CLINICAL AND NEUROPSYCHOLOGICAL MANIFESTATIONS OF ATTENTION-DEFICIT/HYPERACTIVITY DISORDER IN PRESCHOOL CHILDREN

by

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Abstract

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Adviser: Jeffrey Halperin, Ph.D.

Objectives: To examine the following five sets of issues in a non-referred sample of preschool children: (a) the factor structure of AD/HD behaviors, (b) gender differences in AD/HD symptoms and subtypes, c) agreement between parents and teachers regarding AD/HD diagnoses and symptom severity, d) the relationship of AD/HD symptoms to neuropsychological status, and e) familial correlates of AD/HD symptoms. **Method:** Ratings of AD/HD symptoms were obtained from parents and teachers of preschoolers (N=212) in the New York Metropolitan Area. Following group classification [i.e., at risk (AR) vs. control (CT)], a subgroup of participants (N=72) was invited to participate in an on-campus assessment. **Results:** Factor analytic methods applied separately to parent and teacher ratings each yielded a two-factor solution (Parent: Hyperactivity-Impulsivity, Inattention; Teacher: Hyperactivity-Impulsivity, Hyperactivity-Inattention). AD/HD symptoms and subtypes were more prevalent in preschool boys. Parent and teacher ratings of AD/HD symptom domains were moderately correlated; however, agreement regarding diagnostic status was poor. AR children received significantly higher scores on laboratory measures of activity level and performed significantly worse than CT's on measures of nonverbal working memory and motor inhibition. AR preschoolers were significantly more noncompliant than CT's during parent-child interactions. Mothers of AR preschoolers exhibited more negative behavior and less encouragement under structured conditions. No differences were found between the disciplinary practices reported by parents of AR and CT preschool children. **Conclusions:** Group differences in neuropsychological status and parenting practices seem to emerge during the preschool years, and may underlie early behavioral expressions of the disorder. When assessed longitudinally, these factors may distinguish those with early manifestations of AD/HD from "phenocopies" who do not go on to develop the disorder.

ACKNOWLEDGEMENTS

Several years ago, the National Institute of Mental Health (NIMH) released a consensus statement outlining key research directions in the field of child psychopathology. Among them was the need to identify the early manifestations of Attention-deficit/Hyperactivity Disorder (AD/HD) and risk factors associated with the continuity of childhood externalizing behavior. Shortly thereafter, I approached Dr. Jeffrey Halperin and expressed interest in exploring such issues. Although the idea involved venturing into uncharted waters, Dr. Halperin welcomed the idea with open arms, and committed himself fully to cultivating this new program of research. For the past nine years that I have worked with Dr. Halperin he has always taken the time, often from a demanding schedule, to support my research and clinical aspirations. I am eternally grateful for the confidence he has inspired, the personal and professional growth he has fostered, and his unwavering commitment to bettering the lives of children and their families.

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Last, but not, least, I want to extend my heartfelt gratitude to my mother, Diane Marks, grandmother, Vivian Fein, and close friends, Mark Bodie and Mark Smolin, whose love and friendship have meant more than words can say.

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GENERAL INTRODUCTION

Attention-deficit/Hyperactivity Disorder (AD/HD) is a chronic psychiatric disorder characterized by levels of inattention, hyperactivity, and impulsivity that are developmentally inappropriate, and by definition, negatively impact an individual's psychosocial functioning. Although most research on AD/HD has focused on school-aged children, data indicate that problem behaviors almost always emerge during the preschool years (McGee, Williams, & Feehan, 1992). During this time, it is often difficult to distinguish between problem behaviors that are transient and those that are clinically significant (Campbell, 1995). While such distinctions may be difficult for informants to make, preschool children described as inattentive, impulsive, and hyperactive by parents and/or teachers can be distinguished from controls on laboratory measures of these behavioral domains (Alessandri, 1992; Campbell, Ewing, Breaux, & Szumowski, 1986; Marakovitz & Campbell, 1998), lending credence to the validity of the ratings. In contrast, comparatively little is known regarding the early clinical and familial correlates of AD/HD and the extent to which preschoolers with symptoms of AD/HD exhibit neuropsychological deficits resembling those frequently observed in school-aged children with the disorder (Pennington & Ozonoff, 1996).

Factor analytic studies conducted with school-aged children using parent and teacher ratings of AD/HD symptoms have consistently yielded a two-factor solution in which inattention and hyperactivity items load on separate factors, while impulsivity items load primarily with hyperactivity symptoms or split their variance. Consequently, separate inattention and hyperactivity-impulsivity symptom lists were selected for inclusion in DSM-IV (American Psychiatric Association [APA], 1994). Unfortunately, the factor structure of parent and teacher ratings of AD/HD symptoms has not been systematically explored in samples of preschool

children, leaving unresolved the question of how applicable the current diagnostic nomenclature is to younger children.

Investigations conducted with school-aged children have revealed higher diagnostic prevalence rates and more pronounced psychiatric and psychosocial morbidity in boys. Conversely, few researchers have systematically assessed whether gender differences in AD/HD symptoms observed in older children also occur in preschoolers, and the extent to which such discrepancies occur at dimensional (i.e., symptom severity) and/or categorical (i.e., diagnostic prevalence) levels. In addition, the fact that most studies of preschool children have primarily relied upon ratings obtained from parents has precluded investigators from determining whether parents and teachers are in relative agreement with regard to the presence or absence of AD/HD diagnoses (categorical concordance) as well as the severity of individual symptom domains (dimensional concordance).

A number of studies conducted in school-aged children have implicated executive function deficits in AD/HD. Relative to age- and gender-matched controls, children with AD/HD have been shown to have deficits in working memory (Barkley, Grodzinsky, & DuPaul, 1992; Pennington & Ozonoff, 1996), planning (Pennington, Grossier, & Welsch, 1993), cognitive flexibility (Chelune et al., 1986; Tripp, Ryan, & Peace, 2002), time perception (Rubia, Taylor, Taylor, & Sergeant, 1999), motor inhibition (Oosterlaan & Sergeant, 1985), and phonemic fluency (Pineda, Ardila, & Rosselli, 1999), leading some theorists to posit that the symptoms of children with AD/HD are the direct result of a primary deficit in executive functions. Although the assessment of neuropsychological functioning in children with AD/HD has been the subject of considerable investigation, comparatively little is know regarding the developmental onset of executive function deficits in children with AD/HD and the degree to which such impairments

may underlie early behavioral expressions of the disorder. Studies examining the neuropsychological status of preschool children with AD/HD have yielded highly equivocal findings, with some investigators reporting patterns of neuropsychological dysfunction that parallel those identified in school-aged children (Hughes, Dunn, & White, 1998; Mariani & Barkley, 1997), and others failing to find an association between domains of executive functioning and symptoms of AD/HD (Sonuga-Barke, Dalen, Daley, & Remington, 2002).

To some degree, the inconsistencies noted above may stem from variations in selection criteria and statistical methodology (e.g., covariation for age and/or IQ), but may also reflect the fact that most current measures of executive functioning are inappropriate for use with preschoolers, as they are often too long, insufficiently engaging, or require reading skills that have yet to fully mature. More importantly, whereas tasks such as the Stroop Interference Test and Trail Making Test include paired control conditions to more readily isolate the construct(s) of interest, most executive function indices used with preschool children lack such process specificity. As such, it becomes difficult to ascertain whether reports of executive dysfunction reflect genuine deficits in specific neurocognitive domains (e.g., visual working memory) or whether such phenomena occur secondary to problems with more basic level functions (e.g., visual form discrimination) subsumed by executive function indices.

Robust differences have also emerged between preschoolers with AD/HD and age-matched controls on numerous measures of family functioning. Like their older counterparts, preschoolers with symptoms of AD/HD have been shown to exhibit more frequent episodes of noncompliance and inappropriate behavior, while their caregivers issue more commands and are generally more punitive toward their children (DuPaul, McGoey, Eckert, & Van Brakle, 2001). However, at present, the jury is still out as to whether parent and child behaviors vary as a

function of task demands, with some investigators observing more punitive and controlling maternal behavior during both unstructured and structured play (Campbell, Breaux, Ewing, Szumowski, & Pierce, 1986), and others suggesting that parents are disproportionately more likely to exhibit negative behavior toward their children under more structured task conditions (DuPaul et al., 2001). In addition, few studies have systematically explored the disciplinary techniques and lifestyles/rules (e.g., level of parental investment, strategies for responding to child-initiated provocation) of families of disruptive preschoolers, and whether such practices differ from those of typically developing preschool children.

The primary aim of the current study was to obtain parent and teacher ratings of AD/HD symptoms in a large sample of non-referred preschool children in order to examine: (a) the factor structure of AD/HD behaviors, (b) gender differences in AD/HD symptoms and subtypes, and c) agreement between parents and teachers regarding AD/HD diagnoses and symptom severity. An assessment cohort comprised of disruptive/at risk and typically developing preschool children was drawn from the larger sample to investigate group differences in neuropsychological status and familial functioning. It was specifically hypothesized that:

1. Like their school-aged counterparts, parent and teacher ratings of AD/HD symptoms in preschoolers will yield a two-factor solution in which Inattention items and Hyperactive-Impulsive items load on distinct behavioral dimensions.
2. Preschool boys will be rated as significantly more symptomatic than girls.
3. Parent-teacher concordance regarding the severity of AD/HD symptoms will yield a significant rater effect characterized by weak cross-informant correlations. Rates of categorical concordance will be compromised due to poor agreement as to which children represent the probands.

4. At risk preschool children will perform significantly worse than controls on measures of executive functioning.
5. Parents of at risk children, relative to parents of typically developing preschoolers, will use more negative commands/statements and fewer positive commands during structured interactions, and will report being more punitive with their children at home.
6. At risk preschool children will exhibit significantly greater levels of disruptive behavior (e.g., noncompliance) than their typically developing peers during both structured and unstructured parent-child interaction sessions.

BACKGROUND

Attention-deficit/Hyperactivity Disorder (AD/HD) is a chronic psychiatric syndrome characterized by developmentally inappropriate levels of inattention, impulsivity and overactivity, for which more than 1,000,000 children in the U.S. receive psychopharmacologic intervention (Jensen et al., 1999; Safer, Zito, & Fine, 1996). Two-thirds of children with the disorder meet criteria for one or more comorbid psychiatric conditions (APA, 2000), and relative to age-matched controls, are at disproportionately greater risk for displaying more severe externalizing behaviors (e.g., substance abuse, delinquency, physical aggression), occupational difficulties (Murphy & Barkley, 1996), and academic underachievement (Zentall, 1990) during adolescence and adulthood. DSM-IV (APA, 1994) requires the onset of symptoms prior to age seven; however, symptoms generally appear during the preschool years (Ross & Ross, 1982), and in a subset of preschool youth, emerge 1-2 years before being brought to the attention of a mental health professional (Wilens et. al., 2002). Yet, while copious evidence exists to support the ontogenesis and public health ramifications of AD/HD, the majority of research has historically focused on school-aged children, with comparatively little known regarding the early manifestations of the disorder.

As with their school-aged counterparts, estimates of AD/HD prevalence among preschoolers tend to vary considerably as a function of ascertainment method. Lavigne and colleagues (1996), using consensus diagnoses, found that 2% of community preschoolers met DSM-III-R (APA, 1987) criteria for AD/HD. In a separate community sample of low-income preschoolers, nearly 6% were identified as meeting diagnostic criteria for the disorder (Keenan et al., 1997). Not surprisingly, rates of externalizing disorders in general and AD/HD in particular,

are typically much higher among clinically-referred samples, with AD/HD prevalence estimates ranging between 60% (Keenan & Wakschlag, 2000) and 86% (Wilens et al., 2002).

Yet, while few would take issue with the fact that the essential characteristics of the disorder emerge during the preschool years (Conner, 2002), studies have shown that, in many instances, these concerns are ephemeral in nature, and remit prior to school entry (Campbell, 1990). Among youngsters whose symptoms are of sufficient duration and severity to merit a diagnosis of AD/HD during the preschool years, about half will meet criteria for an externalizing disorder by the time they reach school age (Barkley, 1998; Campbell, 1995). Thus, in assessing preschoolers who present with significant attentional or behavioral difficulties, the clinical task is to distinguish between those who will develop persistent AD/HD and those who have developmentally appropriate and transient symptoms or AD/HD-like symptoms from other causes (Conner, 2002).

Complicating matters is the limited repertoire of appropriate measures available to distinguish age inappropriate levels of hyperactivity, impulsivity, and inattention from normative temperamental variations that may occur during the preschool period. In particular, researchers struggle to utilize tasks that are developmentally appropriate, psychometrically sound, and constructed in such a way so as to promote insight into developmental trends and diagnostic continuity. In the case of behavioral rating scales, many lack adequate norms for assessing age differences within the preschool period (Miller, Koplewicz, & Klein, 1997). In addition, the limited number of preschool-aged boys and girls included in normative samples may preclude a meaningful interpretation of gender differences, and could obstruct efforts to dissociate age-appropriate frustrations and temperamental volatility from behaviors indicative of a more maladaptive developmental trajectory. Yet, even when such normative data do exist, researchers

have found that, with few exceptions, impulsivity symptoms do not have a high degree of specificity when examined in samples of preschool-aged children (Kadesjö, Kadesjö, Hägglöf, & Gillberg, 2001), suggesting that behavioral dyscontrol may be perceived as a characteristic feature of the preschool period. The absence of developmentally sensitive instruments, when coupled with the previously reported desistence patterns has, in the view of some investigators, engendered a reluctance to diagnose the disorder during the preschool years, which in turn, could delay the implementation of treatment (Byrne, Bawden, DeWolfe, & Beattie, 1998). At the same time, however, researchers have documented an incremental rise in the use of psychotropic medications among preschool children over the past decade (Zito et al., 2000). As a result, many mental health providers are caught in a quagmire, with the jury still out regarding: (a) how to most appropriately conceptualize early manifestations of AD/HD, (b) how to effectively differentiate clinically significant behavioral disturbances from normative, often transient temperamental variations, and (c) the circumstances under which pharmacological or behavioral interventions are indicated.

Unraveling the aforementioned issues is a complex endeavor, and though investigators have begun to more fully appreciate the importance of early assessment and intervention, many unanswered questions still remain. In an effort to shed light on the early manifestations of AD/HD, the current study addressed five primary thematic issues by studying a cohort of non-referred preschool children: (i) the factor structure of AD/HD symptom ratings completed by parents and teachers; (ii) gender differences in AD/HD symptoms and diagnostic subtypes; (iii) dimensional and categorical estimates of parent-teacher concordance; (iv) neuropsychological correlates of AD/HD symptoms; and (v) familial correlates of AD/HD. Each of these issues will be explored in the forthcoming sections, first by reviewing studies that have been conducted with

school-aged children, and then by examining the analogous issues as they relate to samples of preschool children.

Factor Structure of DSM-IV AD/HD Ratings in School-Aged Children

Since its inception as a diagnostic entity, AD/HD has undergone a host of conceptual shifts that have been largely reflected in the various iterations of the DSM (APA, 1980, 1987, 1994). What has remained consistent, however, is the notion that the disorder is characterized by a triad of symptoms, namely inattention, hyperactivity, and impulsivity. Although there is considerable agreement with respect to the presence of the three core symptom domains, less agreement exists with regard to methods for distinguishing among AD/HD subtypes, and understanding which AD/HD symptoms are present in different individuals with the disorder. DSM-III (APA, 1980) considered attention deficit disorder to be a multidimensional disorder with inattention as the central feature. Within this framework, two subtypes were delineated: one characterized by inattention and impulsivity (ADD/-H), and the other by inattention, impulsivity, and hyperactivity (ADD/+H). DSM-III-R (APA, 1987) shifted to a unidimensional, polythetic classification strategy based on the premise that all three symptom domains were highly intercorrelated (Pillow, Pelham, Hoza, Molina, & Stultz, 1998), but failed to outline specific thresholds for each domain. More recently, DSM-IV (APA, 1994) has outlined three AD/HD subtypes. The most clinically prevalent of these, the Combined Type (AD/HD-CT), is analogous to the DSM-III category of ADD/+H. Predominantly Inattentive (AD/HD-I) and Predominantly Hyperactive-Impulsive (AD/HD-HI) subtypes are new to DSM-IV. The former resembles DSM-III's ADD/-H diagnosis, yet differs in that it does not include the presence of impulsivity

symptoms; the latter is characterized primarily by hyperactive and impulsive symptomatology but not inattention.

The shift from the DSM-III-R to the DSM-IV conceptualization of AD/HD occurred in response to findings (Lahey et al., 1990; Newcorn et al., 1989) which demonstrated that the unidimensional framework of DSM-III-R promoted increased heterogeneity and resulted in larger group membership by increasing the number of response permutations that could satisfy diagnostic criteria (Lahey et al., 1988). Additionally, a growing body of evidence emerged to support the notion that the primary symptom domains of AD/HD could be organized into two relatively distinct symptom categories. For instance, DuPaul (1991) reported a two-factor solution of parent and teacher ratings consisting of inattention-hyperactivity and impulsivity-hyperactivity factors. More frequently, however, exploratory factor analyses of parent and teacher ratings of symptoms (Bauermeister, Alegria, Bird, Rubio-Stipec, & Canino, 1992; Healey et al., 1993; Lahey et al., 1988) have found that inattention and hyperactivity items load on separate factors, while impulsivity items load primarily with hyperactivity symptoms or split their variance. These findings were subsequently replicated using the much larger DSM-IV field trials sample (Lahey et al., 1994), and in representative samples of AD/HD children using parent and teacher rating scales (DuPaul et al., 1997, 1998). Consequently, separate hyperactivity-impulsivity and inattention symptom lists were selected for use in DSM-IV.

Most factor analytic studies conducted to date have relied predominantly on exploratory methods, and have used varimax rotation techniques to generate orthogonal factor solutions. Yet, even with such stipulations, it is often the case that correlations between factors are high (DuPaul, 1991) because of items that tend to load on multiple factors. An alternative strategy to exploratory factor analytic methods involves the use of confirmatory factor analysis (CFA),

which better allows investigators to "determine whether cross loadings represent significant theoretical issues regarding the overlap between disorders, or constitute analytical artifacts produced by forcing orthogonality between highly correlated constructs." (Pillow et al., 1998, p. 294). In addition, CFA techniques enable investigators to assess the "goodness-of-fit" of alternative theoretical models. Pillow et al. (1998) conducted two sets of confirmatory analyses; the first involved testing DSM-III, DSM-III-R, and DSM-IV AD/HD algorithms when only AD/HD items were included in the analysis. Based upon the high comorbidity among AD/HD, Oppositional Defiant Disorder (ODD), and Conduct Disorder (CD), a second CFA was also undertaken to establish second-order factors of disruptive behavior disorders (DBD's). In keeping with the notion that final factor solutions hinge on the nature or number of items included in the analysis, these investigators found support for a DSM-III factor model when AD/HD items were examined in isolation; however, similar analyses conducted on the entire set of DBD items provided empirical support for distinct AD/HD and ODD/CD factors, with the AD/HD factor closely resembling the DSM-IV factor structure, and impulsivity items splitting their variance across both factors. Given the high rates of overlap among the DBD's and the fact that comorbidity is often the rule rather than the exception, the authors ultimately assigned greater plausibility to the latter model, and emphasized that, in no instance did the DSM-III-R model (i.e., a unidimensional framework) account for the obtained data.

Factor Structure of DSM-IV AD/HD Ratings in Preschoolers

Although factor-analytic studies conducted with school-aged samples using parent and teacher ratings of AD/HD symptoms have consistently yielded a two-factor solution in which Inattention items and Hyperactive-Impulsive items load on distinct behavioral dimensions

(Lahey et al., 1994), analogous undertakings in younger children represent largely uncharted territory. Although preschoolers were included in the DSM-IV field trials sample, diagnoses were arrived at through the administration of semi-structured clinical interviews (Diagnostic Interview Schedule for Children – DISC) rather than self-report scales, and were confined to groups of clinically-referred children and adolescents. Further, separate factor analyses for the subset of 4- and 5-year-olds included in the larger sample of children and adolescents were not conducted. Additionally, among the small handful of factor analytic studies conducted using preschool samples, most have relied on data gathered from parents, with comparatively little known regarding the factor structure of ratings obtained from preschool teachers or day care workers (Miller et al., 1997).

In light of the fact that no study conducted to date has explored the factor structure of parent and teacher ratings of DSM-IV AD/HD symptoms in samples confined to preschoolers, one goal of the current study was to investigate the extent to which such ratings yield a factor solution that maps onto the diagnostic conceptualization delineated in DSM-IV. Elucidating the factor structure of AD/HD ratings may more readily enable researchers and clinicians to gauge the early behavioral manifestations of the disorder, and more importantly, could help to shed light on the general applicability of the current nomenclature to preschool children.

Gender Differences in AD/HD Symptoms and Subtypes in School-Aged Children

Despite the numerous changes that have been made to the diagnostic nomenclature, AD/HD symptoms and diagnoses have long been considered to be more common among males (APA, 1980, 1987, 1994), with estimates of male-to-female ratios ranging between 3:1 and 9:1, depending upon the method of investigation (i.e., epidemiologic vs. clinically-referred

strategies). Patterns of male predominance do, however, seem to vary as a function of AD/HD subtype, ranging from 4:1 for the Primarily Hyperactive-Impulsive Type and 2:1 for the Primarily Inattentive Type (Wolraich, Hannah, Pinnock, Baumgaertel, & Brown, 1996). Unique cognitive and behavioral concomitants have also been shown to map onto individual diagnostic subtypes, such that AD/HD-I children typically display more prominent cognitive deficits, academic underachievement, and internalizing features, but lower rates of externalizing behavioral problems (Wolraich et al., 1996). AD/HD-HI individuals are noted to evince more oppositionality, conduct problems, and physical aggression (Eiraldi, Power, and Nezu, 1997; Gaub & Carlson, 1997a; Lahey, Schaughency, Hynd, Carlson, & Nieves, 1987), but often exhibit fewer academic and internalizing problems. Finally, AD/HD-CT incorporates the behavioral concerns common to both AD/HD-I and AD/HD-HI.

When juxtaposed with the aforementioned gender differences in subtype prevalence, these data also point to sex differences in cognition and behavior that may extend above and beyond phenotypic variations in AD/HD itself. In support of this assertion, Gaub & Carlson (1997b), in a meta-analytic review of 18 studies, reported that AD/HD girls, relative to age-matched boys, exhibited greater intellectual impairment and lower levels of hyperactivity, conduct disorder, and other externalizing behaviors. Collapsing across studies, girls were also found to display lower levels of inattention and internalizing behavior, and less peer aggression. However, additional analyses indicated that such patterns were largely confined to non-referred children with AD/HD; similar rates of impairment were identified on all three parameters among clinically-referred samples of AD/HD children. The tendency for girls to be perceived as less inattentive may also be attributable to the fact that girls with AD/HD are often less overtly disruptive, and hence apt to be rated as less symptomatic in *multiple* domains (McGee & Feehan,

1991). This phenomenon has also been proposed to account for gender discrepancies in referral rates and overall diagnostic prevalence (Berry, Shaywitz, & Shaywitz, 1985).

One potentially important factor that might underlie the gender prevalence gap is age. Cohen and colleagues (1993) reported that, while the prevalence rate for AD/HD boys fell by approximately 20% between the ages of 10 and 20, no such decline was observed for females during the same developmental period. Moreover, persistence of AD/HD features among girls during the pre-adolescent and adolescent periods may also mediate age-related declines in neurocognitive functioning and peer acceptance (Brown, Madan-Swain, & Baldwin, 1991).

Gender Differences in AD/HD Symptoms and Subtypes in Preschool Children

As noted above, studies conducted in school-aged samples have generally revealed higher rates of AD/HD symptoms and subtypes in boys relative to girls. However, until the past decade, few researchers had systematically assessed the degree to which gender differences in AD/HD symptoms also occur in preschoolers, and the extent to which such differences discrepancies occur at dimensional (i.e., symptom severity) and/or categorical (i.e., diagnostic prevalence) levels. Using a panoply of different measurement techniques, investigators have reported significantly elevated levels of parent-identified hyperactive-impulsive behavior (Gadow, Sprafkin, & Nolan, 2001; Gimpel & Kuhn, 2000), externalizing behavior (Lavigne et al., 1996), overall AD/HD symptom severity (Gadow et al., 2001; Gimpel & Kuhn, 2000), and total behavior problems (Lavigne et al., 1996) among preschool boys relative to preschool girls. Similar gender-based disparities have also been reported for teacher ratings, with males rated as more severely impaired in both AD/HD symptom domains (Gadow et al., 2001; Miller et al., 1997). In contrast, other researchers (Campbell & Breaux, 1983; Kadesjö et al., 2001; Richman,

Stevenson, & Graham, 1982) have failed to identify an association between gender and dimensional estimates of inattention, hyperactivity-impulsivity, and/or overall AD/HD severity in samples of preschoolers.

Categorically based methods have also yielded somewhat equivocal findings. Studies of AD/HD conducted using community-based preschool samples have generally identified male to female ratios (for any AD/HD subtype) of approximately 2:1 (Gadow et al., 2001; Lavigne et al. 1996), nearly half that reported in epidemiologic investigations of school-aged children (Wolraich et al., 1996). In contrast, marked discrepancies have been observed regarding the gender distribution of AD/HD diagnoses among clinically-referred preschoolers, with some investigators identifying nearly parallel rates of the disorder among boys and girls (Gadow et al., 2001), and others reporting patterns of male predominance (approximately 5:1 male to female ratio) that are commensurate with findings in school-aged children with the disorder (DeWolfe, Byrne, & Bawden, 2000a). Although the reasons for such inconsistencies are not clear, differences in age and inclusion criteria (e.g., use of dimensional cut-points vs. adherence to categorical diagnostic criteria) are likely to a play formidable role.

Employing a modified version of the AD/HD Rating Scale-IV (DuPaul et al., 1998), Gimpel & Kuhn (2000) found that male and female preschoolers were equally likely to meet criteria for AD/HD-I and AD/HD-HI, while males were disproportionately more likely to receive a diagnosis of AD/HD-CT. Although the original DSM-IV field trials inquiry (Lahey et al., 1994) neglected to specifically assess gender differences in the subset of 3- to 7-year-olds included in the larger sample, a subsequent investigation (Lahey et al., 1998) revealed no gender differences in the prevalence of AD/HD subtypes among preschoolers; however, all were

significantly more common among boys (AD/HD-$I_{M:F}$ = 3:2; AD/HD-$HI_{M:F}$ = 4:1; AD/HD-$CT_{M:F}$ = 5:1).

Overall, the above findings suggest that, like their older counterparts, AD/HD symptoms and subtypes may be more prevalent among preschool boys relative to preschool girls. However, no study conducted to date has used parent and teacher ratings of AD/HD symptoms to ascertain gender differences in the prevalence of AD/HD subtypes among non-referred preschool children. The current study sought to address this gap by exploring gender differences in AD/HD symptoms and subtypes; such efforts were undertaken separately for both parent and teacher ratings, and together using an "either-or" algorithm (Lahey et al., 1994) for combining information from both informants. Gender differences in the prevalence of AD/HD subtypes in preschool children are particularly important given that sex differences in cognition and behavior may accompany phenotypic variations in AD/HD itself (Gaub & Carlson, 1997b).

Dimensional and Categorical Estimates of Parent-Teacher Concordance in School-Aged Children with AD/HD

Data also indicate that gender differences in the prevalence of AD/HD symptoms and subtypes may vary as a function of informant. For measures of inattention, hyperactivity, and externalizing behavior, both parents and teachers have historically rated boys with AD/HD as showing significantly greater levels of severity relative to girls (Gaub & Carlson, 1997b). In contrast, discrepant effect sizes were revealed for impulsivity as a function of rater source: AD/HD girls were noted to be significantly more impaired by parent report, but significantly less impaired based upon teacher ratings. One possible reason for such informant discrepancies relates to the comparative standard(s) or anchor(s) by which parents and teachers base their

ratings. Parent ratings are typically influenced by their own experiences with the child as well as teacher reports regarding their child's behavior in an academic setting (Mitsis et al., 2000). In completing such ratings, parents are usually assumed to reference their child's behavior against the behavior of the child's sibling(s) or other same-sex children in environments with few established rules or attentional constraints. Conversely, teachers may judge problem behaviors in relation to populations of boys and girls in a more structured milieu. If teachers compare boys *and* girls to a norm established by boys (who are often more overtly disruptive), or if the setting is one in which severe externalizing behaviors predominate (e.g., a classroom with numerous emotionally disturbed children), only the most impaired girls will be identified. Under such circumstances, girls who exhibit less ostensible, but nonetheless clinically significant behavioral features, may go largely undetected (McGee & Feehan, 1991).

Head-to-head comparisons of parent, teacher, and child reports of AD/HD symptoms have frequently yielded low to moderate correlations (κ_{range} = .13-.61; Loeber, Green, Lahey, & Stouthamer-Loeber, 1991), with discrepancies usually ascribed to unique information that may be provided by each informant. Historically, children tend to acknowledge fewer disruptive behaviors than either parents or teachers, although higher concordance rates have been reported for older child respondents (Edelbrock et al., 1986). Mitsis and colleagues (2000) examined the concordance between parent and teacher identified AD/HD subtypes in a clinically referred sample using structured clinical interviews aligned to DSM-IV diagnostic criteria (Diagnostic Interview Schedule for Children Version 2.3 – DISC-2.3). According to the authors, parent-teacher agreement for *any* AD/HD subtype was modest (74% agreement; k = 0.20), while agreement regarding *individual* subtypes was poor (30% agreement for AD/HD-CT, 10% agreement for AD/HD-I, and 4% agreement for AD/HD-HI). Combining information across

parent-and teacher informants using an "or" symptom algorithm (Lahey et al., 1994) yielded a marked increase in AD/HD-CT cases, and a sharp reduction in the rate of nondiagnosis. Dimensional estimates of overall symptom concordance between parents and teachers was acceptable ($r = 0.42$), with somewhat better agreement reported for symptoms of hyperactivity-impulsivity than for symptoms of inattention. In contrast, a significant "rater effect" was observed, such that parent ratings of their child's behavior at school were more closely associated with their reports of the child's behavior at home than they were with ratings obtained from teachers. Stated differently, ratings varied more closely as a function of informant than setting. Chance agreement at the individual symptom level between teacher and parent reports of classroom behavior was felt to underscore the importance of obtaining data from multiple informants when making diagnostic decisions.

Dimensional and Categorical Estimates of Parent-Teacher Concordance in Preschool Children

The DSM-IV requirement that impairment occur in multiple settings has enabled investigators to explore rates of parent-teacher agreement, both in terms of the presence or absence of AD/HD diagnoses (categorical concordance) as well as the severity of individual symptom domains (dimensional concordance). Although investigations of this kind conducted in school-aged samples have yielded marked disparities, the fact that such children typically all attend a formal school setting with defined behavioral expectations has greatly facilitated such comparisons. In contrast, not as many 3- to 5-year-olds participate in an academic setting, leaving many providers to rely exclusively upon a parent's verbal report or questionnaires instead of the recommended multi-informant assessment process (Barkley, 1990; Moser &

Kallail, 1995). Reliance upon information from a single informant, in addition to negating aspects of the diagnostic protocol, may also lead to over-identification or under-identification of the disorder (Gimpel & Kuhn, 2000).

Surprisingly, most investigators have not documented parent-teacher concordance rates even in instances in which data were gathered from both informants. Failure to ascertain information regarding cross-situationality may cause investigators to overlook a key risk factor associated with the persistence of early disruptive behavior (Barkley, 1998; Miller et al., 1997; Sandberg, Rutter, & Taylor, 1978). Consequently, elucidating early rates of parent-teacher concordance might help to shed light on the relative pervasiveness of early externalizing behaviors, and as previously indicated, could have prognostic value with regard to patterns of persistence and remittance. In the current study, measures of parent-teacher concordance were evaluated dimensionally by examining correlations among inattention and hyperactivity-impulsivity summary scores derived from parent and teacher AD/HD Checklist ratings. Concordance rates for diagnostic subtypes and agreement regarding the absolute presence or absence of an AD/HD diagnosis were also ascertained.

Neuropsychological Correlates of AD/HD in School-Aged Children

Research exploring the biological underpinnings of disruptive behavior has focused on a host of etiologic mechanisms. Although the specific nature of the dysfunction remains unknown, data from the fields of neuropsychology (Barkley, 1994, 1997; Pennington & Ozonoff, 1996), neurochemistry (Solanto, 1998), neuroimaging (Hynd et al., 1993), and molecular genetics (Rowe et al., 1998) suggest that externalizing behaviors are likely to reflect a multifactorial etiologic process. Within the past several decades, investigators have suggested that the cognitive

sequelae of AD/HD primarily encompass deficits in executive functioning. Although many definitions have been proposed (Eslinger, 1996), executive functions are almost universally believed to incorporate planning, self-regulation, organizational skills, goal-setting, problem solving, and judgment (Lezak, 1993; Luria, 1973; Pribram, 1973), and are thought to be mediated by reciprocal connections between the prefrontal cortex (PFC) and basal ganglia. Executive dysfunction theories of AD/HD emerged following observed behavioral parallels between children with AD/HD and adults with damage to the PFC (Mattes, 1980). Consistent with such models, school-aged children with the disorder have been shown to perform significantly worse than gender- and age-matched controls on a host of neuropsychological indices believed to be subserved by frontal-subcortical pathways, including measures of working memory (Barkley et al., 1992; Pennington & Ozonoff, 1996; Tripp et al. 2002), planning (Pennington et al., 1993), cognitive flexibility (Boucugnani & Jones, 1989; Chelune et al., 1986; Gorenstein, Mammato, & Sandy, 1989; Tripp et al., 2002), time perception (Rubia et al., 1999), motor inhibition (Oosterlaan & Sergeant, 1985; Trommer, Hoeppner, Lorber, & Armstrong, 1988), and phonemic fluency (Grodzinsky & Barkley, 1999; Pineda et al., 1999). The fact that these deficits have been found on tasks requiring both fast and slow information processing (Pennington & Ozonoff, 1996; Seidman, Biederman, Faraone, Weber, & Ouellette, 1997), and usually hold after controlling for comorbid psychiatric and learning disorders (Nigg, Hinshaw, Carte, & Treuting, 1998), has prompted several theorists (e.g., Shue & Douglas, 1992) to suggest that the behavioral perturbations observed in children with AD/HD stem from the inability of frontostriatal networks to effectively integrate multi-sensory information required to plan, set goals, monitor progress, anticipate outcomes, and translate thought into purposeful action.

Others have taken an information processing approach, with the notion that such models may more readily permit the identification of core cognitive processes being tapped by neuropsychological measures (Cohen, 1993). According to Tannock (1998), three component processing systems have been implicated based upon their discriminative capabilities and evidence of distinct neural substrates: (1) sustained attention and vigilance, assessed using continuous performance test (CPT) paradigms (Corkum & Siegel, 1993; Halperin, Wolf, Greenblatt, & Young, 1991); (2) visual selective attention and spatial orienting, evaluated using spatial orienting tasks (Swanson et al., 1991); and (3) response inhibition, examined via stop-signal or delay-aversion paradigms (Schachar & Logan, 1990; Sonuga-Barke, Taylor, & Hepenstall, 1992).

Yet, while some theorists have gone as far to suggest that the symptoms of AD/HD and information processing disturbances result from a primary deficit in frontostriatal executive functions, other researchers have failed to provide empirical support for such claims (Loge, Staton, & Beatty, 1990; Schaughency et al., 1989), or have argued that executive theories of AD/HD should be interpreted cautiously due to a host of methodological limitations (e.g., small sample sizes, variability in selection and/or diagnostic criteria), small effect sizes (Pennington & Ozonoff, 1996), and, in some cases, disregard for psychiatric comorbidity (Sergeant, Geurts, & Oosterlaan, 2002). In addition, Klorman and colleagues (1999) reported that patterns of executive dysfunction may be primarily confined to children with combined type AD/HD, while Seidman et al. (1997) failed to identify neuropsychological deficits among a sample of girls with the disorder. Other researchers (e.g., Tripp et al., 2002) have suggested that the behavioral dyscontrol observed in children with AD/HD might adversely affect their test-taking skills, irrespective of the construct(s) under investigation, which in turn, could contribute to deficits in

"non executive" domains (e.g., language, spatial abilities, etc.). Moreover, the fact that AD/HD probands, even after controlling for psychiatric comorbidity (Faraone, Biederman, Weber, & Russell, 1998), typically perform more poorly than matched controls on measures of cognitive functioning (Barkley, DuPaul, & McMurray, 1990; Shallice et al., 2002) raises the possibility that intellectual compromise, not executive dysfunction per se, accounts for groupwise differences on neuropsychological indices. By extension, controlling for intellectual abilities has been shown to eradicate or otherwise attenuate groupwise disparities in neuropsychological status (Seidman et al., 1997; Tripp et al., 2002).

Despite the aforementioned limitations, neuroimaging data have provided compelling evidence implicating the prefrontal cortex (PFC) and its interconnections in the pathogenesis of AD/HD. Using structural MRI techniques, children with AD/HD have been shown to have volumetric reductions in the prefrontal cortex (Castellanos et al., 1996; Filipek et al., 1996; Hynd, Semrud-Clikeman, Lorys, Novey, & Eliopulos, 1990), basal ganglia (Aylward et al., 1996; Castellanos et al., 1996; Casey et al., 1997; Hynd et al., 1993) and genu and splenial regions of the corpus callosum that contain fibers that traverse prefrontal and posterior association cortices (Hynd et al., 1991, Semrud-Clikeman et al., 1994). Importantly, morphological abnormalities may underlie patterns of functional impairment, with anomalies in frontostriatal circuitry (prefrontal cortex, caudate, and globus pallidus) found to be associated with poorer performance on measures of response inhibition in children and adolescents with AD/HD (Casey et al., 1997).

Several investigators have also utilized similar approaches to examine brain regions, which up until recently, had not been commonly implicated in the pathogenesis of the disorder. Berquin et al. (1998) and Mostofsky et al. (1998) identified reductions in the size of the posterior

cerebellar vermis in children with AD/HD that were largely specific to the inferior posterior lobe (lobules VIII-X). Although the precise reason(s) for such structural differences is/are not clear, Himelstein and colleagues (2000) have suggested that compromised integrity of the cerebellum, via its projections to the thalamus, may be less able to moderate the functioning of regions within the PFC.

While structural neuroimaging techniques provide a glimpse into neural regions that may be implicated in AD/HD, it is clear that morphological abnormalities do not always translate into behavioral dysfunction. Rather, functional neuroimaging studies are necessary to correlate anomalous patterns of neural activation with "real world" functional impairment. Using xenon-133 and single photon emission tomography (SPECT), Lou and colleagues (Lou, Henriksen, Bruhn, Borner, & Nielsen, 1989; Lou, Henriksen, & Bruhn, 1990) reported patterns of striatal dysfunction (hypoperfusion) in children with AD/HD that were partly reversed following the administration of methylphenidate (Ritalin).

Recent studies have employed functional magnetic resonance imaging (fMRI) techniques to examine changes in brain activation that occur in response to performing cognitive tasks and/or pharmacological interventions. Relative to controls, children with AD/HD have been shown to exhibit significant increases in frontal activation and decreases in striatal activation while performing response inhibition (e.g., Go/No-Go) tasks (Vaidya et al., 1998). Differential patterns of stimulant responsivity were observed, with probands, and not controls, showing increases in striatal activation following methylphenidate administration. Finally, Anderson, Polcari, Lowen, Renshaw, & Teicher (2002) reported increases in T_2 relaxation time (corresponding to decreases in local blood volume) in regions of the cerebellar vermis with

moderate and high doses of methylphenidate that were especially pronounced in AD/HD children identified as hyperactive using data gathered from infrared motion sensors.

Neuropsychological Correlates of AD/HD in Preschool Children

Although studies of school-aged children are replete with investigations into the neurobiological and neurocognitive underpinnings of AD/HD, such efforts have been far more limited with samples of preschool children (Baving, Laucht, & Schmidt, 1999; Mariani & Barkley, 1997). Several reasons may account for this dichotomy. First, many neuroimaging techniques used with school-aged children have a number of important limitations when applied to preschoolers (e.g., the confounding effects of movement artifact), and relative to other forms of data, may be less able to tap into functional/neurocognitive impairments. Further, of the measures used to assess the integrity of information-processing models or executive dysfunction theories, many are inappropriate for use with preschoolers, as they are often too long, insufficiently engaging, or require reading skills that have not yet developed. Within the past decade, a number of researchers (e.g., Corkum, Byrne, & Ellsworth, 1995; Espy, Kaufmann, McDiarmid, & Glisky, 1999; Prather, Saramento, & Alexander, 1995) have responded to this perceived deficiency by developing a host of tasks appropriate for use with preschool children. A subset of these may be most appropriately conceptualized as measures designed to tap into the central behavioral features of AD/HD (e.g., attentional deficits and overactivity), whereas others have been adapted from animal models and studies of human adults to more specifically assess domains of neuropsychological functioning (e.g., working memory, impulse control, set-shifting).

In light of the reported associations between general intellectual abilities and executive functioning in preschoolers (Sonuga-Barke et al., 2002), the above techniques will be discussed in greater detail following a review of studies that have examined the cognitive profiles of preschool children with manifestations of AD/HD. Although studies of normally developing children suggest that inhibitory control and working memory undergo considerable maturation during the preschool years (e.g., Diamond & Taylor, 1996), this line of research is beyond the scope of this investigation and will therefore not be discussed in the forthcoming sections. Rather, the primary emphasis will be on both cross-sectional and longitudinal studies that have examined the neurocognitive sequelae of AD/HD symptoms or diagnoses among preschoolers.

Several researchers have examined the relationship between externalizing behaviors and overall cognitive functioning in samples of preschool children. Similar to their school-aged counterparts, preschoolers with symptoms of AD/HD often present with compromised intellectual abilities (DuPaul et al., 2001), which appear to stem from elevated levels of hyperactivity rather than symptoms of inattention or comorbid conduct problems (Sonuga-Barke, Lamparelli, Stevenson, Thompson, & Henry, 1994). According to Sonuga-Barke and colleagues (1994), "the fact that hyperactive children enter school already at a cognitive disadvantage points to a common origin for both intellectual and behavioral problems, some time during early development (p. 957)." Such cognitive disparities may also become more pronounced over time, as attentional deficits, overactivity, and/or poor impulse control continue to interfere with the AD/HD child's ability to acquire skills essential for normal intellectual and psychoeducational development.

In keeping with the aforementioned primacy of impulsive features among disruptive preschool youth, Byrne, DeWolfe, & Bawden (1998) observed that, relative to matched controls,

preschoolers with AD/HD committed a significantly greater number of *commission* errors on a selective attention task, and were comparatively unable to restrain themselves from touching a series of "off limits" toys (77% of probands vs. 0% of controls). In contrast, the same investigators found no groupwise difference in the number of cancellation task *omission* errors, and failed to identify discrepancies in ratings of off-task behavior obtained during the structured assessment procedure. Contrary to the nearly ubiquitous reports of hyperactivity communicated by parents of AD/HD children during the interview process, both groups evinced similar levels of out-of-seat behavior during structured and unstructured periods, and were indistinguishable with regard to their degree of mobility while engaged in unstructured play.

Although the above findings would, in many respects, seem to validate the patterns of behavioral ratings described earlier (i.e., more salient impulsivity and fewer attentional concerns), a subsequent study by the same investigators (DeWolfe, Byrne, & Bawden, 2000b) using a larger cohort of preschool children failed to replicate many of their earlier results. Specifically, no significant group differences emerged with regard to objectively defined levels of impulsivity (rates of unsanctioned play: 60% of probands vs. 36% of controls), while robust discrepancies were reported for measures of off-task behavior and observed mobility during a play periods (AD/HD > controls).

Consistent with reports of greater off-task behavior, hyperactive preschoolers also frequently perform worse than controls on computerized, analog, and observational measures of sustained attention (Alessandri, 1992; Byrne et al., 1998; Harper & Ottinger, 1992; Mahome, Hiemenz, & Pillion, 2002) and impulse control (Byrne et al., 1998; Campbell, Breaux, Ewing, & Szumowski, 1984), and have been described as more inattentive during both structured assessments (Harper & Ottinger, 1992) and unrestricted free play conditions (Alessandri, 1992;

DeWolfe, Byrne, & Bawden, 2000b). Successful treatment with stimulant medications has not only been shown to normalize the behavioral ratings of AD/HD preschoolers, but has also been found to eradicate group differences on measures of vigilance and impulsivity (Byrne et al., 1998).

Campbell and colleagues (1984, 1986, 1998), in an eloquent series of prospective investigations, followed two cohorts of preschool children from age 3 to age 9 in an attempt to determine which measures would distinguish hard-to-manage children who did and did not go on to develop AD/HD. These two subgroups were compared on a wide array of clinical, behavioral and laboratory measures ascertained when the children were 4 years old. These measures, which included ratings (parent and teacher), behavioral observations, and analogue measures of inattention, impulsivity and activity level were highly discriminative of the "at risk" and control groups at age 4 (Campbell, Pierce, March, Ewing, and Szumowski, 1994). However, measures taken at age 4 did not distinguish those high risk children who did and did not go on to develop AD/HD at age 6, although 6-year-old behavior was highly predictive of AD/HD and other disruptive behaviors at the age of 9 (Marakovitz & Campbell, 1998). Thus, an examination of the core symptom domains during the preschool years does not appear to be useful for distinguishing among hard-to-manage preschoolers children who go on to develop AD/HD from phenocopies who outgrow their disruptive tendencies.

As to the more central question of whether preschoolers with AD/HD display neuropsychological deficits that mirror their school-aged counterparts, the answer has yet to be conclusively determined. Relative to matched controls, preschool boys with AD/HD have been shown to exhibit deficits in motor control and working memory (Mariani and Barkley, 1997) and secondary impairments in aspects of academic achievement. Hughes and associates (Hughes,

Dunn, & White, 1998) reported significant group differences between hard-to-manage and control preschoolers on four of six executive function indices, including measures of inhibitory control, working memory, and cognitive flexibility. However, virtually all group differences were no longer significant after controlling for verbal ability and socioeconomic status. In addition, the fact that performance on such tasks was also highly associated with acts of aggression and antisocial behavior (Hughes, White, Sharpen, & Dunn, 2000) calls into question whether patters of executive dysfunction were related to features of AD/HD per se. Sonuga-Barke and colleagues (2002), after partialling out the effects of age and IQ, failed to find an association between working memory or planning skills and symptoms of AD/HD in a heterogeneous sample of preschool children. Rather, the authors proposed that compromised behavioral inhibition may serve as a harbinger for the emergence of more global executive function deficits that appear later in development.

Among the handful of studies that have investigated patterns of cognitive and neuropsychological functioning in children under age 7, most have been conducted in small samples and have employed cross-sectional designs that preclude inquiries into the predictive capabilities of neurocognitive markers obtained during the preschool years. In an effort to circumvent these methodological concerns, Kalff et al (2002) prospectively examined the extent to which early neuropsychological status distinguished between 5- and 6-year-old children [Mean (SD) age at baseline = 5.87 (0.41) years] who did and did not go on to meet criteria for DSM-IV AD/HD (any subtype) 1½ years later [Mean (SD) age at 18-month follow-up = 7.08 (0.39) years]. After controlling for a host of demographic variables (sex, age, parental occupation, and estimated IQ) and baseline child behavior checklist (CBCL) ratings, a significant main effect emerged for group, such that children with AD/HD performed significantly worse

than controls on early measures of visual interference, visual motor integration and auditory working memory. No differences were found between comorbid and non-comorbid AD/HD groups; however, AD/HD children with coexisting ODD or CD exhibited more pronounced neurocognitive impairment relative to ODD or CD children without AD/HD. Thus, early patterns of neuropsychological dysfunction seem to confer risk for later AD/HD and not ODD or CD, although psychiatric comorbidity is often common among school-aged children.

Taken together, the findings from the above studies provide somewhat limited support for the notion that preschool children with manifestations of AD/HD display unique patterns of neurocognitive functioning relative to normally developing preschool youth. Unfortunately, such findings have been inconsistent due to variations in selection criteria, assessment techniques, and statistical methodology (e.g., covariation for age and/or IQ), which in turn, render it difficult to draw precise conclusions regarding both the concurrent and predictive utility of neuropsychological parameters in disruptive preschoolers. Furthermore, none of the tasks used in previous studies incorporated paired reference conditions to isolate the construct(s) of interest. Consequently, it is unclear whether reports of executive dysfunction reflect genuine deficits in specific neurocognitive domains (e.g., visual working memory) or whether such phenomena occur secondary to problems with more basic level functions (e.g., visual form discrimination) subsumed by executive function indices.

The current study sought to remedy this gap by employing four novel executive function tasks designed to assess: (i) verbal working memory; (ii) nonverbal working memory; (iii) perceptual inhibition (i.e., susceptibility to interference); and (iv) motor inhibition (i.e., inhibition of prepotent responding). All neuropsychological indices consisted of both experimental and control/reference conditions to facilitate process specificity, and have been designed to be both

brief and engaging. Key issues addressed by this investigation included: (a) the extent to which at risk and typically developing preschool children differed on the above executive function parameters; (b) whether performance on laboratory measures of activity corresponded with performance on the executive function tasks; and (c) the association between early neuropsychological status and parent and teacher ratings of AD/HD symptoms.

Familial Correlates of AD/HD in School-Aged Children

While the above studies provide compelling evidence in support of a neural basis of disruptive behavior, it is clear that a variety of familial factors (e.g., child-rearing practices, family relations, and social context) also have a major impact on child development. A number of studies have examined the relationship between child behavior and parenting styles using structured task and free-play interaction paradigms. Objective coding systems such as the Response Class Matrix (RCM) procedure (Mash, Terdal, & Anderson; 1973) were employed in many of these studies (Barkley & Cunningham, 1979; Tallmadge & Barkley, 1983; Johnston, 1996), with the goal of capturing reciprocal interactions between the dyad (i.e., child responses to parental antecedents as well as parental reactions to child behaviors). Relative to mothers of control participants, mothers of hyperactive children have been shown to be less responsive to appropriate childhood behavior (e.g., prosocial engagement, remaining on-task, quiet play), and more structured and intrusive in their interactions. Though initially construed as a response to the children's dyscontrol, the authors suggested that such excessive limit-setting could also foster child misbehavior (Cunningham & Barkley, 1979). Situational demands also seem to have a palpable impact on parental behavior, with more numerous directives issued under structured task conditions (Tallmadge and Barkley, 1983). However, even when self-report methods are

employed, parents of hyperactive children typically acknowledge using more negative-reactive (e.g., verbal reprimands, physical punishment, loss of privileges) and fewer positive parenting strategies (e.g., rewarding appropriate behavior, discussing the problem with the child) in response to episodes of acting out (Johnston, 1996). In contrast, several investigators have suggested that discrepant parenting styles may be better accounted for by the relative presence or absence of comorbid disruptive (i.e., ODD and CD) behaviors, with few if any differences identified between parents of children with "pure" AD/HD vs. parents of comparison controls (Harvey, Danforth, Ulaszek, & Eberhardt, 2001). According to such a model, ineffective parenting would contribute to the emergence and/or persistence of conduct problems, but would be less likely to impinge upon the development or continuity of AD/HD.

Differences in *parental* behavior constitute only a piece of a larger puzzle, with marked variations also observed in *childhood* behavior using analogous laboratory paradigms. Compared to typically developing peers, children with AD/HD are significantly more hyperactive and off-task, and less compliant (Cunningham & Barkley, 1979), particularly under conditions that are more structured or otherwise place greater demands on their attentional resources (Tallmadge & Barkley, 1983). Age and comorbid defiance tend to mediate such patterns, such that older and less oppositional children are typically more compliant and better able to sustain their attention over protracted time periods (Barkley, Karlsson, Pollard, & Murphy, 1985; Johnston, 1996). Irrespective of age, children with AD/HD have also been rated by parents as more demanding of their time, less socially skilled, and generally more stressful to rear (Pelham & Lang, 1999).

While few investigators would argue that poor parenting causes AD/HD (Whalen & Henker, 1998), effective parenting skills do mitigate the severity of behavioral difficulties in these children (Barkley, 1990). Furthermore, among children who do not have AD/HD, poor

parenting is likely to result in increased rates of disruptive behavior similar to that seen in children with AD/HD (Barkley, 1990). Of note, children's behavior and parenting styles are highly interdependent (Bell & Harper, 1977). Not only do parenting strategies (Anderson, Hinshaw, & Simmel, 1994) and stress levels (Johnston & Pelham, 1990) affect the child's behavioral repertoire, but highly disruptive children appear to elicit greater use of negative and controlling strategies in their parents (Barkley, 1988). In addition, age-related declines in childhood disruptive behavior are often accompanied by reductions in parental negativity (Barkley et al., 1985). Further, successful treatment of children with AD/HD not only yields increases in childhood compliance, but also results in increased attention to such compliance and reductions in the frequency of parental commands and intrusiveness (Barkley & Cunningham, 1979). Finally, power-assertive punishment styles (e.g., screaming, threatening, hitting, isolating; Cohen, Brook, Cohen, Velez, &, Garcia, 1990) and parental discord (Emery, 1982) may exacerbate, if not directly elicit, child and adolescent externalizing behavior.

Familial Correlates of AD/HD in Preschool Children

Using interaction paradigms similar to those employed in studies of school-aged children, researchers have found that parents of disruptive preschool children are often less rewarding of appropriate play, issue more frequent directives, and are more punitive (e.g., make more negative statements) toward their children, particularly under more structured conditions (DuPaul et al., 2001; Mash & Johnston, 1982); others have observed more punitive and controlling maternal behavior during both unstructured and structured play (Campbell, Breaux, et al., 1986). Compared with their typically developing peers, preschoolers with AD/HD exhibit manifestations of noncompliance and inappropriate behavior that are more severe and pervasive

(DuPaul et al., 2001), and are often more demanding of their caregivers (Campbell, 1995). Thus, while the behavior of disruptive preschoolers does not appear to hinge on situational factors, the degree of parental negativity may be more apt to vary in proportion to the level of task structure.

The reciprocal nature of dyadic interactions coupled with the importance of early parental attachment indicate that preschool children may be particularly vulnerable to the impact of adverse parenting techniques (Keown & Woodward, 2002). Indeed, there is some suggestion from early observational studies that the negative mother-child interactions of hyperactive children are especially prominent during the preschool period. Mash and Johnston (1982) compared and contrasted the mother-child interactions of younger and older hyperactive children with those of aged-matched control participants. Whereas the interactions of older hyperactive children resembled the inquisitive and intermittently noncompliant behavior that characterized younger normal children, younger hyperactive children displayed more than twice the rate of negative and noncompliant behavior as older hyperactive children, and were less responsive to directives during a structured task. In addition, the level of dyscontrol exhibited by younger hyperactive children prompted their mothers to assume the role of disciplinarian, which in turn, precluded opportunities for non-task related interactions.

As a group, mothers of hyperactive preschool children experience lower levels of self-esteem even relative to mothers of older hyperactive children (Mash & Johnston, 1983) and mothers of preschool children at risk for ODD (Cunningham & Boyle, 2002), and acknowledge levels of stress and impact comparable to those reported by parents of children with autism, an ostensibly more impairing condition (Donnenberg & Baker, 1993). In addition, parents of children with AD/HD typically rate themselves as less effective caretakers (DeWolfe, Byrne, & Bawden, 2000a), have greater difficulty anticipating and avoiding problems (Keown &

Woodward, 2002), possess a more restricted/negative repertoire of behavioral management strategies (Cunningham & Boyle, 2000), and describe their parenting role as more restricted in nature (DeWolfe, Byrne, & Bawden, 2000a). Interestingly, however, the burden of rearing a preschooler with AD/HD does not appear to detrimentally affect overall family functioning (Cunningham & Boyle, 2002), which according to some investigators (e.g., DeWolfe, Byrne, & Bawden, 2000a), may reflect the expectation that the child's behavioral concerns will be transient in nature.

Several longitudinal studies of preschool children have examined parenting characteristics relative to a number of outcome measures obtained during later childhood and adolescence. McGee and colleagues (McGee, Partridge, Williams, & Silva, 1991; McGee & Silva, 1982; McGee, Silva, & Williams, 1984) found that children whose behavior problems persisted came from more discordant families characterized by higher rates of separation and poorer family relationships. Other studies that followed community samples from the preschool or kindergarten years through middle childhood demonstrate links between negative, harsh and inconsistent parental behavior and both the development and maintenance of disruptive behavior (Campbell, Pierce, Moore, Marakovitz, & Newby, 1996; McFadyen-Ketchum, Bates, Dodge, & Pettit, 1996; Pettit, Bates, & Dodge, 1993; Shaw, Owens, & Vondra, 1996). While most of these studies focused more on oppositional-defiant and aggressive behavior than on AD/HD, the high comorbidity of AD/HD with these disruptive behaviors increases the likelihood that similar parent-child characteristics apply to outcomes in children with early AD/HD symptoms.

In her series of longitudinal investigations of hard-to-manage preschool children, Campbell (1987, 2002) observed that the severity of early hyperactive and aggressive behavior, as well as the degree of controlling and negative parental behavior during play, predicted adverse

outcomes at age 6, while negative maternal control in the playroom at age 3 predicted maternal ratings of hyperactivity at age 9. Notably, family measures and negative maternal control were more robust predictors of continuing behavior problems at age 9 than were observational and laboratory measures of the child's behavior. Thus, among children who exhibit externalizing behaviors during the preschool years, those with more negative parenting styles may be most likely to persist or escalate to more severe disruptive behaviors later in development (Campbell, 1990; Keown & Woodward, 2002).

Thus, compelling evidence exists to support the notion that parent-child interactions involving disruptive preschool children are both qualitatively and quantitatively different relative to those of typically developing preschoolers and even school-aged children with externalizing behavior problems. However, at present, the jury is still out as to whether parent and child behaviors vary as a function of task demands. In addition, few studies have systematically explored the disciplinary techniques and lifestyles/rules (e.g., level of parental investment, strategies for responding to child-initiated provocation) of families of disruptive preschoolers, and whether such practices differ from those of typically developing preschool children. Clarifying the role of situational variables and parental disciplinary practices may not only shed light on factors associated with early disruptive behavior, but could also uncover potential avenues for early intervention.

SUMMARY

AD/HD is a chronic psychiatric disorder characterized by age-inappropriate levels of inattention, hyperactivity, and impulsivity. Among school-aged children, it constitutes the most common reason for referral to mental health professionals and represents a potent risk factor for

adverse outcomes during adolescence and adulthood. Exploratory factor analytic studies conducted in school-aged samples using parent and teacher ratings of DSM-IV AD/HD symptoms have generally yielded a two-factor solution (i.e., distinct inattention and hyperactivity-impulsivity factors); however, similar efforts have yet to be undertaken in samples restricted to preschool children. Significant gender-based disparities have been reported for both parent and teacher ratings of AD/HD symptom domains, with school-aged and preschool boys displaying greater impairment relative to age-matched girls. Despite the sizable toll that AD/HD exacts on both individuals and society as a whole, ratings of AD/HD symptoms completed by parents and teachers of school-aged children have generally revealed poor rates of diagnostic concordance. In contrast, the fact that many preschool children do not yet attend school has precluded similar inquiries in younger samples. Data compiled from neuroimaging studies and neuropsychological investigations of school-aged children indicate that abnormalities in fronto-striato-thalamo-cortical and fronto-cerebellar circuits are likely to be central to the pathogenesis of AD/HD, and that compromised integrity of such pathways may underlie deficits in neurocognitive functioning frequently observed in children with the disorder. Studies examining the neuropsychological status of disruptive preschool children have yielded highly equivocal findings, which to some extent, may be a consequence of variations in selection criteria and statistical methodology (e.g., covariation for age and/or IQ) and/or a failure to isolate the construct(s) in question. Finally, prominent familial correlates have been associated with childhood disruptive behavior, including more punitive maternal behavior and greater rates of child noncompliance.

CURRENT INVESTIGATION

Although research conducted over the past two decades has greatly advanced our understanding of early manifestations of AD/HD, a number of unresolved issues remain. First, no study conducted thus far has systematically assessed the factor structure of parent and teacher ratings of AD/HD symptoms or explored rates of concordance between parent and teacher ratings of AD/HD symptoms in a sample confined to preschool children. Second, although data suggest that preschoolers with manifestations of AD/HD display unique patterns of neurocognitive functioning relative to normally developing preschool children, such findings have been inconsistent due to variations in selection criteria, assessment techniques, and statistical methodology (e.g., covariation for age and/or IQ), which in turn, render it difficult to draw precise conclusions regarding both the concurrent and predictive utility of neuropsychological parameters in disruptive preschoolers. Finally, it remains to be determined the extent to which the parent child interactions of preschool children differ as a function of task demands and whether families of disruptive preschoolers employ disciplinary techniques that differ from those of typically developing preschool children.

In light of the aforementioned gaps in the literature, the current investigation was undertaken to address five primary sets of questions by comparing a non-referred sample of preschoolers designated at risk for AD/HD with a group of typically developing preschool children:

I. Aim 1: To what degree do AD/HD symptoms and subtypes vary as a function of gender and informant in preschool children?

II. Aim 2: Do ratings completed by parents of preschool children correspond to those completed by teachers, both in terms of the severity of individual symptom domains

(dimensional concordance) and the presence or absence of AD/HD diagnoses (categorical concordance)?

III. Aim 3: Do ratings of DSM-IV AD/HD behaviors obtained from parents and teachers conform to the two-factor solution identified using school-aged samples?

IV. Aim 4: What are the neuropsychological correlates of AD/HD symptoms in preschool aged children? Do preschool children identified as being at risk for AD/HD exhibit patterns of neuropsychological impairment that parallel those reported in samples of school-aged children?

V. Aim 5: Do the mother-child interactions of disruptive preschool children and their typically developing peers vary as a function of situation or task demands? Are there appreciable differences between the disciplinary practices and lifestyles of families of at risk vs. typically developing children?

Three related secondary questions were also addressed:

VI. Aim 6: Among samples of preschool children, how well do laboratory measures of activity level correspond to performance on neuropsychological indices?

VII. Aim 7: Is there an association between parent and teacher ratings of AD/HD symptoms and laboratory measures of activity level?

VIII. Aim 8: To what extent are parent and teacher ratings of AD/HD symptoms associated with childhood neuropsychological status?

STUDY HYPOTHESES:

1. Like their school-aged counterparts, parent and teacher ratings of AD/HD symptoms in preschoolers will yield a two-factor solution in which Inattention items and Hyperactive-Impulsive items load on distinct behavioral dimensions.
2. Preschool boys will be rated as significantly more symptomatic than girls.
3. Parent-teacher concordance regarding the severity of AD/HD symptoms will yield a significant rater effect characterized by weak cross-informant correlations. Rates of categorical concordance will be compromised due to poor agreement as to which children represent the probands.
4. At risk preschool children will perform significantly worse than controls on measures of executive functioning.
5. Parents of at risk children, relative to parents of typically developing preschoolers, will use more negative commands/statements and fewer positive commands during structured interactions, and will report being more punitive with their children at home.
6. At risk preschool children will exhibit significantly greater levels of disruptive behavior (e.g., noncompliance) than their typically developing peers during both structured and unstructured parent-child interaction sessions.

METHODS

PARTICIPANT ASCERTAINMENT

Recruitment was conducted using a two-step procedure previously described by Campbell and colleagues (Campbell, Ewing, et al., 1986) to gather parent and teacher ratings on a relatively large sample of children from which an assessment cohort could then be selected. To facilitate this process, we received New York City Board of Education approval for the project, which allowed us to approach all New York City public pre-K programs. During this segment of the project (Phase I), principals of private and public preschools located in Queens, New York were contacted and permission was requested to screen the school for children with attention and behavior problems. A subset of Phase I participants were subsequently selected for inclusion in the on-campus assessment (Phase II) portion of the study. Selection procedures for both project components are outlined below.

PHASE I SCREENING PROCEDURE

Thirteen preschools within close proximity to Queens College agreed to participate, and parents of children in these schools were sent DSM-IV AD/HD checklists along with consent forms which would allow us to collect similar ratings from the child's teacher. The checklists consisted of the 18 AD/HD behaviors listed in DSM-IV, which were rated on a 4-point scale (0 = not at all; 1 = somewhat; 2 = pretty much; and 3 = very much). As has been suggested by other investigators (e.g., DuPaul et al., 1998; Kadesjö et al., 2001), a symptom was considered to be present if it received a rating of 2 (pretty much) or 3 (very much). All consent forms and behavioral rating scales were returned directly to the principal investigator to preserve both the confidentiality of parent reports and the objectivity of teacher ratings.

As a result of these mailings, we received consent and both parent and teacher ratings for 212 children (123 boys, 89 girls). Children for whom DSM-IV AD/HD checklists were completed ranged in age from 2.84 – 5.92 years (2.84 –3.97 years: 25.8%; 4.00 – 4.99 years: 60.4%; 5.00 – 5.92 years: 13.8%) with a mean (± SD) age of 4.38 (± 0.63) years.

SELECTION OF GROUPS FOR PHASE II

Diagnosis of "at risk" and control status was based upon combined parent - teacher ratings modeled after DSM-IV AD/HD criteria. To be considered at risk, a child needed to receive a "pretty much" or "very much" rating on at least six Inattention or Hyperactive-Impulsive symptom items by either informant. To meet criteria for the control group, a child needed to receive a "pretty much" or "very much" rating on fewer than three Inattention and three Hyperactive/Impulsive symptom items according to both parent and teacher ratings. This more liberal method of classification of at risk status was employed to cast a wide net of children with behavioral difficulties.

Based upon these criteria, 56 (25.3%) children (42 boys, 14 girls) met criteria for the at risk group and 102 (46.2%) met criteria for the control group (51 boys, 51 girls). At risk and control participants identified on the basis of the Phase I screening differed significantly with regard to age [at risk group mean (± SD) age = 4.50 (± 0.52) years, median age = 4.48 years; control group mean (± SD) age = 4.28 (± 0.66) years, median age = 4.40 years], $t = -2.17$, $p < .05$. In addition, the male to female ratio of at risk participants (3:1) significantly exceeded that of controls (1:1; $\chi^2 = 9.33$, $p = .002$).

Among the 102 children from the Phase I cohort who met criteria for the control group 50 participants (23 boys, 27 girls) came to the laboratory at Queens College for further "on site"

assessments. Importantly, control participants who were and were not seen for Phase II evaluations did not differ significantly with regard to parent and teacher ratings of AD/HD symptom domains (all $p > .05$). Fifty six participants from the Phase I cohort met criteria for the at risk group. Among them, 22 (18 boys, 4 girls) were seen for Phase II assessments. Once again, at risk participants who did and did not complete the Phase II evaluations did not differ significantly with respect to dimensional ratings of inattention and hyperactivity-impulsivity completed by parents and teachers (all $p > .05$).

As shown in Table 1, the two groups that came to the laboratory (i.e., at risk and control) did not differ significantly with respect to age or performance on a measure of general knowledge (WPPSI-R Information subtest). However, the at risk group was comprised of a disproportionately greater number of males relative to the control group (81% vs. 46%; $\chi^2 = 7.35$, $p < .01$). Significant differences were also observed with regard to dimensional ratings of inattention (IN) and hyperactivity-impulsivity (HI) symptoms reported by parents and teachers, which is not surprising given that DSM-IV AD/HD Checklist ratings were used for group classification purposes. Of note, separate consent forms were used for each portion (i.e., Phases I and II) of the study, and parents were informed during the screening phase and subsequent invitational telephone contact that participation in Phase I did not obligate them to participate in the on-campus assessment.

Table 1: Phase II sample characteristics

	Normal Control N = 50 Mean (SD)	At Risk N = 22 Mean (SD)	t	*p*
Age	4.23 (0.69)	4.46 (0.46)	1.43	.10
WPPSI-R Information	10.38 (3.38)	8.95 (3.00)	1.65	.10
Hyperactivity-Impulsivity Total: Parent	4.66 (3.05)	16.95 (5.33)	10.11	<.001
Inattention Total: Parent	4.74 (3.05)	10.68 (6.05)	4.37	<.001
Hyperactivity-Impulsivity Total: Teacher	2.70 (4.59)	12.68 (10.26)	4.38	<.001
Inattention Total: Teacher	2.56 (3.61)	10.36 (8.21)	4.28	<.001

Although racial/ethnic data were not collected on the screening form, among the children evaluated in the laboratory, 35% were Caucasian, 3% were African American, 21% were Latino, 24% were of Asian descent and 18% were of "other" or mixed ethnicity according to demographic data obtained from the parents of all Phase II participants. The families who participated in the on-campus evaluation were of primarily middle class status with 47% reporting a family income greater than $70,000/year and 90% of the families reporting a total income above $25,000 per year. Additionally, 44% of fathers and 48% of mothers reportedly received four-year undergraduate degrees. Among the children, 86% lived with both parents who were married. Parents were compensated $10.00 for transportation costs associated with the campus visit; children were provided with snacks and stickers during the assessment.

There were no gender or ethnic restrictions, but both the children and their parents were required to be English-speaking. Children diagnosed with mental retardation, a pervasive developmental disorder, a diagnosed neurological disorder (e.g., epilepsy), or those who were taking systemic medication for a chronic medical condition were excluded from participation.

PHASE II ASSESSMENT PROCEDURES

The on-campus assessment took approximately two hours to complete, and involved the gathering of information from the parent, testing data from the child, and a 15-minute videotaped observation of the parent and child together. One obstacle identified during the conceptualization phase of the project was the dearth of executive function measures appropriate for use with preschool children. In response to this, our research group conducted pilot studies examining an array of potential executive function measures (described below) that are appropriate for samples ranging in age from 3 years to adulthood (Perachio, & Halperin, 1993, Nassauer & Halperin, 2003). These tasks have been designed to be both brief and engaging, making them particularly suitable for use with preschool populations.

CHILD ASSESSMENT MEASURES

Three forms of data were collected from the children: 1) objective measures of activity level to validate the distinction between at risk and control groups; 2) an estimate of overall cognitive function to characterize the sample; and 3) measures to assess four aspects of executive functioning: a) inhibition of response to distracting stimuli (Stimulus Conflict Task; SCT), b) response organization (Response Conflict Task; RCT), c) non-verbal working memory (Delayed Non-Matching to Sample Test; DNMST), and d) memory for time (Recency Memory Test; RMT). In light of reports highlighting the importance of process specificity (Sergeant et al., 2002), all neuropsychological indices were developed in our laboratory and consisted of both experimental and control/reference conditions that would allow for the relative isolation of the constructs of interest. All participants were administered a series of practice trials (on paper and

computer) prior to the start of each task to ensure comprehension of the relevant instructions. Practice trials were repeated until a sufficient level of proficiency could be demonstrated, operationalized as 2/3 or 3/3 correct practice trials for the DNMST and RMT; more subjective criteria were used to gauge comprehension of SCT and RCT instructions. A fixed/standardized test administration order was employed to systematically vary task types so as to help maintain interest and limit fatigue effects.

1. Objective Measures of Activity Level

Motor activity was recorded throughout the Phase II assessment using two solid-state actigraphs. Actigraphs were worn around the waist and non-dominant ankle. Both actigraphs (Model WAM-7164) were obtained from Computer Sciences and Applications (CSA), Inc. of Shalimar, Florida, and utilize internal accelerometers (acceleration magnitude 0.05 – 2.00 G; frequency response of 0.25 – 2.50 Hz) to store data on the number of movements per unit time. Prior to the commencement of each Phase II assessment, both actigraphs were initialized using a reader interface unit (RIU) and programmed to obtain movement counts in 60 sec. epochs. After each evaluation was completed, the actigraphs were returned to the RIU and the data downloaded into separate Microsoft Excel spreadsheets. Descriptive statistics (i.e., mean, median, and SD) were generated separately for each participant's ankle and waist actigraph data using computational algorithms included within Microsoft Excel. The same two actigraphs were used during all Phase II assessments, and were consistently placed on the same location for each child (i.e., waist and non-dominant ankle).

It is important to note that assessments of activity level taken during structured test sessions are reliable (Reichenbach et al., 1992), yield measures that are correlated with parent

and teacher ratings of hyperactivity (Reichenbach et al., 1992; Fairweather, Reilly, Grant, Whittaker, & Paton, 1999), and have been shown to effectively discriminate hard-to-manage preschool boys from comparison controls (Campbell et al., 1994). In addition, Fairweather et al. (1999) have shown CSA actigraphs to be a valid method for assessing physical activity in preschool children, and have identified significant associations between actigraph readings obtained from different locations on the torso (i.e., left vs. right hip).

2. General Cognitive Functioning: Wechsler Preschool and Primary Scale of Intelligence-Revised (WPPSI-R): Information Subtest

This well-normed subtest includes 27 questions that sample a broad range of knowledge about events or objects in the environment. Rudimentary items require less advanced verbal skills, and simply require the child to point to a picture to make a response selection. The remaining items are brief oral questions about common objects and events to which the child responds verbally. The Information subtest has been shown to have excellent internal consistency ($r = 0.84$) and test-retest reliability over 3-7 week intervals ($r = 0.78$), and with an average "*g*" loading of 0.79, has been identified as the single best predictor of overall cognitive functioning within the WPPSI-R. In light of its strong association with general intellectual abilities (63% of its variance may be attributed to *g*), performance on the WPPSI-R Information subtest served as a covariate in the statistical analysis of the project data. Specifically, it was necessary for purposes of addressing the research hypotheses, to ensure that any group differences with respect to neuropsychological functioning were not accounted for by differences in general intellectual ability. Importantly, the use of the WPPSI-R Information subtest as a statistical covariate was undertaken to partial out IQ effects, but not aspects of IQ that subsume

elements of executive function. This concept is particularly critical given emerging evidence suggesting that IQ covariation may attenuate groupwise differences on neuropsychological parameters (Seidman et al., 1997; Tripp et al., 2002).

3. Executive Function Battery

a. Perceptual and Motor Conflict Test (PMCT; Nassauer & Halperin, 2003): This task consists of separate perceptual (stimulus) and motor (response) conflict components. The Stimulus Conflict Task (SCT) consists of three conditions. The child is seated in front of a computer monitor with a two-button computer mouse. For Condition 1, a series of left- or right-pointing arrows appear in the center of the screen. The child must press the button corresponding to the side to which the arrow is pointing (direction). For Condition 2, a series of rectangular boxes appear on either the left or right side of the monitor; the child must press the button on the side on which the rectangle appears (location). Data indicate that responses to the rectangle (location) are significantly ($p<.01$) faster, but not less accurate, than responses to the arrow (direction), suggesting that Condition 2 is easier (Nassauer & Halperin, 2003). Condition 3 consists of trials in which either a left- or right-pointing arrow appeared on either the left or right side of the screen. Children are required to inhibit the prepotent response to stimulus location and respond instead to arrow direction. Errors and reaction time (RT) to Condition 3 have been shown to be significantly ($p < .001$) greater than to either of the other two conditions (Nassauer & Halperin, 2003). This task assesses a construct similar to that of the Stroop Test (Stroop, 1935, Golden, 1978). However, unlike the Stroop, it can be used with young children because it does not require reading. The entire task takes less than 5 min. to administer. In order to isolate the construct of perceptual

inhibition, all SCT analyses were conducted using Condition 3 as the primary dependent measure and performance on Condition 1 as a statistical covariate.

The Response Conflict Task (RCT) is a brief (< 5 min.) computerized measure of response organization and motor inhibition. The first (compatible) condition is identical to that of the SCT; children are asked to press a button which corresponds to the direction that a centrally-located arrow is pointing. Following 20 trials, the task changes such that the child must press the button that is on the opposite side from where the arrow is pointing (incompatible condition). The child is therefore required to inhibit a prepotent response and engage a newly acquired response set. Data indicate significant differences in error rates and RT between compatible and incompatible task conditions (Nassauer & Halperin, 2003). Motor inhibition was ascertained by examining RT and error rates on the incompatible condition, controlling for performance on analogous indices from the compatible condition.

b. The Delayed Non-Matching to Sample Test (DNMST) requires the child to hold a visual image "online." It is analogous to tasks used in monkeys to demonstrate deficits following prefrontal cortex (PFC) lesions (Fuster, 1984). Non-verbalizable figural stimuli are presented to the child on a computer screen for 4 sec., followed by a 1 sec. delay. Then, a response screen containing the original figure and one new figure is presented. The child must identify [by pointing to] the new figure. This task increases difficulty level every 3 trials such that the first 3 trials contain stimuli with a single figure and a response screen containing two figures; the second level contains 2 figural stimuli and 3 response options; the third level contains 3 initial stimuli and 4 response options. The control task is a non-matching to sample task with

no delay - the child views the stimulus and response figures simultaneously. Both task conditions are administered until the child gets 2 or 3 trials incorrect within a given level (up to 4 task levels; possible score range = 0 – 12). This test takes approximately 10 minutes to complete.

c. The Recency Memory Test is a task designed to measure memory for relative time, and has been shown to effectively distinguish patients with PFC and non-PFC lesions (Milner & Petrides, 1984). Verbalizable pictorial stimuli are presented on a computer screen at a rate of 1 per sec. After the pictured stimuli are displayed, a response screen is presented containing two pictures. In the control condition, which assesses simple recognition, only one response picture was previously seen and the child must indicate, by pointing, which picture was seen before. In the memory for time condition, both pictures on the response screen were previously seen and the child needs to indicate which picture was seen last or most recently. Similar to the DNMST, conditions increase in difficulty every 3 trials, and administration is discontinued if the child provides two of three incorrect responses within a task level (up to 8 task levels; possible score range for each condition = 0 – 24).

PARENT ASSESSMENT PROCEDURES

1. Demographics and Development Interview: Parents were administered a semi-structured interview to obtain demographic information and developmental data about the child. The demographic section gathers data related to the determination of ethnicity, socioeconomic status and family/household composition. The developmental history assesses, among other things: 1) gestation period (duration); 2) birth weight; 3) illnesses, substance use (i.e.,

cigarettes, alcohol, drugs), and medications taken during pregnancy; 4) birth complications; 5) developmental milestones; 6) illnesses and injuries during early childhood; and 7) whether concerns (or referral) about behavioral or learning problems were ever discussed with the child's pediatrician or another professional.

2. Alabama Parenting Questionnaire-Preschool Revision: Parents completed a modified version of the Alabama Parenting Questionnaire (APQ; Shelton, Frick & Wootton, 1996). The original scale was comprised of a 42-item inventory which assesses aspects of parenting practices related to disruptive behaviors in children. Our modified version eliminated 10 items which pertained primarily to older children and/or were not appropriate for the preschool age-range. Parents were asked to rate the frequency with which they use various forms of punishments and reinforcements/encouragements with their child, as well as the frequency of various modes of interacting. Individual item endorsements were totaled to generate separate subscale scores pertaining to Involvement (e.g., "Helps child with work", "Drives child to activities"), Positive Parenting (e.g., "Compliments child", "Rewards child for behavior"), and Inconsistent Discipline (e.g., "Threatens to punish but doesn't", "Lets child out of punishment early"). The three subscales from the original APQ have been shown to have good to excellent internal consistency and test-retest reliability (Shelton et al., 1996). In addition, Inconsistent Discipline factor scores have been found to be positively correlated with the diagnosis of a disruptive behavior disorder ($r = 0.38$, $p < .05$; Shelton et al., 1996). Appendix A contains a copy of the modified APQ.

3. HOME: Parents were also administered the HOME (Bradley & Caldwell, 1988), a semi-structured interview designed to evaluate the quality of the child's home and learning environment. Whereas the APQ primarily documents the use of reinforcement and disciplinary practices, the HOME captures information relating to the family's lifestyle and rules (e.g., level of parental investment, amount of exposure to television or videos, difficulty with child rearing, use of learning techniques, strategies for responding to child-initiated provocation). In studies of cognition in preschool children, the HOME proved a better predictor of later cognition than either socioeconomic status (Johnson et al., 1993) or low birth weight (Weisglas-Kuperus, Baerts, Smrkovsky, & Sauer, 1993).

PARENT-CHILD INTERACTION PROCEDURES

Each parent-child dyad was assessed during a 15-minute videotaped session that was subsequently scored using a modified version of the Parent Child Interaction System (PARCHISY; Deater-Deckard, Pylas, & Petril, 1997; Deater-Deckard, 2000). The modified PARCHISY includes a series of 7-point Likert scale items used to rate the interactions of parents and children. Separate PARCHISY codes were obtained during three periods over the course of a fifteen-minute playroom interaction. The first segment of the playroom interaction (7 min.) consisted of "free-play," in which the parent and child are instructed to play as they normally would at home. At the onset of the next segment, "clean-up," parents were asked to have their child clean up the toys that were used during free-play (3 min.). During the final segment (5 min.), parents completed a worksheet with their child ("structured-task"). Parental behavior was classified in terms of: (a) Positive Content, (b) Negative Content, (c) Positive Affect, (d) Negative Affect, (e) Responsiveness to child's questions, comments or behaviors, commands, (f)

On task (obtained during clean-up and structured task periods only) and (f) Verbalizations. Child behavior was coded for: (a) Positive Affect (smiling, laughter), (b) Negative Affect: Sadness, (c) Negative Affect: Anger, (d) Responsiveness to (m)other's questions, comments, or behavior, (e) On-task (obtained during clean-up and structured task periods only), (f) Noncompliance, (g) Autonomy/independence, (h) Activity Level, and (i) Verbalizations. Two dyadic behaviors were also coded to assess the dyad's relative level of conflict and cooperation. Two scorers who were blind to the children's group placement reviewed all of the interactions and received extensive reliability training prior to coding.

DATA ANALYSIS: PRIMARY STUDY AIMS

AIM 1: The relationship of gender and informant to ratings of inattention (IN) and hyperactivity-impulsivity (HI) was examined using a three-way Analysis of Covariance (ANCOVA), with rater (parent vs. teacher) and symptom domain (IN vs. HI) serving as within group variables, gender (males vs. females) serving as the between groups variable, and age serving as the covariate; dimensional summary score, calculated as the total of Likert scale scores within each behavioral dimension (possible range = 0 – 27 for IN and HI), served as the dependent measure.

The prevalence of AD/HD (i.e., Primarily Inattentive, Primarily Hyperactive-Impulsive, and Combined) subtypes was calculated for the entire sample (N = 212) and separately for each gender (N_{boys} = 123, N_{girls} = 89) by applying DSM-IV diagnostic criteria to ratings completed by both informants. Prevalence estimates were also obtained using an "either-or" algorithm for combining parent and teacher ratings. Using this approach, children were still required to meet the aforementioned classification criteria (i.e., ratings of "pretty much" or "very much" on at least six Inattention or Hyperactive-Impulsive symptom items); however, within a given domain,

unique symptoms endorsed by one informant (e.g., parent) could be combined with ratings from the other informant (e.g., teacher). Thus, a child identified as having five inattention symptoms by parent and three inattention symptoms by teacher would meet at risk criteria as long as at least one of the three teacher-identified inattention symptoms was not included in the five reported by the parent. Similar procedures have been advocated by a number of investigators, and have been reported in several studies involving DSM-IV AD/HD rating scales (Lahey et al., 1994).

Aim 2: Estimates of parent-teacher concordance were evaluated dimensionally using IN and HI summary scores (see above) generated for both informants. Pearson-product moment correlations were carried out to examine parent-teacher concordance for both sets of summary scores. Cohen's Kappa (k) reliability procedures were used to assess concordance estimates for diagnostic subtypes and agreement regarding the absolute presence or absence of an AD/HD diagnosis.

Aim 3: The factor structure of parent and teacher [DSM-IV] ratings obtained during Phase I was examined using separate principal components analyses with varimax rotation. Based upon the notion that the eigenvalue criterion for factor retention is primarily intended as a guideline (Kachigan, 1986), scree curves were generated to graphically plot individual eigenvalues against each corresponding factor. As has been suggested by several investigators (Kachigan, 1986; Tabachnick and Fidell, 1996), factors were judged to be significant if eigenvalues: (a) were greater than or equal to 1.00 and (b) fell along a line of best fit on a scree plot, prior to the leveling of the curve. Using the evaluative criteria outlined by Tabachnick and Fidell (1996),

factors were interpreted based upon an examination of items with factor loadings greater than or equal to 0.50 (25% overlapping variance).

Aim 4: To examine group differences with regard to neuropsychological status, performance on each of the executive function indices (i.e., SCT, RCT, DNMST, and RMT) was submitted to separate one-way analyses of covariance (ANCOVA), with group status (i.e., at risk vs. control) serving as the between groups variable and performance on the WPPSI-R Information subtest and the individual paired control conditions serving as statistical covariates. As previously indicated, this approach was employed to allow for the isolation of the specific executive function parameters and to ensure that any group differences with regard to profiles of executive function could not be accounted for by discrepancies in aspects of cognitive functioning.

Aim 5: Group differences with regard to parent-child interaction (PARCHISY) parameters were analyzed using separate 2 (group: at risk vs. controls) x 3 (condition: free play vs. cleanup vs. structured task) Analyses of Variance (ANOVA). Using a cutoff of $\geq 90\%$ agreement with the observer-trainer (with a one point allowance), inter-rater reliability was achieved for eight of the original 18 categories/scales. These included four childhood subscales (Noncompliance; Positive Affect; Negative Affect: Sadness, Negative Affect: Anger), three parent subscales (Positive Affect, Negative Affect, and Negative Control), and one dyadic category (Conflict). ANOVA's were only performed on categories for which sufficient inter-rater reliability could be demonstrated.

Subjective ratings of parenting practices, assessed via the APQ-Preschool Revision, were scored in accordance with the algorithm described by Shelton et al. (1996), but with

modifications to reflect the deletion of 10 items deemed inappropriate for studies of preschool-aged children. Individual item endorsements were totaled to generate separate subscale scores pertaining to Involvement (e.g., "Helps child with work", "Drives child to activities"), Positive Parenting (e.g., "Compliments child", "Rewards child for behavior"), and Inconsistent Discipline (e.g., "Threatens to punish but doesn't", "Lets child out of punishment early"). A Multivariate Analysis of Variance (MANOVA) was used to evaluate group differences on all three dimensions.

Finally, at risk and control groups were compared on items of interest from the HOME, including questions pertaining to child rearing difficulty (Items B11a, B11c, B12), the impact of the child on parental quality of life (Item B11e), and the extent to which children elicit negative feelings from parents (Items B11b and B11d). Also examined were questions dealing with spanking (Item B13) and the use of particular disciplinary techniques (Item D6a-g). Items with Likert scale response options (Items B11a-e and B12) were analyzed using nonparametric Mann Whitney U tests. Questions with dichotomous response choices (Items D6a-j and 13) were evaluated using chi-square procedures.

Data Analysis: Secondary Study Aims

Aim 6: Two-tailed partial correlations (controlling for reference task performance) were used to examine the relationship between laboratory measures of activity level (actigraphs placed on the waist and non-dominant ankle) and performance on the various neuropsychological indices (i.e., SCT, RCT, DNMST, and RMT). Median movement counts were again used in all actigraph analyses to limit the Type I error rate and to minimize the impact of outliers.

AIM 7: Age-controlled partial correlations (two-tailed) were used to examine the relationship between the same laboratory measures described above, and parent and teacher ratings of AD/HD behaviors (IN and HI summary scores; refer to Aim 1A for an explanation of how these scores were derived).

AIM 8: The relationship of parent and teacher ratings of inattention and hyperactivity-impulsivity (dimensional summary scores) to measures of neuropsychological functioning was examined using separate partial correlations, with performance on the WPPSI-R Information subtest and the individual paired reference conditions serving as statistical covariates.

RESULTS

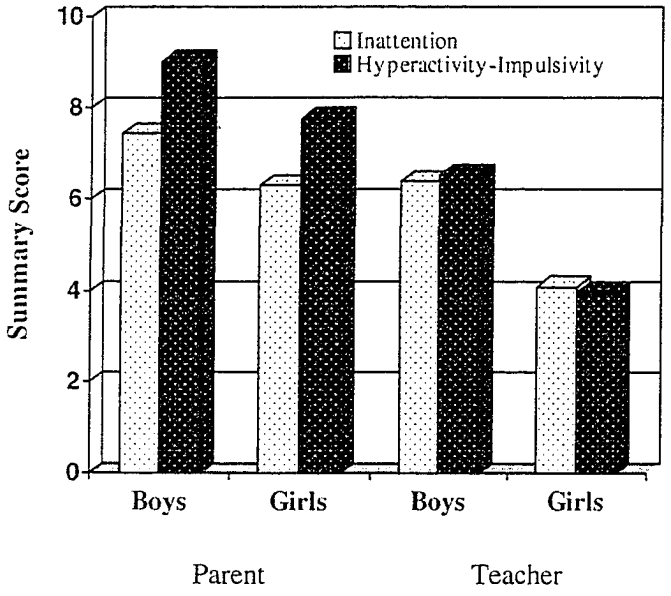
Aim 1: Relationship of Gender and Informant to Ratings of AD/HD Behaviors

As shown in Figure 1, a significant main effect was found for gender, such that boys were rated as significantly more symptomatic relative to girls. A significant effect for rater was also demonstrated, with parents rating children as significantly more symptomatic relative to teachers. No significant main effect was identified for symptom domain; however, there was a tendency for parents to rate girls as more symptomatic relative to teacher perceptions of the analogous behaviors ($p < .10$). Neither remaining two-way interaction nor the three-way interaction reached statistical significance.

Rates of DSM-IV AD/HD subtypes varied as a function of informant, with the Hyperactive-Impulsive Type (AD/HD-HI) most frequently identified by parents and the Combined Type (AD/HD-CT) most commonly reported by teachers. Consistent with what has been found in the literature, meeting symptom criteria for AD/HD-Inattentive type (AD/HD-I) was relatively rare among these preschoolers irrespective of informant (see Figures 2 and 3).

As shown in Figure 2, nearly twice as many boys met criteria for an AD/HD subtype by parent report as compared to girls (22% vs. 12%). The gender disparity regarding prevalence rates was even wider according to teacher ratings (see Figure 3), with 21% of boys and only 5% of girls satisfying diagnostic criteria. Using the aforementioned "either-or" algorithm for combining parent and teacher ratings, 35% of boys and 17% of girls met criteria for an AD/HD subtype (see Table 2). Of note, these data are consistent with expectations based upon previous data from studies of preschoolers. According to Campbell (2002), approximately one-third of the "at risk" children will likely meet criteria for AD/HD at the age of six years, thus putting the prevalence rate in this sample at 9.3% (i.e., one-third of 27.8% - see Table 2).

Figure 1: Three-way analysis of Covariance (ANCOVA) examining the impact of gender, symptom domain, and rater to ratings of AD/HD behaviors in preschoolers*



Effect	F	*p*
Gender	8.55	.004
Symptom Domain	0.03	>.10
Rater	4.55	.03
Gender x Symptom	0.09	>.10
Gender x Rater	3.63	.06
Rater x Symptom	0.58	>.10
Gender x Symptom x Rater	0.00	> .10

* controlling for age; df: 1, 204 for all F's

Figure 2: Parent rated AD/HD subtypes in non-referred preschool boys and girls (N = 212)

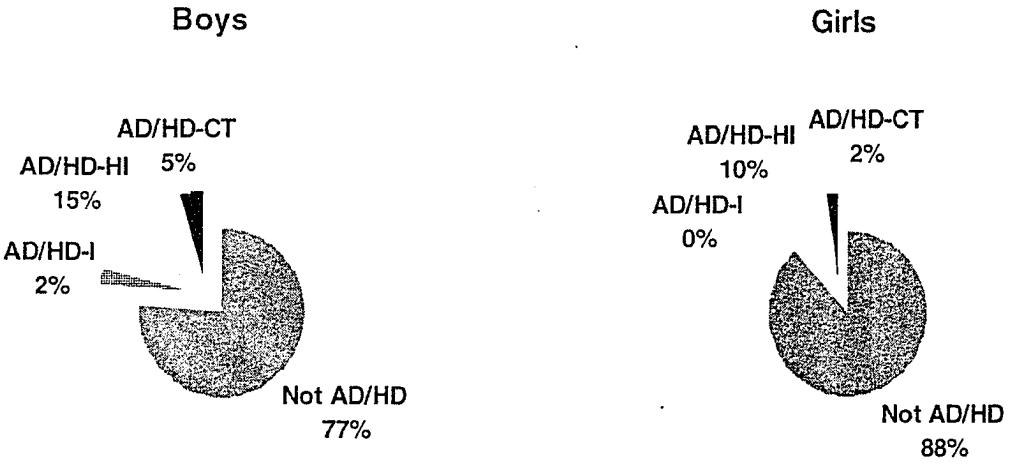


Figure 3: Teacher rated AD/HD subtypes in non-referred preschool boys and girls (N = 212)

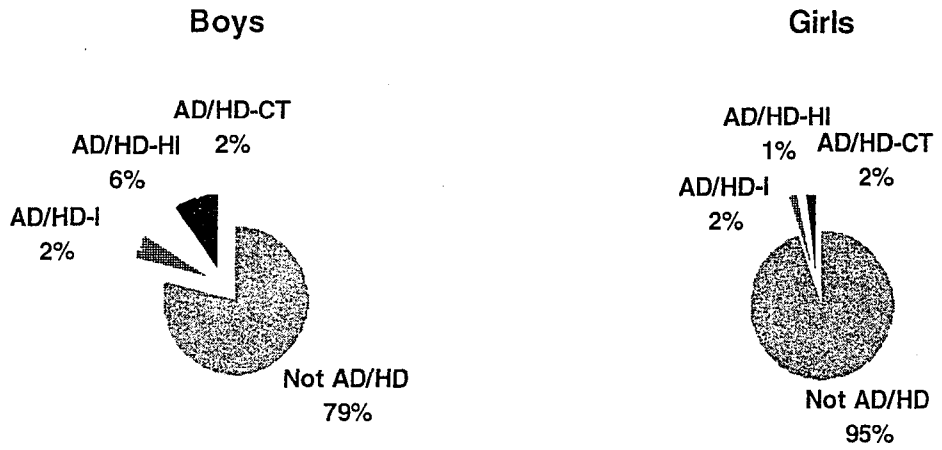


Table 2: Diagnostic status of boys (N = 123) and girls (N = 89) based upon combined "either-or" symptom algorithm

Diagnostic Status	Boys	Girls	Total
AD/HD-I	3 (2.4%)	4 (4.5%)	7 (3.3%)
AD/HD-HI	19 (15.4%)	9 (10.1%)	28 (13.2%)
AD/HD-CT	21 (17.1%)	3 (3.4%)	24 (11.3%)
AD/HD-any type	43 (35.0%)	16 (17.0%)	59 (27.8%)
Not AD/HD	80 (65.0%)	73 (82.0%)	153 (72.3%)

Aim 2: Dimensional and Categorical Estimates of Parent-Teacher Concordance

As previously indicated, IN and HI summary scores were tabulated by totaling Likert scale ratings with each behavioral domain. Significant relationships were identified between all four summary scores generated; however, not surprisingly, the most robust associations were found for within-informant scores rather than across symptom domains (see Figure 4). Parent-teacher concordance for diagnostic subtypes, while statistically significant, was quite weak overall ($k = .19$, $p < .001$). Although parents and teachers were somewhat better able to agree on

the presence or absence *of* an AD/HD diagnosis (k = .26, $p < .001$), concordance as to *which* children represented the probands was relatively weak (see Table 3).

Figure 4: Cross-informant relationships between parent and teacher ratings of inattention and hyperactivity-impulsivity (all $p \leq .001$)

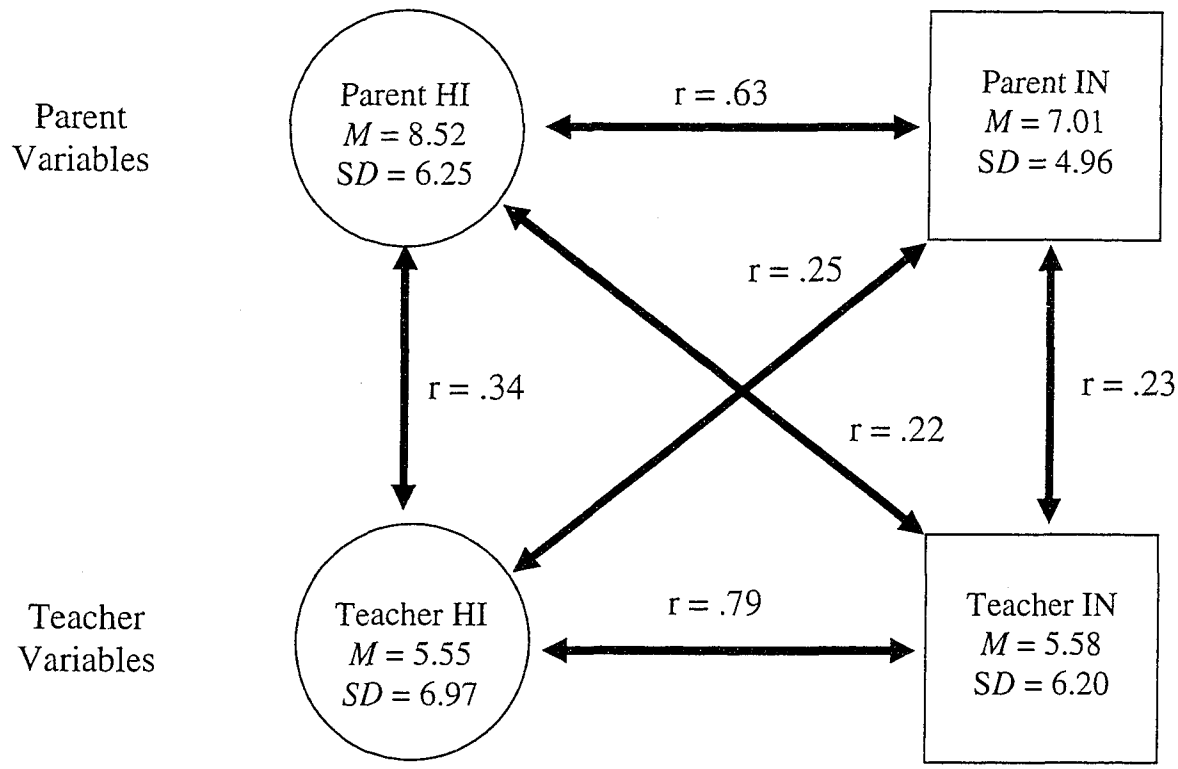


Table 3: Dichotomous categorical concordance of AD/HD diagnoses using parent and teacher ratings of AD/HD symptoms (N = 212)

	Not AD/HD: Parent	**AD/HD-any type: Parent**
Not AD/HD: Teacher	158	26
AD/HD-any type: Teacher	19	14

Aim 3: Factor Structure of Parent and Teacher AD/HD Ratings in Non-referred Preschoolers

A principal components analysis (PCA) with varimax rotation applied to the DSM-IV AD/HD Checklist – Parent Version (N = 212) yielded four factors with eigenvalues exceeding 1.00. However, as shown in Figure 5, a single straight line comfortably fit only the first two eigenvalues; thereafter, another line with a markedly different slope best fit the remaining 16 components. Based upon the aforementioned criteria, only the first two factors (52% of the total variance) were retained for subsequent analysis and interpretation. Items clustered in a manner consistent with findings reported in studies of school-aged samples, and closely approximated the DSM-IV factor structure (i.e., separate IN and HI factors; see Table 4).

Figure 5: Relationship between PCA eigenvalues and extracted factors using the DSM-IV AD/HD Checklist–Parent Version

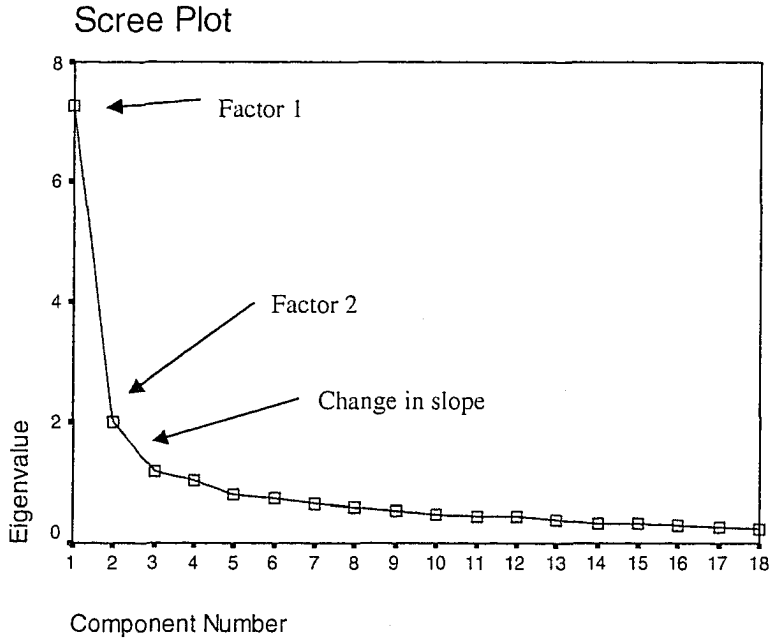


Table 4: Factor analysis of Parent DSM-IV AD/HD items using varimax rotation *

Item	Factor 1 (Hyperactivity-Impulsivity)	Factor 2 (Inattention)
INATTENTION ITEMS		
1. Poor attention to detail/carelessness	---	.76
2. Difficulty focusing	---	.67
3. Doesn't seem to listen	---	.64
4. Doesn't follow through on instructions	---	.76
5. Difficulty organizing things	---	.61
6. Avoids/dislikes paying attention	---	.74
7. Loses things (e.g. books, pencils, toys)	---	---
8. Easily distracted	---	---
9. Forgetful	---	.58
HYPERACTIVE-IMPULSIVE ITEMS		
10. Fidgets or has trouble sitting still	.58	---
11. Gets up from seat without permission	.57	---
12. Restless or runs around too much	.77	---
13. Difficulty playing quietly	.63	---
14. On the go/acts like driven by a motor	.76	---
15. Overly talkative	.75	---
16. Blurts out answers	.71	---
17. Difficulty waiting turn	.69	---
18. Interrupts or intrudes	.76	---
Percentage of Variance Explained	28%	24%

* --- denotes factor loadings less than .50

Analogous procedures conducted using the DSM-IV AD/HD Checklist – Teacher Version yielded two-factors (72% of the total variance), which exceeded the eigenvalue cutoff and satisfied the scree test criteria (see Figure 6). Consistent with the pattern observed for the analysis of parent ratings, a clear differentiation emerged between inattention and impulsivity symptoms. In contrast, hyperactivity and inattention symptoms were less clearly distinguished, with the former splitting their variance across both factors. On the basis of factor loading

patterns, Factor 1 (38% of the variance) was labeled "Hyperactivity-Inattention", while Factor 2 (34% of the variance) was termed "Hyperactivity-Impulsivity" (see Table 5).

Figure 6: Scree curve illustrating the relationship between PCA eigenvalues and extracted factors using the DSM-IV AD/HD Checklist–Teacher Version

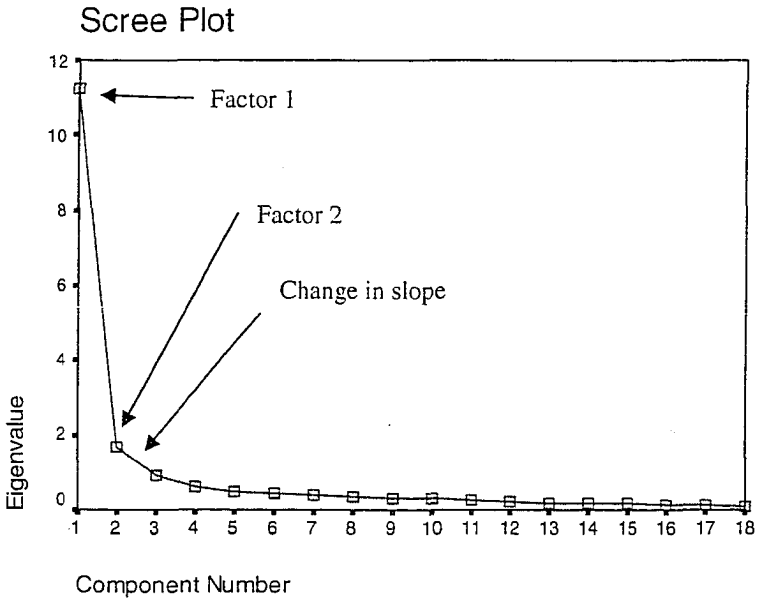


Table 5: Factor analysis of Teacher DSM-IV AD/HD items using varimax rotation *

Item	Factor 1 (Hyperactivity-Inattention)	Factor 2 (Hyperactivity-Impulsivity)
INATTENTION ITEMS		
1. Poor attention to detail/carelessness	.78	---
2. Difficulty focusing	.79	---
3. Doesn't seem to listen	.72	---
4. Doesn't follow through on instructions	.80	---
5. Difficulty organizing things	.77	---
6. Avoids/dislikes paying attention	.68	---
7. Loses things (e.g. books, pencils, toys)	.69	---
8. Easily distracted	.79	---
9. Forgetful	.73	---
HYPERACTIVE-IMPULSIVE ITEMS		
10. Fidgets or has trouble sitting still	.56	.66
11. Gets up from seat without permission	.57	.69
12. Restless or runs around too much	.54	.69
13. Difficulty playing quietly	.63	.64
14. On the go/acts like driven by a motor	---	.72
15. Overly talkative	---	.78
16. Blurts out answers	---	.86
17. Difficulty waiting turn	---	.81
18. Interrupts or intrudes	---	.84
Percentage of Variance Explained	38%	34%

* --- denotes factor loadings less than .50

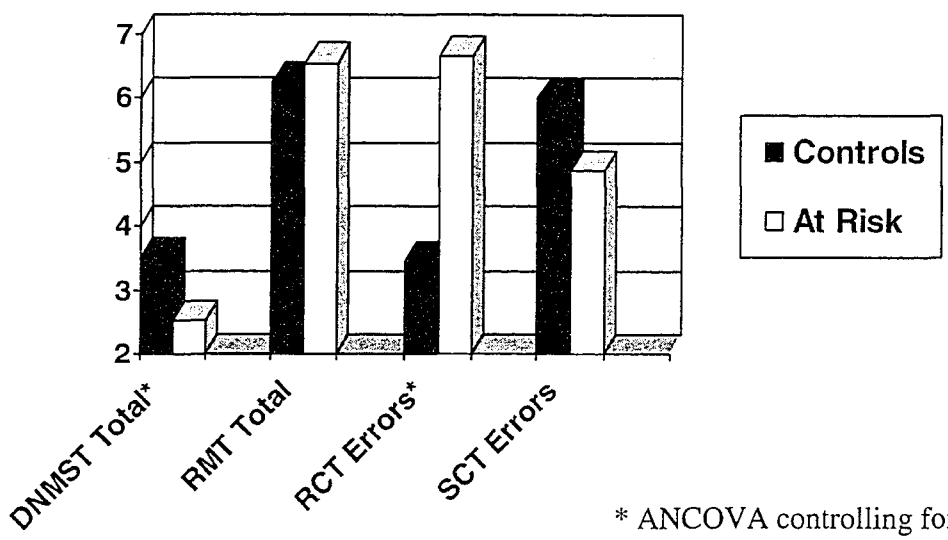
Aim 4: Neuropsychological Profiles of At Risk and Control Preschool Children

As shown in Figure 7, at risk preschoolers performed significantly worse than controls on measures assessing nonverbal working memory (DNMST) and motor/response inhibition (RCT). In contrast, no group differences were identified on indices of verbal working memory (RMT) or perceptual inhibition (SCT). Relative to controls, at risk participants displayed faster reaction

times on both PMCT measures; however, these differences did not reach statistical significance ($p > .10$).

Relative to the control group, a significantly greater proportion of at risk participants scored greater than or equal to a standard deviation above the mean number of errors committed by control participants on the RCT (see Table 6). A greater proportion of at risk participants also scored greater than or equal to a standard deviation below the mean score earned by control participants on the DNSMT ($p < .10$).

Figure 7: Group differences on executive function indices



* ANCOVA controlling for WPPSI-R Information and control condition, $p < .05$

Table 6: Proportion of Normal Control and At Risk participants scoring ≥ 1 SD below mean performance of Normal Control participants on neuropsychological indices*

	Normal Control (N = 50)	At Risk (N = 22)	χ^2	*p*
DNMST Total	54%	80%	3.12	.08
RMT Total	51%	70%	1.98	.13
RCT Errors**	24%	68%	11.08	.001
SCT Errors**	35%	52%	1.68	.15

* controlling for performance on paired control condition and WPPSI-R Information scaled score; ** RCT and SCT error rates reflect proportion scoring ≥ 1 SD above mean

Aim 5: Objective and Subjective Estimates of Parenting Practices in At Risk and Control Preschoolers

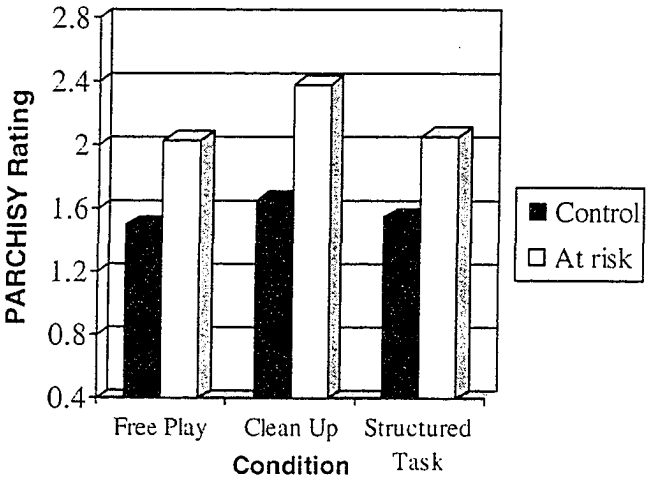
PARENT-CHILD INTERACTION PROCEDURES

The examination of parent-child interactions was undertaken from a reciprocal perspective, which operates on the premise that parent and child behavior mutually influence each other. In keeping with this model, and to fully capture the "contributions" of each member of the dyad, measurement of such interactions entailed the independent assessment of child and parent behavior. As previously noted, the investigation of dyadic interactions was limited to the eight PARCHISY categories for which pre-established inter-reliability standards could be met. Group by condition analyses of variance (ANOVA's) indicated that at-risk preschoolers were significantly more noncompliant than controls irrespective of task demands (see Figure 8a). There were no significant group by condition interactions for child measures, suggesting that the behavior of both groups did vary in accordance with situational expectations.

No significant group effects were identified for parent behavior; however, there were significant main effects for condition such that both groups of parents showed significantly less positive affect and were more punitive during clean-up and structured task periods (see Figures 8b and 8c). A group by condition interaction was also found in parents for positive affect, indicating that the reduction in expressions of warmth during structured periods was significantly more pronounced among at risk parents (see Figure 8b). There was also a tendency for parents of at risk children to display more frequent manifestations of negative affect during the same two interaction periods (see Figure 8c). Taken together, these data indicate that differences between at risk and control children are largely consistent across conditions. Conversely, parental behavior varied as a function of task demands, with parents of at risk children exhibiting disproportionately more negative behavior and fewer forms of encouragement in the context of heightened situational demands.

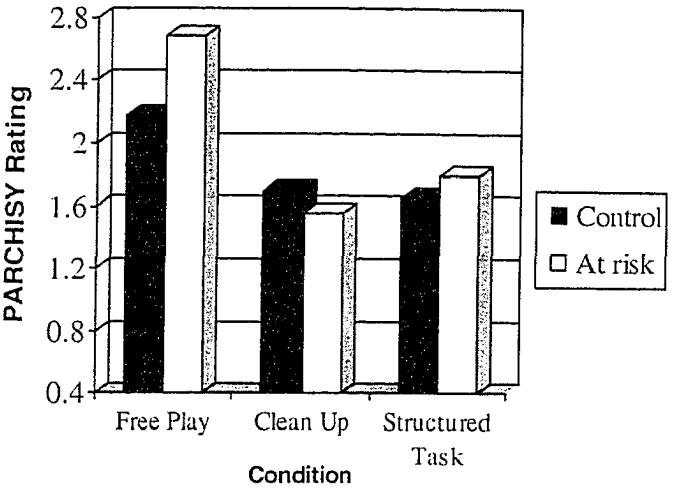
Figure 8: Impact of group membership and condition on rates of: (a) child noncompliance, (b) parental positive affect, and (c) parental negative affect

(a)*



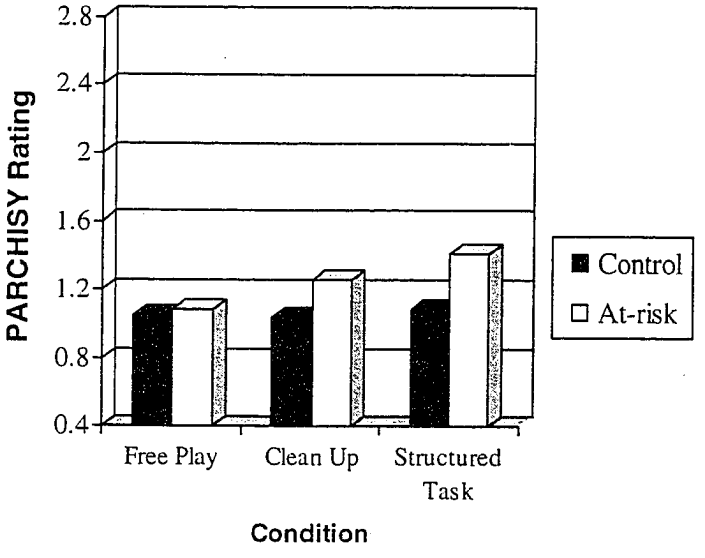
*Main effect condition: F=5.54, $p<.05$

(b)**



**Main effect condition: F=20.23, $p < .001$; Group x condition Interaction: F=3.35, $p<.05$

(c) ***



*** Main effect condition: F=3.47, p<.05; Group X condition trend: F=3.58, $p=.06$

Ratings of Parenting Practices

Contrary to our expectations, no significant differences were found between at risk and control parents on any of the subscales from the APQ-Preschool Revision ($F_{3,64} = 0.76$, $p > .10$). Although the precise reason(s) for the discrepancy between objective and subjective parenting indices is/are not clear, one possibility is that parents of at risk preschoolers are not fully cognizant of the affective changes that may accompany situational manipulations. Nevertheless, a number of group differences emerged on responses to items from the HOME, with parents of at risk children acknowledging significantly greater difficulty with aspects of child rearing (Items B11a and B12, both $p < .005$). In addition, at risk children, relative to controls, were reported to engage in more frequent bothersome activities (Item B11b, $p = .001$), and more often triggered parental anger (Item B11d, $p < .01$). No significant differences were found for any of the other HOME indices examined.

Secondary Aims

Aim 6: Relationship of Laboratory Indices of Activity Level to Performance on Neuropsychological Indices

Using reference task controlled partial correlations, significant inverse relationships were identified between median actigraph data obtained from the waist and non-dominant ankle and reaction time on the RCT (r = -0.33 and -0.39 respectively; both $p < .05$). Interestingly, the fact that such relationships occurred in the absence of an association with RCT error rates suggests that increases in motor activity were associated with more efficient, but not more error-prone motor inhibition. No significant relationships were observed between actigraph measures and the other neuropsychological tasks (all $p > .10$).

Aim 7: Correspondence between Laboratory Measures of Activity Level and Ratings of AD/HD Behaviors

As expected, significant positive associations were identified between laboratory measures of motor activity and dimensional ratings of AD/HD behaviors completed by parents and teachers (IN and HI summary scores). After controlling for age, both sets of actigraph measurements were significantly associated with virtually all ratings of IN and HI (see Table 7). While the associations between actigraph results and IN ratings might be taken to imply limited specificity, it should be noted that parent and teacher IN-HI correlations equaled .77 and .94, respectively. Hence, the associations between laboratory analogues of activity level and IN ratings may, in part, speak to the challenges associated with differentiating IN and HI in preschoolers.

Table 7: Pearson product-moment correlations between objective indices of motor activity and DSM-IV IN and HI summary scores[§]

	Parent IN	Parent HI	Teacher IN	Teacher HI
Ankle: Median	.25**	.28*	.35*	.40*
Waist: Median	.17	.27**	.42*	.48*

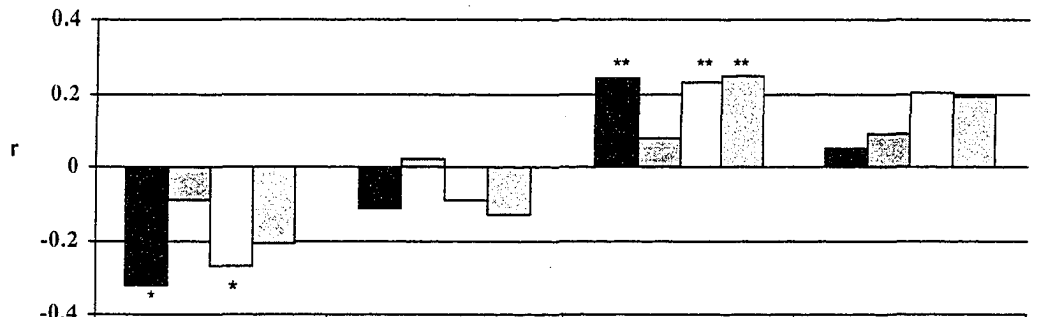
[§] all values controlled for age; *$p < .05$; **$p < .10$

Aim 8: Association between AD/HD Ratings and Executive Functioning in Preschoolers

Performance on the DNMST was inversely correlated with parent and teacher ratings of HI, such that higher ratings were associated with poorer performance (see Figure 9). Positive relationships were also found between the number of errors on the RCT and parent and teacher

HI ratings; however, these relationships did not reach statistical significance ($p < .10$). No other significant relationships were found between neuropsychological indices and ratings of AD/HD behaviors.

Figure 9: Relationship of executive function measures to ratings of AD/HD symptoms



	DNMST Total	RMT Total	RCT Errors	SCT Errors
■ HI (P)	-0.32	-0.11	0.24	0.05
□ IN (P)	-0.09	0.02	0.08	0.09
□ HI (T)	-0.27	-0.09	0.23	0.2
□ IN (T)	-0.21	-0.13	0.25	0.19

$^{*}p < .05$; $^{**}p < .10$

DISCUSSION

The current investigation was undertaken to address five fundamental areas which, while extensively studied in school-aged children, have been comparatively unexplored in samples of preschool children: (i) the factor structure of parent and teacher ratings of AD/HD symptoms; (ii) gender differences in AD/HD symptoms and diagnostic subtypes; (iii) parent-teacher concordance regarding the severity of AD/HD symptoms and diagnoses; (iv) neuropsychological correlates of AD/HD; and (v) the degree to which parents of at risk and control preschool children display unique patterns of dyadic interactions and disciplinary practices. These initiatives were addressed using a two-step recruitment method, which first involved obtaining ratings of AD/HD symptoms from parents and teachers of preschool children in the New York Metropolitan area (Phase I). Following group classification (i.e., at risk vs. control), a subgroup of Phase I participants was invited to participate in an on-campus (Phase II) assessment, which involved the acquisition of information from the parent, assessment data from the child, and participation in a 15-minute parent-child interaction.

Relationship of Gender and Informant to Ratings of AD/HD Behaviors

Using an either-or symptom algorithm to combine information from parent and teacher informants (Lahey et al., 1994), 27.8% of participants in the current study met DSM-IV criteria for an AD/HD diagnosis. Though much higher than the reported prevalence of AD/HD in epidemiologic studies of school-aged samples, these data are consistent with reports which indicate that AD/HD symptoms tend to remit with age in many preschool children (Campbell, 2002). Campbell et al. (1986) observed that approximately one-third of hard-to-manage children preschoolers in their longitudinal study met criteria for AD/HD by age six. If a similar desistance

pattern were to occur for the current sample, the estimated "true" prevalence rate would be 9.3%. However, in light of the fact that the cohorts followed by Campbell and associates included children who were clinically-referred because of disruptive behavior problems, their rate of persistence may actually exceed that of the current study, which was restricted to an investigation of non-referred preschool children.

Although researchers have historically agreed that AD/HD-I is relatively uncommon in this age group, there has been some disagreement as to whether AD/HD-HI or AD/HD-CT is more prevalent among preschool children (Byrne, Bawden, Beattie, & DeWolfe, 2000; DuPaul et al., 2001). In the current study, the prevalence of the latter two subtypes was nearly identical, with 13.2% of preschoolers meeting criteria for AD/HD-HI and 11.3% meeting criteria for AD/HD-CT; AD/HD-I was comparatively rare, with only 3.3% of participants satisfying diagnostic criteria.

The severity of AD/HD *symptoms* varied as a function of rater, with parents rating children as significantly more symptomatic relative to teachers. Informant-based discrepancies were identified with regard to DSM-IV AD/HD *subtypes,* with AD/HD-HI most frequently identified by parents and AD/HD-CT most commonly reported by teachers. Thus, both parents and teachers acknowledge that hyperactive-impulsive behaviors represent a cardinal feature of the disorder during the preschool period. However, the fact that teachers, but not parents, reported greater rates of AD/HD-CT may speak to situational differences regarding task demands or opportunities to observe the behaviors in question. Relative to parents, teachers may place a greater premium on concentration, on-task behavior, and organizational skills, and may therefore be in a better position to identify developmentally inappropriate levels of such behaviors in preschool children.

As expected, significant positive relationships were identified between movement counts obtained from the waist and non-dominant ankle and dimensional ratings of AD/HD behaviors completed by parents and teachers. In large part, the association between actigraph counts and *inattention* seemed to occur secondary to high within-informant IN-HI correlations (.77 and .94 for parent and teacher ratings, respectively). The magnitude of these associations highlights the complexities associated with discriminating IN and HI in preschoolers, and leaves the question unresolved as to whether the inattention of preschool children reflects a true deficit or if such patterns occur secondary to excessive motor activity and/or poor impulse control.

Consistent with what has been reported in studies of preschool (Byrne, DeWolfe, et al., 1998; Kadesjö et al., 2001) and school-aged children (Gaub & Carlson, 1997b, Wolraich et al., 1996), boys in the current study were rated as significantly more symptomatic than girls, and were more than twice as likely to meet criteria for an AD/HD subtype (35.0% vs. 17.0% using combined "either-or" symptom algorithm). Interestingly, hyperactive/impulsive symptoms were not primarily confined to boys; rather, AD/HD-HI was quite common irrespective of gender. Nonetheless, the fact that the gender gap in the prevalence of AD/HD subtypes was considerably wider for teacher ratings (21% of boys vs. 5% of girls) vs. parent ratings (22% of boys vs. 12% of girls) may lend credence to the notion that parents and teachers utilize different standards upon which to base their ratings. As has been suggested in studies of older AD/HD children (McGee & Feehan, 1991), the teachers in the current investigation may have been more likely to employ a normative standard based upon the behavior of disruptive boys, leaving girls who display less severe behavioral disturbances comparatively undetected.

Dimensional and Categorical Estimates of Parent-Teacher Concordance

Parent-teacher agreement regarding the severity of AD/HD symptom domains (i.e., dimensional concordance) revealed a significant rater effect, such that the most robust associations were found for *within informant* scores rather than for *within symptom* scores tabulated for different informants. Thus, parent and teacher ratings of HI were each more strongly associated with *their own* ratings of IN than they were for the other informant's ratings of HI (see Figure 2). Furthermore, teacher IN ratings were just as strongly associated with parent HI ratings as they were with parent IN ratings.

The present study was also among the first to use ratings of AD/HD symptoms to systematically explore the extent to which parents and teachers agree regarding the presence or absence of AD/HD diagnoses and subtypes in preschool children. As anticipated, parent-teacher concordance for diagnostic subtypes, while statistically significant, was quite weak overall. Although parents and teachers were somewhat better able to agree on whether an AD/HD diagnosis was present or not, agreement as to *which* children represented the probands was poor. Taken together, the findings from the current investigation indicate that, similar to their school-aged counterparts (Mitsis et al., 2000), ratings of AD/HD symptoms completed by parents and teachers of preschool children are only modestly associated, irrespective of whether concordance is assessed dimensionally or categorically. The limited congruence between parent and teacher ratings further underscores the tendency of these informants to contribute unique information to the assessment process and highlights the importance of obtaining data from multiple informants when making diagnostic decisions.

Factor Structure of Parent and Teacher AD/HD Ratings

A principal components factor analysis with varimax rotation applied to DSM-IV AD/HD Checklist ratings completed by parents of all Phase I participants (N =212) yielded two orthogonal factors (52% of total variance explained) which exceeded the established eigenvalue cutoff (> 1.00) and fell along a line of best fit on a scree plot prior to the leveling of the curve. As previously indicated, items clustered together in a manner consistent with findings reported in studies of school-aged samples (Healey et al., 1993; Lahey et al., 1988), and closely approximated the DSM-IV factor structure (i.e., distinct inattention and hyperactivity-impulsivity factors). The first of these factors, "Hyperactivity-Impulsivity", accounted for 28% of the variance and included all nine DSM-IV AD/HD Hyperactivity-Impulsivity items and none of the DSM-IV AD/HD Inattention items (all factor loadings < .50). The second factor, "Inattention", accounted for an additional 24% of the variance and contained 7 of the 9 DSM-IV Inattention items and none of the DSM-IV Hyperactivity-Impulsivity items (all factor loadings < .50). The fact that two Inattention items ("Loses things" and "Easily distracted") failed to load on either factor may reflect an expectation on the part of parents that such behaviors are normative features of the preschool period. Consequently, these behaviors may have limited discriminative utility when applied to groups of preschool children.

Similar efforts were undertaken to examine the factor structure of DSM-IV AD/HD Checklist ratings completed by teachers. Consistent with the pattern observed for parent ratings, a two-factor solution emerged (72% of total variance explained), characterized by a clear distinction between inattention and impulsivity items. However, hyperactivity and inattention symptoms were less well-differentiated by teachers, with the former splitting their variance between both factors. The first of these factors, "Hyperactivity-Inattention", accounted for 38%

of the variance and included all nine DSM-IV AD/HD Inattention items and four items pertaining to excessive activity ("Fidgets or has trouble sitting still"; "Gets up from seat without permission"; "Is restless or runs around too much"; and "Has difficulty playing quietly"), but did not include any of the DSM-IV impulsivity symptoms (all factor loadings < .50). The second factor (34% of additional variance), "Hyperactivity-Impulsivity", included all nine DSM-IV AD/HD Hyperactivity-Impulsivity items and none of the DSM-IV AD/HD Inattention items (all factor loadings < .50). Interestingly, the inability of teachers to parse out inattentive features from manifestations of hyperactivity reaffirms the uncertainty as to whether the inattention of preschool children reflects a true deficit or a byproduct of excessive motor activity.

Overall, these data suggest that the manner in which ratings of DSM-IV AD/HD items "hang together" when applied to preschool children may, to some extent, vary as a function of informant. Specifically, while parent ratings yielded a factor structure closely resembling that outlined in the DSM-IV, analogous efforts using teacher ratings failed to provide empirical support for a "pure" inattention factor. This finding, if replicated, could have important implications regarding methods used to identify AD/HD subtypes in preschool children.

Neuropsychological Profiles of At Risk and Control Preschool Children

Previous inquiries into the neuropsychological status of disruptive preschool children have yielded inconsistent findings, with some investigators reporting patterns of executive function (e.g., working memory and motor control) deficits that parallel those observed in school-aged children (Mariani & Barkley, 1997) and others failing to identify an association between executive function parameters and symptoms of AD/HD after controlling for the effects of age, IQ, and/or socioeconomic status (Hughes et al., 1998; Sonuga-Barke et al., 2002).

Furthermore, given that few if any of the tasks used in previous studies included paired control/reference conditions, conclusive statements cannot be made as to whether the observed impairment(s) were the result of genuine executive function deficits or compromised basic sensory or perceptual skills. Finally, most measures of executive functioning used with school-aged samples are inappropriate for use with preschool children due to their length, complexity, and/or lack of engagement.

In light of the perceived dearth of appropriate measures and the importance of process specificity (Sergeant et al., 2002), a series of novel executive function tasks was employed in the current study to isolate four discrete cognitive constructs: a) perceptual inhibition (Stimulus Conflict Task; SCT); b) motor inhibition (Response Conflict Task; RCT); c) nonverbal working memory (Delayed Non-Matching to Sample Test; DNMST); and d) memory for time (Recency Memory Test; RMT). All four tasks consisted of both experimental and control/reference conditions to allow for the isolation of the construct(s) of interest, and were designed to be brief and engaging.

Consistent with the findings of Mariani & Barkley (1997), at risk preschool children in the current study performed significantly worse than controls on measures of nonverbal working memory (DNMST) and motor inhibition (RCT). These differences remained even after controlling for estimated intellectual functioning (WPPSI-R Information scaled score) and performance on the relevant control/reference tasks. As such, group differences in neuropsychological status cannot be better accounted for by differences in general intellectual ability or impaired performance on more basic level cognitive tasks subsumed by the executive function indices. In addition, the relationships between DNMST and RCT scores and both parent and teacher HYP-IMP scores lends credence to the construct validity of the tasks, and is

consistent with recent models which suggest that executive function difficulties may contribute to behavioral disorganization and impulse control deficits similar to those observed in children with AD/HD (Barkley, 1997).

Significant inverse associations were also identified between actigraph movement counts obtained from the waist and non-dominant ankle and reaction time on the RCT. However, as previously indicated, such relationships occurred in the absence of an association with RCT error rates, suggesting that greater motor activity may enhance the efficiency of inhibitory processes, while having a minimal impact on the ability to inhibit prepotent response patterns.

No differences were identified between at risk and control participants on measures of verbal working memory (RMT) or perceptual inhibition (SCT). Although other investigators have also failed to identify groupwise differences on measures of verbal learning (Mariani & Barkley, 1997), this is the first study to identify a dissociation between perceptual and motor inhibition in preschool children. In the case of at risk preschoolers, poor impulse control does not seem to be the result of compromised early stage interference modulation (i.e., capacity to screen out irrelevant stimulus characteristics), but rather appears to stem from their inability to inhibit later stage prepotent response tendencies. This pattern is similar to that reported by Nigg and colleagues (2002), who identified deficits in motor inhibition, but not interference control in school-aged children with AD/HD-CT and AD/HD-I.

Taken together, these findings indicate that, like their older counterparts, at risk preschoolers appear to experience difficulties in aspects of executive functioning. Specifically, impairments in nonverbal-working memory and motor regulation may be among the earliest deficits to surface in at risk preschoolers, while verbal working memory and temporal sequencing skills may be insufficiently developed to have discriminative validity during the

preschool years. It is also noteworthy that the skills measured by both tasks found to discriminate at risk and typically developing preschoolers have been shown to be subserved by regions within the right prefrontal cortex (PFC) and their reciprocal connections within the basal ganglia (Fuster, 2002; Goldman-Rakic, 1996). Thus, even young children with manifestations of AD/HD may present with perturbations in PFC mediated executive functions.

Familial Correlates of AD/HD in Preschoolers: Parent-Child Interactions

As noted above, the evaluation of parent-child interactions was approached from a reciprocal perspective in an effort to capture both child responses to parental antecedents as well as parental reactions to child behaviors. Using the dimensionally-based Parent Child Interaction System (PARCHISY; Deater-Deckard et al., 1997), the behavior of children and their parents was independently assessed during three separate interaction periods (Free Play, Clean-up, and Structured Task). An examination of the eight PARCHISY categories for which acceptable inter-rater reliability was achieved indicated that at risk preschool children were significantly more noncompliant than control participants irrespective of task demands. In contrast, the parenting styles of both groups of parents were found to be situationally dependent, with mothers of at risk and control preschool children displaying less positive, and more negative affect during clean-up and structured task periods. A group by condition interaction was also identified with respect to rates of positive affect, such that the reduction in expressions of warmth observed during structured periods was significantly more pronounced in parents of at risk preschool children. Parents of at risk preschoolers also showed a tendency to be more punitive under the same circumstances.

Thus, as hypothesized, the behavioral differences between at risk and control preschool children were largely consistent across conditions, while parental behavior varied as a function of task demands; when increased structure was added, parents of at risk children engaged in more negative behaviors and displayed fewer forms of encouragement. Although some investigators have observed more punitive and controlling maternal behavior during both unstructured and structured play (Campbell, Breaux, et al., 1986), data from the current study more closely parallel the findings of DuPaul and colleagues (2001) who also observed situationally dependent behavior patterns for parent, but not child behavior. Given the bidirectional nature of dyadic interactions, it was difficult to ascertain from the current study whether negative parental behaviors occurred secondary to their child's behaviors, or were characteristic of the parents. Nevertheless, the fact that parenting styles may, to some degree, moderate the course of early externalizing behaviors (Campbell, 1990; Keown & Woodward, 2002) suggests that parental interventions could help to offset the persistence and/or escalation of early maladaptive behavior.

Familial Correlates of AD/HD in Preschoolers: Ratings of Parenting Practices

Despite the aforementioned group differences observed during parent-child interactions, no significant discrepancies were identified between the parents of at risk and control preschool children on the three subscales (Involvement, Positive Parenting, and Inconsistent Discipline) from the Alabama Parenting Questionnaire (APQ)-Preschool Revision. Several possibilities could account for the schism between objective and subjective parenting indices. First, the parents of at risk preschool children may lack insight into the impact that rearing a disruptive child has on their parenting techniques. Secondly, there may be a reluctance on the part of

parents to acknowledge the use of punitive or socially unacceptable parenting skills or disciplinary techniques. Finally, additional clues may be gleaned from an examination of responses to items on the HOME interview, where parents of at risk preschoolers reported that their children were more bothersome, provocative, and generally more difficult to rear. Thus, it is possible that a failure to observe group differences on the APQ-Preschool Revision was the result of an attributional bias on the part of at risk parents whereby their children's misbehavior rather than own parenting practices was perceived to have a more negative impact on the harmony of the dyad.

LIMITATIONS

Despite the fact that the current study is likely to augment the existing knowledge base regarding the early clinical, neurocognitive, and familial underpinnings of AD/HD, the findings from the present investigation should be interpreted in the context of several important limitations. First, group assignments were made on the basis of liberal categorical cut-points rather than through strict adherence to DSM-IV diagnostic criteria. The rationale for this approach, as stated at the outset, was to cast a wide net of children with behavioral difficulties. Further, investigators have cautioned against the use of strict diagnostic criteria, as such practices may be taken to imply greater levels of stability than may be warranted under the circumstances (Campbell, 1990). More importantly, the fact that at risk and control participants differed significantly on laboratory measures of activity level supports the validity of the classification strategies employed and reinforces the notion that developmentally inappropriate hyperactivity can, in fact, be objectively distinguished from normative levels of activity among preschoolers. Nevertheless, it is conceivable that the use of more restrictive classification strategies (e.g.,

requiring cross-situational behavioral disturbances, restricting symptom counts to "very much" endorsements) and/or mandating the presence of psychosocial impairment as a prerequisite for inclusion in the at risk group could have impacted diagnostic prevalence rates, parent-teacher concordance, and groupwise differences regarding neuropsychological functioning and familial characteristics. In support of this assertion, Wolraich and colleagues (1998) identified significant reductions in the prevalence of DSM-IV AD/HD subtypes once impairment was taken into consideration.

A related limitation involves the fact that efforts were not systematically made to assess the presence of psychiatric comorbidity among children who completed both the screening (Phase I) and assessment (Phase II) portions of the project. As such, it is possible that coexisting behavioral disturbances (e.g., ODD) could have influenced several of the issues under investigation including, but not limited to, the factor structure of AD/HD ratings and group differences in neuropsychological status and parenting techniques. Nevertheless, the fact that the participants in the current study were not specifically referred for behavioral disturbances reduces the likelihood of encountering as severe a pattern of comorbidity as has been reported in clinically-referred samples (Keenan & Wakschlag, 2000). Moreover, the limited number of at risk participants who completed the Phase II assessments precluded an investigation into the impact of psychiatric comorbidity on neuropsychological and familial functioning.

Another limitation involves the fact that a fixed order of administration was used during the Phase II assessments. Although similar strategies have also been employed by other investigators (e.g., Sonuga-Barke et al., 2002), it is possible that fatigue effects negatively impacted performance on tasks presented toward the end of the evaluation. In addition, while the use of the WPPSI-R Information scaled score was selected as a covariate because of its strong

association with *g*, it may also be the most culturally sensitive subtest – an important consideration given the ethnic heterogeneity of the sample. Although the novel executive function tasks used in the current study greatly facilitated the isolation of discrete executive function domains, the psychometric properties (e.g., reliability and validity) of these tasks have not been established. However, the relationships between DNMST and RCT scores and ratings of hyperactivity-impulsivity provide support for the construct validity of the tasks. Finally, the assessment of parent-child interactions was restricted due to complexities associated with achieving inter-rater reliability using the PARCHISY system. Although this was, to some extent, circumvented by only analyzing the eight categories for which sufficient reliability could be demonstrated, doing so also limited the number and types of data points that could be examined.

Future Directions

Although longitudinal investigations of inattentive, impulsive, and overactive preschool children indicate considerable stability of these behaviors over time (Campbell, 2002; Campbell, Pierce, et al., 1996) the examination of early behavioral difficulties seems to have limited prognostic utility (Marakovitz & Campbell, 1998). Consequently, a goal of future studies will be to examine the extent to which neuropsychological and parenting factors, both independently and in combination, are useful for distinguishing disruptive preschool children who do and do not go on to develop AD/HD. The ability to distinguish these two groups of children might help to clarify the etiologic determinants of the disorder, and perhaps more importantly, assist in the identification of children for whom early intervention is warranted. Further, such findings could help in the development of strategies for preventive interventions in preschool children. Moreover, the "developmentally flexible" and adaptive nature (e.g., progressive increases in

difficulty, "drop out points") of the neuropsychological tasks used in the current study make them particularly well-suited for prospective investigations, where the same constructs can be assessed at different time points using the *same series of tasks*. This issue is of marked importance, as most longitudinal studies conducted to date have employed different assessment measures at each of the various evaluation points because of ceiling effects that often occur when baseline tasks are used as part of a follow-up assessment. The use of different measures also renders it difficult to ascertain whether the same domains are being measured in the same fashion over time, and precludes investigators from monitoring developmental changes in raw scores.

FINAL SUMMARY

In several respects, the current investigation has paved new ground by exploring issues which, up until now, have been largely relegated to studies of school-aged children. These initiatives were undertaken by recruiting a non-referred sample of preschool children, which relative to clinically-referred methods, may provide a more accurate depiction of the naturally occurring manifestations of AD/HD, unfettered by potential referral biases and high rates of psychiatric comorbidity. The ethnic diversity of the sample is also an important strength, and bolsters the external validity of the findings.

The factor structure of parent ratings of AD/HD symptoms closely resembled what has been reported in studies of school-aged children (i.e., distinct separation of inattention and hyperactivity, with impulsivity loading primarily with hyperactivity items). Analogous efforts conducted using teacher ratings also yielded a two-factor solution, characterized by a clear separation of inattention and impulsivity, with hyperactivity items splitting their variance between the two. AD/HD symptoms and subtypes were disproportionately more prevalent in

preschool boys than girls; however, gender-based disparities varied considerably as a function of informant. Parent and teacher ratings of AD/HD symptom domains (IN and HI summary scores) were moderately correlated; however, agreement as to which children met criteria for which AD/HD subtype was relatively poor. As a group, at risk preschoolers received significantly higher scores on laboratory based measures of activity level and performed significantly worse than age-matched controls on measures of nonverbal working memory and motor control. Relative to their typically developing peers, at risk preschoolers were significantly more noncompliant during parent-child interactions, irrespective of task demands. Parenting styles varied as a function of task demands, with mothers of at risk preschoolers exhibiting more negative behavior and less encouragement in the context of heightened situational demands. In contrast, no group differences were identified regarding the disciplinary practices used by parents of at risk and typically developing preschool children.

Overall, these data suggest that group differences in neuropsychological status and parenting practices, frequently reported in studies of school-aged children, do in fact seem to emerge during the preschool years, and may underlie early behavioral expressions of the disorder. These factors, when assessed longitudinally, may hold promise for distinguishing those who have early manifestations of AD/HD from "phenocopies" who display transient behavioral disturbances and do not go on to develop the disorder.

APPENDIX A

Alabama School-aged Assessment Service

APQ - Preschool Revision

(Parent Form)

Child's Name:_____ ID#:_____

Date Completed:_____

Parent Completing Form (Circle one): Mother Father Other_____

Instructions: The following are a number of statements about your family. Please rate each item as to how often it *TYPICALLY* occurs in your home. The possible answers are Never (1), Almost Never (2), Sometimes (3), Often (4), Always (5). *PLEASE ANSWER ALL ITEMS.*

	Never	Almost Never	Sometimes	Often	Always
1. You have a friendly talk with your child	1	2	3	4	5
2. You let your child know when he/she is doing a good job with something	1	2	3	4	5
3. You threaten to punish your child and then do not actually punish him/her	1	2	3	4	5
4. You volunteer to help with special activities that your child is involved in	1	2	3	4	5
5. You reward or give something extra to your child for obeying you or behaving well	1	2	3	4	5
6. You play games or do other fun things with your child	1	2	3	4	5
7. You child talks you out of being punished after he/she has done something wrong	1	2	3	4	5
8. You asked your child about his/her day at school	1	2	3	4	5
9. You help your child with his/her work	1	2	3	4	5

	Never	Almost Never	Sometimes	Often	Always
10. You feel that getting your child to obey you is more trouble than it's worth	1	2	3	4	5
11. You compliment your child when he/she does something well	1	2	3	4	5
12. You drive your child to a special activity	1	2	3	4	5
13. You praise your child if he/she behaves well	1	2	3	4	5
14. You hug or kiss your child when he/she has done something well	1	2	3	4	5
15. You talk to your child about his/her friends	1	2	3	4	5
16. You let your child out of a punishment early (like lift restrictions earlier than you originally said)	1	2	3	4	5
17. You get so busy that you forget where your child is and what he/she is doing	1	2	3	4	5
18. Your child is not punished when he/she has done something wrong	1	2	3	4	5
19. You attend parent-teacher meetings/conferences, or other meetings at your child's school	1	2	3	4	5
20. You tell your child that you like it when he/she helps out around the house	1	2	3	4	5
21. You don't tell your child where you are going	1	2	3	4	5
22. The punishment you give your child depends on your mood	1	2	3	4	5
23. Your child is at home without adult supervision	1	2	3	4	5

	Never	Almost Never	Sometimes	Often	Always
24. You spank your child when he/she has done something wrong	1	2	3	4	5
25. You ignore your child when he/she is misbehaving	1	2	3	4	5
26. You slap your child when he/she has done something wrong	1	2	3	4	5
27. You take away privileges from your child as a punishment	1	2	3	4	5
28. You send your child to his/her room as a punishment	1	2	3	4	5
29. You hit your child with a belt, switch or other object when he/she has done something wrong	1	2	3	4	5
30. You yell or scream at your child when he/she has done something wrong	1	2	3	4	5
31. You calmly explain to your child why his/her behavior was wrong when he/she misbehaves	1	2	3	4	5
32. You use time out (make him/her sit or stand in a corner) as a punishment	1	2	3	4	5

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