Specificity of Inattention, Impulsivity, and Hyperactivity to the Diagnosis of Attention-deficit Hyperactivity Disorder

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Abstract. Children with attention-deficit hyperactivity disorder (ADHD) were compared with non-ADHD psychiatric patients and normal controls on objective measures of inattention, impulsivity, and hyperactivity to determine the specificity of these symptoms to ADHD. Inattention and impulsivity were assessed using a continuous performance test, and activity was measured using solid state actigraphs. Both patient groups were inattentive relative to normals, but were indistinguishable from each other. However, the ADHD group was more active than both non-ADHD patients and normals, who did not differ from each other. These data suggest that inattention may be a nonspecific symptom of child psychiatric disorder. However, ADHD may be uniquely characterized by overactivity. J. Am. Acad. Child Adolesc. Psychiatry, 1992, 31, 2:190–196. Key Words: attention-deficit hyperactivity disorder, inattention, impulsivity, hyperactivity.

Since the introduction of DSM-III (American Psychiatric Association, 1980), inattention, impulsivity, and overactivity have been considered to be the cardinal symptoms of attention-deficit hyperactivity disorder (ADHD). This characterization is based upon an extensive literature indicating that groups of ADHD children are more inattentive, impulsive, and overactive than normal controls. Purposely measured of these constructs, including behavior rating scales (Conners, 1969; McGee et al., 1984), observational procedures (Abikoff et al., 1977; Atkins et al., 1985; Milich et al., 1982), continuous performance tests (Klee and Garfinkel, 1983; Sykes et al., 1971), psychometric tests (Campbell et al., 1971; Tant and Douglas, 1982), and actigraphs (Porrino et al., 1983b) have all found ADHD children to score higher than normal controls. Furthermore, treatment with stimulant medication, which provides symptomatic relief to the majority of ADHD children, results in improved performance on most of these measures (Campbell et al., 1971; Porrino et al., 1983a; Rapoport et al., 1980; Rapport et al., 1988; Sykes et al., 1971). Despite the fact that measures of inattention, impulsivity, and activity level appear elevated in ADHD children as compared with normal controls, the specificity of these symptoms to ADHD has not been demonstrated. Children with learning disabilities (Dykman et al., 1979; Swanson, 1981), conduct disorders (Klee and Garfinkel, 1983; Shapiro and Garfinkel, 1986), and those at high risk for schizophrenia (Cornblatt and Erlemeyer-Kimling, 1985; Nuechterlein, 1983; Rutschmann et al., 1977, 1986) have all shown to perform poorly on purported measures of attention. Furthermore, despite the fact that ADHD children are impaired in comparison with normal controls on most measures of attention, studies attempting to distinguish them from other patient groups have generally yielded negative results (Kothari et al., 1985; Shapiro and Garfinkel, 1986; Werry et al., 1987).

Similarly, presumed measures of impulsivity, such as the Matching Familiar Figures or Porteus Maze test, have been found to distinguish both ADHD and non-ADHD patients from normal controls (Roberts and Erikson, 1968; Tant and Douglas, 1982), but their ability to distinguish between ADHD and other patient groups have been inconsistent (Kothari et al., 1985; Loney and Milich, 1982; Tant and Douglas, 1982).

For a variety of methodological reasons (for review, see Conners and Kronberg, 1985) activity level has proven to be quite difficult to objectively measure in children, though its central importance in ADHD has been recognized in DSM-III-R (American Psychiatric Association, 1987). Porrino et al. (1983b) convincingly demonstrated that ADHD children are more active than normal controls in virtually every situation. Yet, few studies (Kothari et al., 1985; Loney and Milich, 1982) have compared ADHD children with other patient groups using objective measures to determine the specificity of this symptom domain to ADHD.

Thus, the data are relatively consistent regarding the fact that, as compared with normal controls, groups of ADHD children are inattentive, impulsive, and hyperactive. Yet, questions remain as to whether these deficits are unique to this diagnostic group or whether they are symptoms that are characteristic of a variety of childhood psychiatric and cognitive disturbances.

To determine the specificity of these symptom dimensions, it is essential that they each be assessed using independent, objective measures that selectively assess the relevant psychological/behavioral construct, rather than more global measures of disturbances. Thus, although rating...
scales may have considerable ecological validity for assessing the ADHD syndrome, they are of limited value for assessing the specificity of individual symptom dimensions to this syndrome. Teacher ratings of inattention and overactivity are consistently reported to be highly correlated with each other (for review see Hinshaw, 1987), and have been found to be more highly associated with the presence of disruptive/aggressive behavior than observed (Schachar et al., 1986) or objectively measured (Halperin et al., 1990a) assessments of the specific constructs. Similarly, most psychometric measures of attention and impulsivity are confounded by a variety of perceptual, academic, or linguistic skills that are also necessary for good performance (for review, see Halperin et al., 1991a). As a result, performance on many psychometric tests is highly related to IQ.

Recently, through modifications of the continuous performance test (CPT), it has been possible to develop objective measures of inattention and impulsivity that are uncorrelated with each other and IQ, reliable over an extended period of time, and for which several forms of construct validity have been ascertained (Halperin et al., 1988, 1991b, in press). Similarly, solid state actigraphs appear to provide accurate, objective, and reliable measures of activity level that are distinct from objective measures of attention and impulsivity (Porrino et al., 1983a, 1983b, Reichenbach et al., 1992).

This study was designed to compare CPT performance and actigraph measures in ADHD children, non-ADHD psychiatric patients, and normal controls to determine the specificity of inattention, impulsivity, and hyperactivity to the ADHD syndrome.

**Method**

**Subjects**

The subjects were 102 children (84 patients and 18 normal controls) between 6.5 and 13 years old. The patient group consisted of unmedicated referrals, within the specified age range, to the child psychiatry outpatient clinic of an urban medical center between November 1989, and August 1990, for whom a complete diagnostic evaluation could be completed. Among the patients, 65 were boys and 19 were girls. The normal controls were nonreferred boys who were recruited from a neighborhood school containing children similar to the patients in ethnic and socioeconomic background. The children were primarily black and Hispanic, and of lower to middle socioeconomic status.

**Diagnostic Procedures**

Each patient was evaluated by a clinician, who was blind to all psychometric data, in the following manner. During their initial contact with the clinic, parents were informed about the evaluation procedures during a parent orientation session and were asked to complete the Child Behavior Checklist (CBCL) (Achenbach and Edelbrock, 1983). In addition, a copy of a school information form, which included the Conners Teacher’s Questionnaire (CTQ) (Goyette et al., 1978), was sent to the child’s teacher. Subsequently, over a period of about 2 weeks, a series of clinical interviews were conducted with the parent and child both separately and together.

After the evaluation, using all available information, the clinician completed a 70-item scale that consisted of the DSM-III-R items for ADHD, oppositional-defiant disorder, conduct disorder, separation anxiety disorder, overanxious disorder, avoidant disorder, major affective disorder, and dysthymia, listed in a randomized order. Each symptom was rated by the clinician as present or absent. If the clinician felt that he or she was unable to accurately assess each item with the available information, he or she was asked to review the item in question with the child’s parent to gather the information. Research diagnoses were then generated using a computer algorithm based upon DSM-III-R criteria. Children with evidence of psychosis and/or neurological disorders were eliminated from the study, as were those receiving psychotropic medication.

Normal control children were recruited from a parochial school in the neighborhood of the clinic where the children were well matched to the patients with regard to ethnic and socioeconomic factors. Teachers of the normal controls also completed the CTQ and most parents completed the CBCL.

**Psychometric Measures**

Each child was administered a 1-hour psychometric test battery by an examiner who was blind to the child’s diagnosis. The battery consisted of the Raven’s Coloured Progressive Matrices (RCPM) (Raven et al., 1985) and the Peabody Picture Vocabulary Test-Revised (PPVT-R) (Dunn and Dunn, 1981), which were used to estimate overall cognitive functioning; the Reading/decoding subtest of the Wide Range Achievement Test-Revised (WRAT-R) (Jastak and Wilkinson, 1984) and the Reading Comprehension subtest of the Peabody Individual Achievement Test-Revised (PIAT-R) (Markwardt, 1989), which were used to assess academic achievement; and a CPT (Halperin et al., 1991c), to objectively assess attention and impulse control. Activity level was measured throughout the test session.

The CPT was modelled after the A-X task of Rosvold et al. (1956) and run on laptop computers (Toshiba, Model T1200). It consisted of 11 letters that were presented in a quasi-random order for a total of 400 letters. Each letter was presented for a duration of 200 milliseconds with a 1.5-second interstimulus interval. There was a 10% target frequency and the entire task lasted approximately 12 minutes. The CPT generated three measures, inattention, impulsivity, and dyscontrol, which are described in more detail elsewhere (Halperin et al., 1988, 1991b, 1991c). These inattention and impulsivity scores have been reported to have greater test-retest reliability and construct validity than the more commonly used omission and commission errors (Halperin et al., 1988, 1991b, 1991c). The less specific measure of dyscontrol has been found to correlate with behavior problems in children, but the precise function it assesses is less clear and its test-retest reliability is considerably lower than the measures of inattention and impulsivity (Halperin et al., 1991c).

Activity level was assessed using an acceleration-sensitive device with solid state memory that stores data on the number of movements per unit time. This monitor, which weighs 3 ounces, was worn in a pouch in a belt around
the waist. Similar devices have been found to discriminate activity level between ADHD and normal boys (Porrino et al., 1983b) and between stimulant and placebo-treated ADHD children (Porrino et al., 1983a). The actigraphs were used only during the assessment session to ensure that activity level was measured from all children in a similar setting. Assessments using these instruments during structured test sessions have been shown to have good test-retest reliability and to generate measures that are correlated with both parent and teacher ratings of hyperactivity (Reichenbach et al., 1992).

Data Analysis

The groups were compared on all age-standardized measures (i.e., RCPM, PPVT-R, WRAT-R, PIAT-R, and CBCL) using one-way analysis of variance. They were compared on the nonstandardized CTQ, CPT, and activity level measures using analysis of covariance (ANCOVA) controlling for age. Where significant overall Fs emerged, post hoc pairwise comparisons were conducted using the Tukey-Kramer method, with the age-controlled means where indicated.

Results

The patients were divided into two groups based upon the presence or absence of ADHD. Within the ADHD group (N = 31), 20 children also met criteria for another disruptive behavior disorder, nine had at least one anxiety disorder diagnosis, and five had an affective disorder. Only nine ADHD children had no other comorbid diagnosis. The non-ADHD group (N = 53) consisted of 19 children with a disruptive behavior disorder other than ADHD (i.e., conduct or oppositional-defiant disorder), 15 with at least one anxiety disorder diagnosis, and seven with an affective disorder. Despite referral to a child psychiatric clinic, 25 children in the non-ADHD group did not meet full diagnostic criteria for any of the eight DSM-III-R diagnoses on the scale; most of these children had subthreshold symptomatology and would likely have qualified for a diagnosis of adjustment disorder. Overall, the ADHD group had significantly [t(82) = 4.82, p < 0.001] more diagnoses than the non-ADHD group (mean = 2.48, range = 1–7 vs. mean = 1.00, range = 0–6).

As shown in Table 1, the three groups did not differ significantly in age, although the non-ADHD patient group was somewhat older than the other two groups. Similarly, the groups did not differ significantly (χ² = 5.35, p > 0.05) in their sex distribution, but there was a somewhat greater proportion of boys in the control group (100%), as compared with the ADHD (80.6%) and non-ADHD patient groups (75.5%). However, the groups did differ significantly on all four measures of cognitive and academic functioning such that the control group performed better than the two patient groups, who did not differ from each other.

Table 2 shows the group comparisons on the CTQ and the CBCL. There were significant group differences on all three factors of the CTQ. Post hoc analyses indicated that the two patient groups were rated as significantly more impaired than controls on the conduct problems and inattention-passivity factors, whereas the ADHD group was rated significantly higher than both the non-ADHD patient group and the normal controls on the hyperactivity factor. There were no significant group differences for the internalizing scale of the CBCL, but on the externalizing and total behavior problems scales, the ADHD group scored significantly higher than the normal controls.

Analyses of covariance yielded significant group differences on the CPT measures of inattention, impulsivity and dyscontrol, and on the actigraph measure of activity level (Fig. 1). Post hoc testing revealed that both the ADHD and non-ADHD patient groups performed significantly poorer than the normal controls on CPT-inattention and dyscontrol, but the two patient groups did not differ significantly from each other. For CPT-impulsivity, the ADHD group performed significantly worse than the normal controls, whereas the non-ADHD patient group was statistically indistinguishable from either of the other two groups. Finally, the ADHD group was significantly more active than both the non-ADHD patients and the normal controls, who did not differ from each other.

Because the two patient groups had significantly lower scores on measures of cognitive function than the normal control group, the CPT and activity data were reanalyzed using ANCOVAs controlling for score on the RCPM, in addition to age. There were no changes in the findings; all significant and nonsignificant group differences remained.

To ensure that the results were not due to differences in sex
distribution, the analyses were redone using only the male subjects (81.4% of the sample). Again, there were no changes in the findings; all significant and nonsignificant group differences remained.

To rule out the possibility that the ADHD group was most impaired on the objective symptom measures because they had the greatest number of diagnoses, the ADHD children were divided into those with ADHD only \( (N = 9) \) and those with ADHD plus other comorbid diagnoses \( (N = 22) \). There were no significant differences between these two ADHD groups on any symptom measure (Table 3).

To rule out the possibility that the patient group differences were due to the fact that many non-ADHD children had less severe disorders, as suggested by the fact that they did not meet criteria for any of the Axis I diagnoses on the scale, the non-ADHD group was divided into those who did \( (N = 28) \) and did not \( (N = 25) \) meet criteria for any of the diagnoses obtainable from the scale. There were no significant differences between these two non-ADHD patient groups on any measure (Table 4).

**Discussion**

This study was designed to objectively assess inattention, impulse control, and activity level in ADHD patients, non-ADHD patients, and normal controls to determine whether abnormalities of these behavioral dimensions uniquely characterize children diagnosed as having ADHD. The data suggest that ADHD children can be distinguished from both normals and other patient groups using an objective measure of activity level, and that unlike psychiatric controls they are more impulsive than normal children. However, ADHD and non-ADHD child psychiatric patients do not differ with regard to inattention, although both groups are more inattentive than normal controls. The data generated by the objective measures were consistent with teacher ratings, which also found ADHD children to be hyperactive relative to both non-ADHD patients and normal controls, while both patient groups were found to be inattentive. These findings could not be accounted for by group differences in age, gender, IQ, or socioeconomic status. Each of these variables was
complex nature of attention, it remains conceivable that different types of attentional problems (e.g., selective vs. sustained attention) are present in different patient groups. Although the CPT is generally considered to be a measure of sustained attention, the data were not analyzed for performance changes over time. Thus, no firm conclusion regarding the type of attentional deficit can be drawn (van der Meer and Sergeant, 1988).

Alternatively, inattention may be characteristic of a wide range of child psychiatric disorders. The non-ADHD patient group in this study contained children with a variety of different diagnoses. Thus, it is not clear whether inattention is characteristic of only a few child psychiatric disorders or whether it is a nonspecific symptom of all childhood psychiatric disorders. Further studies with larger samples of children with relatively pure diagnoses other than ADHD will be required to answer this question. Because of the high degree of comorbidity in this sample, the number of children with pure anxiety (N = 8), pure affective (N = 1), or pure conduct (N = 9) disorders was too few to adequately answer this question. The authors are continuing to collect data from these diagnostic groups in an attempt to address this issue in the future.

These findings may have important implications for clinical practice. The high proportion of non-ADHD children who are inattentive suggests that children with other psychiatric diagnoses are at risk to be mislabeled ADHD, simply because the ADHD diagnosis carries the name of the symptom domain. Furthermore, the data suggest that treatment interventions that target inattention might be applicable to non-ADHD as well as ADHD children.

As with all laboratory measures of childhood psychopathology, the ecological validity of these measures must be considered. Whereas the CPT measure of inattention has considerable face validity, its ecological validity has been called into question (Barkley, 1991). The CPT measure of inattention used in this study was found to have good test-retest reliability over durations of up to several months (Halperin et al., 1991c), has been found to be selectively correlated with teacher ratings of inattention (Halperin et al., 1988), improves following stimulant medication (Matier
et al., 1992), and distinguishes ADHD children from normal controls.

Several lines of data also support the validity of this CPT measure of impulsivity. Unlike total false alarms, which have low test-retest reliability, this measure of impulsivity, based upon false alarm subtype analysis, has good test-retest reliability (Halperin et al., 1991c). Furthermore, the error subtypes that comprise this score have been found to occur at distinct reaction times that follow a priori cognitive processing models of impulsivity (Halperin et al., 1988, 1991b), distinguish aggressive and nonaggressive hyperactive children (Halperin et al., 1990b), and correlate with teacher ratings of impulsivity, but not inattention (Halperin et al., 1988).

Finally, the actigraph measure of activity level has been found to distinguish ADHD children from controls (Portno et al., 1983b) and stimulant from placebo-treated ADHD children (Portno et al., 1983a) in naturalistic settings. However, even within a 1-hour test session, actigraph scores have been reported to have good test-retest reliability and to be correlated with both parent and teacher ratings of hyperactivity (Reichenbach et al., 1992). Interestingly, this method of measuring activity level may serve to best quantify movements such as "fidgeting," which are likely to occur in the classroom. In this study, group comparisons on the actigraph measure paralleled the findings derived from teacher ratings of hyperactivity. These findings were not due to severity of disorder, as assessed by the number of diagnoses. If anything, the pure ADHD children were more active than those with additional comorbid diagnoses.

In summary, the data suggest that ADHD children are uniquely characterized by hyperactivity, but not inattention. Further research is necessary to more clearly delineate whether inattention is a symptom uniquely characteristic of a few specific child psychiatric disorders, a nonspecific symptom of all child psychiatric disorders, or one of several aspects of learning and cognitive problems seen in a wide range of patients.

References


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From Pediatrics

Long-Term Mental Health Effects of a Pediatric Home Care Program.  Ruth E.K. Stein, M.D., and Dorothy Jones Jessop, Ph.D.

Abstract. The increased survival of youngsters with chronic physical disorders has led to concern about their long-term psychological adjustment. Few data are available on how to reduce the psychological morbidity that occurs in the presence of chronic childhood illness. An earlier report of a randomized controlled trial of a pediatric home care program demonstrated that this program, combining comprehensive biomedical and psychosocial care, reduced the short-term psychological morbidity of those receiving home care. However, data have not previously been available on whether the short-term improvement in adjustment is associated with any long-term benefits. This report presents long-term follow-up data collected 4½ to 5 years after enrollment on 68% of the original sample. After this interval there were even larger differences between the experimental and control groups than those previously observed at 6 months and 1 year. This finding provides strong evidence that a comprehensive family-oriented outreach program for youngsters with chronic physical disorders can have long-term mental health benefits. It should encourage clinicians to develop similar programs and investigators to look for long-term effects of other interventions. Pediatrics 1991;88:490-496.


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