An Analysis of Score Patterns of Children With Attention Disorders on the Sensory Integration and Praxis Tests

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Key Words: attention deficit disorder with hyperactivity • sensory integration

Objectives. *The purpose of this study was to identify and describe the score patterns of children with attention deficit hyperactivity disorder (ADHD) on the Sensory Integration and Praxis Tests (SIPT) and to determine whether their score patterns differ significantly from those of children without ADHD.*

Method. *In this retrospective study, the score patterns of 309 children with ADHD were compared with a group of 309 children without ADHD. The children were matched by norm group (reflecting age), gender, and the presence or absence of a learning disability. Both descriptive statistics and multivariate techniques were used.*

Results. *Subjects with ADHD demonstrated relative strengths in the areas of nonmotor visual perception and localization of tactile input and weaknesses with vestibular processing and in most areas of praxis or motor planning. Certain SIPT scores of subjects with ADHD were found to differ significantly from those of subjects without ADHD. The SIPT test that best discriminated the two groups was Space Visualization.*

Conclusions. *The results suggest that it may be helpful for therapists to consider the areas of praxis and vestibular processing in the evaluation and treatment of children with ADHD and that in clinical practice, it would be difficult to distinguish children with ADHD from those without on the basis of their SIPT scores. However, the ways in which the SIPT score patterns of children with ADHD differed from those without assist our understanding of the brain areas and neurological systems involved in children with ADHD.*

Attention disorders may be considered neurophysiological disorders because they are thought to result from a disruption in a functional system that involves the dynamic interaction of both neurochemical and neuroanatomical factors (Riccio, Hynd, Cohen, & Gonzalez, 1993). This disruption involves brain areas and neurological systems important for regulating levels of arousal, attention, organization, and inhibition (Copeland, 1995). In the fourth edition of the *Diagnostic and Statistical Manual* (DSM-IV; American Psychiatric Association, 1994), the overall diagnostic category for attention disorder was termed *attention deficit hyperactivity disorder* (ADHD), and two subtypes were included: *inattention type* and *hyperactivity–impulsivity type.* Criteria for diagnosis of ADHD are largely based on the presence and frequency of a number of behaviors that reflect inattention, impulsivity, and hyperactivity. For purposes of this article, attention disorders of either

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the inattention type or the hyperactivity–impulsivity type will be referred to as ADHD.

As many as 3% to 5% of the school-age population are believed to have an attention disorder (McBurnett, Lahey, & Pfiffner, 1993). In September 1991, the U.S. Department of Education issued a policy memorandum (Davila, Williams, & MacDonald, 1991) clarifying that children with ADHD were eligible to receive special education services classified under the Other Health Impaired category of the Individuals With Disabilities Education Act of 1990 (Public Law 101-476). Therefore, the number of children requiring services is increasing, and efforts are needed to enhance our understanding of these children and to determine the most effective ways to manage their difficulties both medically and educationally.

Children with ADHD are often referred for occupational therapy not because they have attention problems or hyperactivity, but because they have associated problems such as poor balance and motor coordination, poor visuomotor skills, and motor planning deficits (Cermak, 1991). These associated problems are often viewed as disorders of sensory integration (Fisher, Murray, & Bundy, 1991) and under the frame of reference of sensory integration and are believed to result largely from inadequate or inefficient sensory processing of the vestibular, somatosensory, and other sensory systems (Ayres, 1979). Sensory integration deficits are believed to affect a child's ability to perform motor and functional skills and may affect the way a child behaves, including his or her ability to attend, learn, organize, and maintain appropriate levels of activity (Cermak, 1988a).

Several researchers have noted an association between ADHD and sensory integration disorders (Cermak, 1988a; Holborow & Berry, 1986; Kimball, 1986; Oetter, 1986). This association is thought to be linked to the way in which the central nervous system responds to incoming sensory information (Cermak, 1988a). Some children with ADHD as well as some with sensory integration disorders have been identified as being underresponsive or hyporesponsive to various forms of sensory input, whereas other children with these disorders have been identified as being over-responsive or hyperresponsive (Cermak, 1988b; Royeen, 1985; Zentall & Zentall, 1983). Children with ADHD and children with sensory integration disorders also share some common characteristics: They are more likely to have been born prematurely (Als, 1986); they commonly have difficulties with schoolwork despite normal intelligence quotients (Ayres, 1972; Cantwell & Baker, 1992); and they often have motor coordination problems (Fisher, 1991; Holborow & Berry, 1986).

A multimodal approach is supported by many researchers as the most effective method of intervention with children with ADHD (Fiore, Becker, & Nero, 1993). Within this approach, the most common interventions include stimulant medication and parent training techniques (Anastopoulos, DuPaul, & Barkley, 1992). In the educational literature, strategies identified as being helpful in promoting the educational success of students with ADHD include behavior management techniques (Abramowitz & O'Leary, 1990; Fiore et al., 1993), classroom and curriculum accommodations, and cognitive training (Brown, Borden, Wynne, Schleser, & Clingerman, 1986; Fiore et al., 1993). However, empirical evidence in favor of nonpharmacological interventions for students with ADHD is weak (Fiore et al., 1993; Shaywitz & Shaywitz, 1992), and along with stimulant medication, these techniques appear to provide only short-term symptomatic relief.

Sensory integration techniques also may be effective in addressing many of the problem behaviors characteristic of children with ADHD, including inattention, disorganization, and hyperactivity (Bhatara, Clark, & Arnold, 1978; Bhatara, Clark, Arnold, Gunsett, & Smeltzer, 1981; Kantner & Tacco, 1980), but few studies have examined the efficacy of sensory integration therapy with children with ADHD. Zentall and Zentall (1983) suggested that the application of goal-directed sensory input, which is fundamental in sensory integration therapy, may energize or alert the central nervous system, which would reduce the hyperactivity and inattention of children with ADHD.

The purpose of this retrospective study was to examine scores of children with and without ADHD on a test of sensory integration to increase our understanding of the types of sensory integrative dysfunction seen in children with attention disorders. This study leads to an understanding of how and why sensory integration treatment may be of benefit to these children. Furthermore, by comparing scores of children with and without ADHD, we can come to understand which sensory systems are most involved in children with ADHD. The sensory integration test selected for these purposes was the Sensory Integration and Praxis Tests (SIPT; Ayres, 1989) because of its strong psychometric properties, detailed standardized administration procedures, and strong normative data. In this study, the following research questions were addressed:

1. How do children with and without ADHD perform on the individual SIPT tests?
2. What percentage of children with and without

ADHD fall into each of the six SIPT profiles?

3. Do children who are referred for sensory integration testing and who have ADHD score differently on the SIPT than children who do not have ADHD?

Method

Subjects

The SIPT data on subjects included in this retrospective study were provided from the existing data banks at Western Psychological Services in Los Angeles where all SIPT tests are computer scored. Approximately 10,000 children had been tested with the SIPT from July 1989 to October 1993 during the defined study period, representing children from most geographic regions of the United States and some parts of Canada. To be considered for the study, the following criteria were applied: (a) all 17 SIPT tests were scored; (b) the child's age was appropriate for the particular norm group selected; (c) the face transmittal sheet was considered complete, which included the child's grade, whether the child had a neurological impairment, and whether the child was in a special education class. The number of children meeting these criteria was 5,680.

Cases in which the administering therapist had checked the ADD (attention deficit disorder)/Hyperactivity category on the face transmittal sheet were included in the ADHD group (n = 309), and those without the ADD/Hyperactivity category checked were included in the NOADHD group (n = 5,371). A preliminary analysis of demographic data revealed that the cases in the ADHD group differed considerably from the cases in the NOADHD group with respect to three variables: the percentages of younger children (less than 6 years of age) and of girls was lower, and the percentage of children with learning disabilities was higher. Therefore, to select the NOADHD group, cases were matched with the ADHD group on the variables of gender, norm group, and learning disability so that the percentages represented by each of these variables within the two groups were equal (n = 309) (see Table 1).

Table 1
Subject Characteristics

Characteristic	ADHD Group n	ADHD Group %	NOADHD Group n	NOADHD Group %
Gender				
Boys	243	78.6	243	78.6
Girls	66	21.4	66	21.4
Norm group reflecting age				
1–3 (4 years–4 years 11 months)	10	3.2	10	3.2
4–6 (5 years–5 years 11 months)	36	11.7	36	11.7
7–9 (6 years–7 years 5 months)	116	37.5	116	37.5
10–12 (7 years 6 months–8 years 11 months)	147	47.6	147	47.6
Learning disability				
Yes	120	38.8	120	38.8
No	189	61.2	189	61.2
Race				
White	263	85.1	261	84.5
Black	13	4.2	12	3.9
Asian or Hispanic	11	3.6	13	4.2
Other or race information not available	22	7.1	23	7.4

Note. ADHD = attention deficit hyperactivity disorder; NOADHD = no attention deficit hyperactivity disorder; n = 309 for both groups

Instrument

The SIPT is a comprehensive, standardized battery of tests used to identify and measure sensory integration deficits in 4-year-old to 9-year-old children. It is typically administered to children who have mild disabilities, including learning disorders, motor delays, and behavioral problems such as hyperactivity, attention problems, or hypersensitivity to various forms of incoming sensory information. The SIPT consists of 17 individual tests that have been categorized into four overlapping areas: (a) visual form and space perception and visuomotor skills; (b) tactile, kinesthetic, and vestibular processing; (c) praxis; and (d) bilateral integration and sequencing (Ayres & Marr, 1991). Although the SIPT is made up of a number of individual tests, it is meant to be administered as a single battery and interpreted on the basis of the patterns of scores observed.

Initial content, criterion-related, and construct validity were established throughout the development of the earlier version of the SIPT, the Southern California Sensory Integration Tests (Ayres, 1980), and addressed in the development of the SIPT. Support for the constructs measured by the SIPT has been demonstrated by a number of factor analytic studies and cluster analyses (Ayres, 1965, 1977, 1989; Ayres, Mailloux, & Wendler, 1987). Cluster analyses identified groups of children who demonstrated similar score patterns or profiles on the SIPT (Ayres, 1989). A six-cluster solution was generated on the basis of both statistical criteria and clinical criteria. The following profile groups were identified: (a) Low–Average Bilateral Integration and Sequencing; (b) Generalized Sensory Integration Dysfunction; (c) Visuodyspraxia and Somatodyspraxia; (d) Low–Average Sensory Integration and Praxis; (e) Dyspraxia on Verbal Command; and (f) High–Average Sensory Integration and Praxis.

Interrater reliability was demonstrated as being adequate among therapists who were certified to administer the SIPT (Ayres, 1989). Test–retest reliability was found to be satisfactory for most of the tests. The tests with particularly weak test–retest reliability included Post-Rotary Nystagmus (PRN), Kinesthesia, Localization of Tactile Stimuli, and Figure–Ground Perception. More specific information regarding the reliability and validity can be found in the test manual (Ayres, 1989).

Computer scoring of the SIPT provided *Z* scores for each SIPT test. An SIPT profile that indicates whether the child is likened to any of the profile groups was also provided.

Results

All statistical analyses were done with SPSS for Windows, Release 6.0 (Norusis, 1993). To examine individual SIPT test scores, descriptive statistics, including means and standard deviations of the individual SIPT tests, were calculated (see Table 2). The mean test *Z* scores ranged from −1.73 to −.29. Overall, subjects in the ADHD group scored slightly lower than those in the NOADHD group. The pattern of scores, however, was remarkably similar in that both groups received the highest and the lowest scores on approximately the same tests. Subjects with ADHD scored the highest on Figure–Ground Perception, Localization of Tactile Stimuli, and Motor Accuracy, and they scored lowest on Design Copy, Standing and Walking Balance (SWB), and Postural Praxis.

To examine the percentages of subjects in each SIPT profile group, mean D^2 index scores and the percentages of subjects likened to each profile group were calculated for each profile (see Table 3). It is important to note that a subject may be likened to one or more profiles or to no profile and that a score (D^2 index) of less than 1 indicates that the subject is likened to that profile. The results indicated that relatively few subjects were likened to the profile groups; therefore, the D^2 mean scores reported are much greater than 1, ranging from 2.03 to 4.28. After examination of the percentages of subjects included in each profile, subjects in both groups were likened to the Low–Average Bilateral Integration and Sequencing profile most often, followed by the Low–Average Sensory Integration and Praxis profile and the Visuodyspraxia and Somatodyspraxia profile.

To determine differences between groups, multivariate techniques, including multivariate analysis of variance (MANOVA) and discriminative analyses, were applied to both the individual SIPT tests and the profiles. For the individual tests, the results of the MANOVA indicated that subjects in the ADHD group scored differently on the SIPT than did the subjects in the NOADHD group ($F = 2.14$, $p = .005$) (see Table 2). Subject mean scores on four tests in particular stood out as being different for the two groups and were significant well below the .01 level. Subjects with ADHD scored lower than subjects without ADHD on Design Copy ($p = .006$), Space Visualization ($p = .000$), PRN ($p = .006$), and SWB ($p = .002$).

MANOVA was also applied to the mean D^2 values to determine whether the SIPT profiles differed signifi-

Table 2
Descriptive Data of Individual Test *Z* Scores and Results of Univariate *F* Tests

	Mean (*Z* Scores)		Standard Deviation			
Test Name	ADHD	NOADHD	ADHD	NOADHD	F^a	*p*
Space Visualization	−0.89	−0.62	0.96	0.88	13.18	.000*
Figure–Ground Perception	−0.46	−0.30	1.10	1.07	3.00	.084
Standing and Walking Balance	−1.61	−1.28	1.40	1.26	9.28	.002*
Design Copy	−1.73	−1.37	1.64	1.57	7.52	.006*
Postural Praxis	−1.36	−1.22	1.42	1.36	1.58	.209
Bilateral Motor Coordination	−0.81	−0.73	1.13	1.08	0.68	.409
Praxis on Verbal Command	−1.15	−0.98	1.98	1.89	1.18	.277
Constructional Praxis	−0.73	−0.68	1.34	1.34	0.16	.690
Post-Rotary Nystagmus	−0.61	−0.29	1.39	1.49	7.58	.006*
Motor Accuracy	−0.60	−0.39	1.36	1.15	4.16	.042
Sequencing Praxis	−1.09	−0.92	1.20	1.17	3.51	.062
Oral Praxis	−1.23	−1.07	1.45	1.38	2.06	.152
Manual Form Perception	−0.78	−0.79	1.62	1.60	0.02	.890
Kinesthesia	−1.23	−1.01	1.77	1.70	2.38	.124
Finger Identification	−0.68	−0.53	1.27	1.22	1.96	.162
Graphesthesia	−1.21	−1.07	1.25	1.24	1.84	.175
Localization of Tactile Stimuli	−0.46	−0.43	1.91	1.65	0.31	.578

Note. ADHD = attention deficit hyperactivity disorder; NOADHD = no attention deficit hyperactivity disorder
[a] *df* = 1,616
*Significant at $p < .01$

Table 3
Percentage of Subjects Likened to Each Profile, Mean D^2 Index Values, and Univariate *F* Tests

Profile	% Subjects		Mean D^2 Index			
	ADHD	NOADHD	ADHD	NOADHD	F^a	*p*
Low–Average Bilateral Integration and Sequencing	18.4	28.2	2.68	2.27	4.17	.041
Low–Average Sensory Integration and Praxis	15.2	22.3	2.94	2.46	4.93	.027
Visuodyspraxia and Somatodyspraxia	16.2	20.4	2.23	2.03	1.73	.188
High–Average Sensory Integration and Praxis	9.4	13.3	4.28	3.60	5.60	.018
Dyspraxia on Verbal Command	9.7	13.6	2.41	2.16	3.15	.076
Generalized Sensory Integration Dysfunction	6.1	8.4	2.63	2.67	0.08	.778

Note. ADHD = attention deficit hyperactivity disorder; NOADHD = no attention deficit hyperactivity disorder
[a] *df* = 1,616

cantly between the two subject groups. The results indicated that there were no significant differences (F = 2.023, p = .061) at $p < .05$. The results of the univariate tests are reported in Table 3. Interestingly, the subjects in the ADHD group tended to be less often likened to profile groups than did subjects in the NOADHD group.

Discriminant analysis was then used to evaluate whether the individual tests could in combination construct a linear discriminant function that would differentiate children with attention disorders from children without attention disorders. This analysis tells us which of the tests were most helpful or most important in distinguishing the two subject groups. The direct method of analysis was used because this technique considers all variables simultaneously and therefore allows the examination of the interaction or relative importance of all the SIPT tests. One significant linear discriminate function was created, X^2(17 *df*) = 5.92, p = .0042. The relative importance of each variable is signified by the size of its standardized discriminant function coefficient (see Table 4). The discriminant function weighted Space Visualization most heavily, indicating that it was the most important test in distinguishing the subject groups. Constructional Praxis, Manual Form Perception, Design Copy, PRN, and SWB also provided significant contributions.

In summary, despite no significant differences in their SIPT profile groups, the subjects in the ADHD group scored differently on the individual SIPT tests than did those in the NOADHD group. Subjects with ADHD appeared to have more overall sensory integration dysfunction than the subjects without ADHD. The subjects with ADHD had particular difficulty with balance and most areas of praxis. Although the mean score of subjects with ADHD on Space Visualization indicated that nonmotor visual perception was a relative strength for them, Space Visualization was the test that best discriminated the two groups.

Discussion

Interpretation of the SIPT is a complicated process of examining individual test scores, considering the SIPT profile groups, and examining groups of test scores representing four factors or main skill areas (Fisher & Bundy, 1991). Although the difference identified in SIPT scores of subjects with and without ADHD was significant, it would be difficult for clinicians to distinguish between these children on the basis of their SIPT scores. Differentiation between these two subject groups is difficult because the mean scores of the tests that differentiated the two groups were scored similarly in terms of dysfunction. For example, the mean scores of both groups were within the average range on Space Visualization and PRN and within the dysfunctional range on SWB and Design Copy.

The results of this study do, however, contribute to

Table 4
Standardized Discriminant Function Coefficient of SIPT Individual Tests

Test	Standardized Value
Space Visualization	.624
Figure–Ground Perception	.162
Standing and Walking Balance	.306
Design Copy	.468
Postural Praxis	–.160
Bilateral Motor Coordination	–.133
Praxis on Verbal Command	–.097
Constructional Praxis	–.483
Post-Rotary Nystagmus	.447
Motor Accuracy	.086
Sequencing Praxis	.061
Oral Praxis	.126
Manual Form Perception	–.469
Kinesthesia	.066
Finger Identification	.150
Graphesthesia	–.037
Localization of Tactile Stimuli	–.091

Note. SIPT = Sensory Integration and Praxis Tests our understanding of which brain areas and neurological systems appear to be involved in children with ADHD. For example, the vestibular system plays a vital role in managing levels of attention and arousal, and the tests of vestibular function (PRN, SWB) were found to be important in differentiating children with ADHD from those without. Although the mean PRN score for subjects with ADHD was within normal limits, these subjects were more likely to have a below-average PRN score (46% of subjects with ADHD scored less than –1 vs. 32% of subjects without ADHD) than the subjects without ADHD. Although subjects in both groups were suspected of having sensory integration problems, the balance scores for subjects with ADHD were significantly lower than those of subjects without ADHD. In understanding the etiology of ADHD, the involvement of the vestibular system most closely relates to the neurophysiological perspective because this perspective emphasizes a complex interplay of a number of neural pathways, connections, and anatomical structures that is also characteristic of the vestibular system.

Although subjects with ADHD scored lower than those without ADHD on Space Visualization, the mean scores of subjects in both groups were within normal limits. Therefore, the importance of Space Visualization in discriminating the two groups may best be explained by test characteristics rather than by a specific neurological deficit area. Space Visualization is the first test to be administered on the SIPT, and because children with ADHD often experience more difficulty settling into the testing environment than those without ADHD, their scores on this first test may be negatively affected. It may be helpful, therefore, to first administer a fun pretest activity to gain the child's interest and attention and to help him or her settle into the testing environment before beginning standardized testing. Children who are impulsive, including most children with ADHD, are also at a disadvantage on taking the Space Visualization test because it requires that the child not touch the puzzle pieces until he or she is certain of the correct response. Children who are impulsive often experience difficulty resisting the temptation to touch the pieces; therefore, they may be penalized more often than children who are not impulsive. The suggestion in the SIPT test manual for the examiner to stabilize the blocks so that they cannot be moved before choice making may be an important consideration when administering the Space Visualization test to children with ADHD.

The results of this study identify some performance areas that occupational therapists may want to attend to when evaluating children with ADHD. Because children with ADHD often experience difficulty with balance functions and most areas of praxis, these areas as well as the ways in which deficits in these areas affect a child's daily functioning might be targeted for more thorough evaluation. Therapists might also use sensory integration treatment techniques to promote more normal vestibular processing and the development of motor planning abilities. Because the results identified relative strengths with visual perception and basic tactile processing, educators and occupational therapists might implement teaching strategies with children with ADHD that use these skill areas. For example, techniques such as visual cuing and demonstration and hands-on activities may be effective in promoting learning for children with ADHD.

Study Limitations and Research Implications

This study contained a number of limitations. First, children with ADHD had been tested with the SIPT not because they specifically had attention problems, but most likely because sensory integration deficits were suspected. Therefore, the subjects with ADHD are not representative of all children with ADHD; they represent only those who also demonstrate indications of sensory integration dysfunction. Further study of SIPT score patterns of children with confirmed ADHD conditions on the basis of the criteria set forth in the DSM-IV and with subjects without suspected sensory integration deficits is indicated to allow for more complete generalization to the ADHD population.

A second limitation was that the subjects with ADHD were classified as such by their therapists. Although many of the subjects in this group may have been given a formal diagnosis of ADHD, in some cases, therapists may have used their clinical judgment to discern an attention disorder, which increases the likelihood of different therapists using slightly different criteria for classifying a child as having ADHD. This limitation is partially compensated for by the relatively large number of cases used in the present study's analyses.

A third limitation is the psychometric properties of the SIPT. As a relatively new test, few follow-up studies have been conducted to support its reliability and validity. Specifically, test–retest reliability is questionable for some of the individual tests (of particular concern is PRN, which was found to be a discriminator in this study). The factor analytic and cluster analytic studies that have been done to identify specific patterns of dysfunction, including the profile groups of the SIPT, also require further investigation to confirm their existence and importance in the interpretation process of the SIPT scores of children.

Several research directions are supported by the results of this study. Further examination and understanding of the types of vestibular processing difficulties and motor planning abilities of children and adults with attention disorders may provide some guidance with respect to treatment as well as increase our understanding of the clinical presentation of persons with ADHD. Studies that examine the sensorimotor abilities of children and adults who have been diagnosed with ADHD (on the basis of DSM-IV criteria) and who have not been referred for occupational therapy or treated by occupational therapists would also allow for more complete generalization of the types of sensorimotor deficits commonly associated with ADHD. In addition, studies that examine the psychometric properties of the SIPT and look at the types of score patterns seen in other disability groups would be helpful to determine the test's usefulness as a diagnostic tool. ▲

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References

Abramowitz, A. J., & O'Leary, S. G. (1990). Effectiveness of delayed punishment in an applied setting. *Behavior Therapy, 21,* 231–239.

Als, H. (1986). A syntactic model of neurobehavioral organization: Framework for the assessment of neurobehavioral development in the premature infant and support of infants and parents in the neonatal intensive care unit. *Physical and Occupational Therapy in Pediatrics, 6*(3/4), 3–55.

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.

Anastopoulos, A. D., DuPaul, G. J., & Barkley, R. (1992). Stimulant medication and parent training therapies for attention deficit-hyperactivity disorder. In S. Shaywitz & B. Shaywitz (Eds.), *Attention deficit disorder comes of age* (pp. 273–292). Austin, TX: PRO-ED.

Ayres, A. J. (1965). Patterns of perceptual–motor dysfunction in children: A factor analytic study. *Perceptual and Motor Skills, 20,* 335–368.

Ayres, A. J. (1972). Types of sensory integration dysfunction among disabled learners. *American Journal of Occupational Therapy, 26,* 13–18.

Ayres, A. J. (1977). Cluster analyses of measures of sensory integration. *American Journal of Occupational Therapy, 31,* 362–366.

Ayres, A. J. (1979). *Sensory integration and the child.* Los Angeles: Western Psychological Services.

Ayres, A. J. (1980). *Southern California Sensory Integration Tests manual, revised.* Los Angeles: Western Psychological Services.

Ayres, A. J. (1989). *Sensory Integration and Praxis Tests.* Los Angeles: Western Psychological Services.

Ayres, A. J., Mailloux, Z., & Wendler, C. L. (1987). Developmental dyspraxia: Is it a unitary function? *Occupational Therapy Journal of Research, 7,* 93–110.

Ayres, A. J., & Marr, D. B. (1991). Sensory Integration and Praxis Tests. In A. Fisher, E. Murray, & A. Bundy (Eds.), *Sensory integration theory and practice* (pp. 203–233). Philadelphia: F. A. Davis.

Bhatara, V., Clark, D. L., & Arnold, L. E. (1978). Behavioral and nystagmus response of a hyperkinetic child to vestibular stimulation. *American Journal of Occupational Therapy, 32,* 311–316.

Bhatara, V., Clark, D. L., Arnold, L. E., Gunsett, R., & Smeltzer, D. J. (1981). Hyperkinesis treated by vestibular stimulation—An exploratory study. *Biological Psychiatry, 16,* 269–279.

Brown, R., Borden, K., Wynne, M., Schleser, R., & Clingerman, S. (1986). Methylphenidate and cognitive therapy with ADD children: A methodological reconsideration. *Journal of Abnormal Child Psychology, 14,* 481–497.

Cantwell, D. & Baker, L. (1992). Association between attention deficit-hyperactivity disorder and learning disorders. In S. Shaywitz & B. Shaywitz (Eds.), *Attention deficit disorder comes of age* (pp. 145–164). Austin, TX: PRO-ED.

Cermak, S. (1988a, June). The relationship between attention deficit and sensory integration disorders (part 1). *Sensory Integration Special Interest Section Newsletter, 11*(2), 1–4.

Cermak, S. (1988b, September). The relationship between attention deficit and sensory integration disorders (part 2). *Sensory Integration Special Interest Section Newsletter, 11*(3), 3–4.

Cermak, S. (1991). Somatodyspraxia. In A. Fisher, E. Murray, & A. Bundy (Eds.). *Sensory integration theory and practice* (pp. 137–161). Philadelphia, F. A. Davis.

Copeland, E. (1995.) *Attention without tension: A teacher's handbook to attention disorders [ADHD/ADD].* Plantation, FL: Specialty Press.

Davila, R. R., Williams, M. L., & MacDonald, J. T. (1991). *Clarification of policy to address the needs of children with attention deficit disorder within general and/or special education* (Policy memorandum of September 16, 1991). Washington, DC: U.S. Department of Education, Office of Special Education and Rehabilitative Services.

Fiore, T., Becker, E., & Nero, R. (1993). Educational interventions for students with attention deficit disorder. *Exceptional Children, 60*(2), 163–173.

Fisher, A. (1991). Vestibular–proprioceptive processing and bilateral integration and sequencing deficits. In A. Fisher, E. Murray, & A. Bundy (Eds.), *Sensory integration theory and practice* (pp. 71–104). Philadelphia: F. A. Davis.

Fisher, A., & Bundy, A. (1991). The interpretation process. In A. Fisher, E. Murray, & A. Bundy (Eds.), *Sensory integration theory and practice* (pp. 234–249). Philadelphia: F. A. Davis.

Fisher, A., Murray, E., & Bundy, A. (1991). *Sensory integration theory and practice.* Philadelphia: F. A. Davis.

Holborow, P. L., & Berry, P. S. (1986). Hyperactivity and learning disabilities. *Journal of Learning Disabilities, 19,* 426–431.

Individuals With Disabilities Education Act of 1990. (Public Law 101-476). 20 U.S.C. Chapter 33.

Kantner, R., & Tacco, A. M. (1980). Comparison of vestibular stimulation effects on classroom behavior of two hyperactive children with different hyperactive characteristics. *Perceptual and Motor Skills, 50,* 766.

Kimball, J. G. (1986). Prediction of methylphenidate (Ritalin) responsiveness through sensory integrative testing. *American Journal of Occupational Therapy, 40,* 241–248.

McBurnett, K., Lahey, B., & Pfiffner, L. (1993). Diagnosis of attention deficit disorders in DSM-IV: Scientific basis and implications for education. *Exceptional Children, 60*(2), 108–117.

Norusis, M. (1993). *SPSS for Windows* (Base system, release 6.0). Chicago: SPSS Inc.

Oetter, P. (1986, June). A sensory integrative approach to the treatment of attention deficit disorders. *Sensory Integration Special Interest Section Newsletter, 9*(2), 1–2.

Riccio, C., Hynd, G., Cohen, M., & Gonzalez, J. (1993). Neurological basis of attention deficit hyperactivity disorder. *Exceptional Children, 60*(2), 118–124.

Royeen, C. B. (1985). Domain specifications of the construct tactile defensiveness. *American Journal of Occupational Therapy, 39,* 596–599.

Shaywitz, S., & Shaywitz, B. (1992). *Attention deficit disorder comes of age.* Austin, TX: PRO-ED.

Zentall, S. S., & Zentall, T. R. (1983). Optimal stimulation: A model of disordered activity and performance in normal and deviant children. *Psychological Bulletin, 94,* 446–471.