC-III Freedom from Distractibility index than did children without ADHD who had no LD. Among children with ADHD, children who had LD had a greater discrepancy between IQ and both the GDS composite and FDI than did children who had ADHD and no LD. These results suggest that children with LD may have some attention problems even if they do not meet the diagnostic criteria for ADHD and that the presence of LD in children with ADHD may intensify attention problems.

If children with LD have some degree of attention problem even though they fail to meet diagnostic criteria for ADHD, one would expect the discriminative power of the IQ-GDS discrepancy score to be greater for children without (versus with) a learning disability. This is what was found in our study. Though the IQ-GDS composite discrepancy score differed significantly between children with and without ADHD in both the LD and nonLD groups, the difference was considerably greater in the nonLD group.

Our tentative finding of near normal performance on the GDS for clinical children who have problems other than ADHD or LD (e.g., mood and behavior disorders) does not support the popular belief that inattention is a nonspecific symptom of psychopathology in children (Hall, Halperin, Schwartz, & Newcorn, 1997; Halperin et al., 1992), at least when attention is assessed using a continuous performance test. Therefore, the GDS may be helpful in differentiating between children who have a primary or inborn attention deficit (e.g., ADHD) and children whose apparent inattention is due to the interference of a mood or behavior problem.

Future research is now needed to determine if the IQ-GDS cutpoint established in our study is valid for other samples of referred children with and without ADHD. The accuracy of our cutpoint may decrease in replication studies because of shrinkage, and the predictive power of the IQ-GDS discrepancy score is likely to differ in other samples with different ADHD and LD base rates. Therefore, cross-validation is required.

One object of our study was to test the validity of a clinically simple means of comparing GDS performance with IQ. This was done by calculating an IQ-GDS discrepancy score. Using a discrepancy score has limitations (Fletcher et al., 1998; Shaywitz & Shaywitz, 1993), and a more complicated and sophisticated regression-based formula may yield greater accuracy than our simple discrepancy formula, particularly for children with above average intelligence who do not have ADHD. This needs to be investigated in future research. Future studies also should assess the possible impact of specific learning disabilities and comorbid mood and behavior disorders on GDS performance. In our study, children with various types of learning disabilities and mood and behavior disorders were grouped together because of small sample sizes.

Our study is also limited by the fact that there is no definitive means of diagnosing ADHD with 100% accuracy. It has been suggested that 'a gold standard for ADHD is far more a myth than a reality because there are significant and well-documented vulnerabilities associated with all diagnostic strategies' (Gordon et al., 1996, p. 34). Therefore, there is no guarantee that all children in our ADHD group indeed had ADHD combined type and that all children in our non-ADHD group did not have ADHD. However, we attempted to maximize diagnostic accuracy by conducting comprehensive multi-method and multi-source evaluations by both a licensed psychologist and by a physician (i.e., a child psychiatrist or developmental pediatrician) and by requiring diagnostic agreement between the psychologist and physician.

Our findings indicate that the GDS is potentially a clinically useful and meaningful part of an ADHD evaluation that adds unique and objective information to the diagnostic process. Components of an ADHD assessment do not always yield consistent data, and agreement regarding the presence or absence of ADHD may be poor when different sources and methods are compared (Mayes, 1987). A diagnosis of ADHD should be based on multiple sources and methods, including standardized parent, teacher and self-report scales; child and parent interviews; clinical observations; psychometric test data; and a review of school records, previous evaluations, and the child's history. All of these data should be considered to determine if the preponderance of evidence supports or fails to support a diagnosis of ADHD. As stated by Gordon and Barkley (1998), the GDS 'provides one source of information to be integrated with other sources in reaching a final diagnostic decision.' (p. 304)

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