Functional Impairments Associated with DSM-IV Diagnosed Adult Attention-Deficit/Hyperactivity Disorder

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Abstract

It has recently been recognized that adult Attention-Deficit/Hyperactivity Disorder (ADHD) is a valid disorder (Gadow & Weiss, 2001). Much less is known, however, about the assessment of ADHD, and about the functional impairments associated with ADHD, in adults compared to children. The objective of the present study was to characterize the functional impairments in DSM-IV diagnosed ADHD adults compared to community control adults and clinic-referred adults reporting symptoms of inattention, hyperactivity and/or impulsivity who did not meet symptom thresholds for the disorder. **Method:** The sample for this study consisted of 120 adults: 47 adults with ADHD, 43 clinic-referred adults who did not meet criteria for ADHD, and 30 community control adults. All were assessed with a comprehensive battery assessing psychiatric, cognitive, school, and driving impairment. **Results:** ADHD adults showed significantly more impairment than community control adults on all outcome measures. ADHD adults had subtle cognitive deficits, and higher rates of lifetime conduct problems compared to clinic-comparison adults. ADHD adults did not differ reliably from clinic-comparison adults on measures of internalizing disorders, school problems, or driving impairment. Clinic-comparison adults showed significantly more impairment than community control adults on measures of psychiatric functioning and school impairment. **Conclusions:** DSM-IV diagnosed ADHD adults show a pattern of clinical features that mirrors well-documented findings among children with the disorder, and show significantly greater impairment than do community control adults. Adults meeting some, but not all, criteria for ADHD fall in between ADHD adults and community control adults, and may warrant treatment. Our results highlight the importance of assessing ADHD in adults in a manner that attends to the potential reduced sensitivity of the DSM-IV diagnostic criteria for use in adult populations (Faraone, Biederman, Feighner & Monuteaux, 2000).

Résumé

Dernièrement, l'hyperactivité avec déficit de l'attention (THADA) chez les adultes a été reconnue comme un trouble valide (Gadow et Weiss, 2001). On en connaît bien peu, cependant, au sujet de l'évaluation de l'hyperactivité avec déficit de l'attention et à propos des déficiences fonctionnelles associées au THADA chez les adultes par comparaison aux enfants. L'objectif de la présente étude était de caractériser les déficiences fonctionnelles chez les adultes atteints du THADA diagnostiqués selon les critères du DSM-IV, comparativement aux adultes faisant l'objet d'un contrôle communautaire et des adultes vus en milieu clinique qui ont déclaré des symptômes d'inattention, d'hyperactivité ou d'impulsivité sans toutefois répondre aux seuils établis quant aux symptômes de ce trouble. **Méthode :** L'échantillon de l'étude se composait de 120 adultes : 47 adultes atteints du THADA, 43 adultes de milieu clinique qui n'ont pas répondu aux critères du THADA et 30 adultes faisant l'objet d'un suivi communautaire. Tous ont été évalués à l'aide d'une batterie complète de tests permettant de juger des déficiences d'ordre psychiatrique, cognitif, scolaire et en matière de conduite d'un véhicule. **Résultats :** Chez les adultes atteints du THADA, on a pu constater une déficience considérablement plus grande que chez les adultes qui relèvent d'un contrôle communautaire pour tous les indicateurs des résultats. Les adultes atteints du THADA présentaient un déficit intellectuel légèrement perceptible et des taux plus élevés de problèmes de comportement au cours de leur vie comparativement aux adultes de référence en milieu clinique. Les adultes atteints du THADA ne différaient pas sérieusement des adultes de référence en milieu clinique quant aux mesures portant sur les troubles d'internalisation, les problèmes scolaires ou les lacunes au volant d'un véhicule. Les adultes de référence en milieu clinique ont révélé un degré considérablement plus élevé de déficience que les adultes sous contrôle communautaire en ce qui a trait aux mesures de fonctionnement psychiatrique et des lacunes sur le plan scolaire. **Conclusions:** Les adultes atteints du THADA diagnostiqués selon les

critères du DSM-IV présentent une tendance de caractéristiques cliniques reflétant les constatations bien documentées chez les enfants atteints de ce trouble. De plus, ces adultes présentent une déficience considérablement plus grande que les adultes sous contrôle communautaire. Les adultes qui répondent à certains des critères, mais non à tous les critères du THADA, se situent entre les adultes atteints du THADA et les adultes sous contrôle communautaire et un traitement pourrait être justifié dans leur cas. Nos résultats soulignent l'importance de l'évaluation du THADA chez les adultes d'une manière qui puisse tenir compte de l'éventuelle sensibilité réduite des critères de diagnostic du DSM-IV employés chez les populations adultes (Faraone, Biederman, Feighner & Monuteaux, 2000).

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Statement of Original Contributions

Although it has become clear that adults can manifest ADHD (Spencer, Biederman, Wilens & Faraone, 1994; Wilens, Biederman & Spencer, 2002), far less is known about the use of the most recent, and widely used, criteria from the Diagnostic and Statistical Manual for Mental Disorders-Fourth Edition (DSM-IV, APA, 1994) for the diagnosis of ADHD in clinic-referred adults than in children (Faraone, Biederman, Feighner & Monuteaux, 2000; Faraone, Biederman, Spencer, et al., 2000). Additionally, limited information exists about the pattern of impaired functioning associated with DSM-IV diagnosed adult ADHD (Johnson et al., 2001; Murphy & Barkley, 1996c; Murphy, Barkley & Bush, 2001).

The present research has made an original contribution to knowledge in the area of adult ADHD by characterizing some of the functional impairments associated with DSM-IV diagnosed ADHD adults compared with community control adults and with clinic-referred adults reporting symptoms of inattention, hyperactivity and/or impulsivity who did not meet symptom thresholds for the disorder.

In certain respects, the present study represents an advance over previous research as the information available concerning adult ADHD typically derives from studies that have not use DSM-IV diagnostic criteria, have not controlled for potentially confounding variables such as intelligence and learning disabilities, and have not used clinical comparison groups in conjunction with community control groups.

Our findings provide information about the clinical picture of ADHD in clinic-referred adults diagnosed using DSM-IV diagnostic criteria and further highlight the

importance of clinicians/researchers examining the disorder in a manner that attends to the potential reduced sensitivity of current DSM-IV diagnostic criteria the diagnosis in adults with ADHD (Faraone, Biederman, Feighner et al., 2000).

Table of Contents

Attention Deficit/Hyperactivity Disorder (ADHD) is one of the most commonly diagnosed disorders in child and adolescent psychiatry, occurring in approximately 3% to 5% of children (National Institute of Health Consensus Development Conference Statement [NIH], 2000). It is characterized by a pattern of core behavioural symptoms of inattention and/or hyperactivity-impulsivity that is more frequent and more severe than is typically observed in individuals at comparable developmental levels (American Psychiatric Association [APA], 1994). Symptoms of the disorder present themselves in early childhood and are associated with impairments in multiple settings (i.e., home and school). Impairments in functioning including co-occurring psychiatric disorders, cognitive deficits, and problems in academic and adaptive domains are also frequently associated with the diagnosis of ADHD (APA, 1994; American Academy of Child and Adolescent Psychiatry [AACAP], 1997; Barkley, 1998a).

The disorder has been recognized as a potentially lifelong condition (Nadeau, 1995; Weiss, Hechtman & Weiss, 1999). Longitudinal studies of children with ADHD have suggested that symptoms of the disorder persist through adolescence and into adulthood (Klein & Manuzza, 1991; Weiss & Hechtman, 1993). Existing data suggest that somewhere between 1 and 6% of the general population will continue to experience significant ADHD symptoms into adult life (Wender, Wolf & Wasserstein, 2001). Furthermore, several research and clinical accounts of adults presenting with problems of inattention and/or hyperactivity-impulsivity have been documented (Biederman et al., 1993; Downey, Stelson, Pomerleau & Giordani, 1997; Millstein, Wilens, Biederman & Spencer, 1997). There is general consensus that the defining features of ADHD occur

among adults, and that the diagnosis of ADHD is valid in an adult population (AACAP, 1997; Faraone, Biederman, Spencer et al., 2000; Gadow & Weiss, 2001).

Although it has become clear that adults can manifest ADHD (Prince & Wilens, 2000; Spencer, Biederman, Wilens & Faraone, 1994; Wilens, Biederman, & Spencer, 2002), far less is known about the use of the most recent, and widely used, criteria from the Diagnostic and Statistical Manual for Mental Disorders-Fourth Edition (DSM-IV, APA, 1994) for the diagnosis of ADHD in clinic-referred adults than in children (Faraone, Biederman, Feighner, et al., 2000; Faraone, Biederman, Spencer, et al., 2000). Additionally, limited information exists about the pattern of impaired functioning associated with DSM-IV diagnosed adult ADHD (Johnson et al., 2001; Murphy & Barkley, 1996c; Murphy, Barkley & Bush, 2001).

The DSM-IV Field trials provided extensive empirical support for the diagnostic criteria and symptom thresholds for defining ADHD in children and adolescents (Lahey et al., 1994). The Field trial findings were derived from a sample age 4-17 years, however, and information available about the generalizability of the Field trial findings to adults has been fairly limited (Faraone, Biederman, Spencer, et al., 2000; Lahey et al., 1994;). Concerns have been raised about the use of the child-based DSM-IV symptom thresholds for diagnosing the status of ADHD in adults (Faraone, Biederman, Feighner, et al., 2000).

Preliminary research from a general population study (Murphy & Barkley 1996a) and from an evaluation of familial transmission among adult and non-adult relatives of ADHD children (Faraone, Biederman, Feighner, et al., 2000) has suggested that the

symptom thresholds for ADHD established on children may be too restrictive for application to adult populations. Murphy and Barkley found that the cutoff of symptoms recommended in the DSM-IV for a diagnosis of ADHD set a threshold of deviance that was statistically extreme for an adult population. The threshold of six of nine inattentive and/or hyperactive-impulsive symptoms for a diagnosis of ADHD represented a level of deviance corresponding to the 99th percentile in a normalized distribution of adults. The 93rd percentile is the level of deviance often interpreted as the threshold for clinical significance with children or adults with other conditions. Researchers have indicated that use of the DSM-IV diagnostic thresholds could result in underdiagnosis of ADHD even when present (Murphy & Barkley, 1996c). It has been suggested that DSM-IV thresholds may need to be adjusted for use with adults, and that ADHD be recast as a norm-referenced rather than a criterion-referenced diagnosis (Barkley, 1998b; Faraone, Biederman, Spencer et al., 2000).

The DSM-IV does indicate that for individuals (especially adolescents and adults) who currently have symptoms that no longer meet full criteria, "In Partial Remission" should be specified. Additionally, the DSM-IV provides an ADHD Not Otherwise Specified (ADHD NOS) category. ADHD NOS is defined as a category for disorders with prominent symptoms of inattention or hyperactivity-impulsivity that do not meet criteria for ADHD (APA, 1994). No diagnostic symptom thresholds are provided for these categories, however, and very little has been documented about their use as categories.

The relative uncertainty about the use of DSM-IV symptom thresholds for the diagnosis of ADHD in adults compared to children suggests the need for additional studies of referred adults being assessed for ADHD using DSM-IV diagnostic criteria. Studies using clinic-based samples of adults presenting for assessment of ADHD may be instructive when considering whether DSM-IV ADHD diagnostic criteria, designed for diagnosing young children, are appropriate for use with adults or whether revisions of these criteria for use with adult populations may be justified. It is important that studies of adult ADHD examine the disorder in a manner that attends to the potential reduced sensitivity of current DSM-IV criteria for the diagnosis in adulthood (Faraone, Biederman, Feighner et al., 2000).

In addition to research examining specific diagnostic criteria for ADHD, it has been indicated that future studies should examine the nature and severity of the impact of the diagnosis on individuals, families and society of adults with ADHD beyond the age of twenty (NIH, 2000). Functional impairments such as psychiatric comorbidity, cognitive deficits, academic and adaptive impairments, although not diagnostic of ADHD, are commonly observed in children diagnosed with the disorder, and are associated with considerable long-term costs to society (NIH, 2000). If adult ADHD is a clinically significant disorder, it too should be associated with functional impairments in multiple domains (Faraone, Biederman, Spencer et al., 2000). In fact, impairment is a requirement for the diagnosis. Determining whether the pattern of impairments associated with the adult diagnosis matches the pattern of impairments that has been clearly established in the literature examining children with ADHD is important in providing further

information about the persistence, and the outcomes, of the disorder into adulthood. Understanding the clinical picture of adult ADHD also will enable health care providers to provide the most effective care and treatment strategies for individuals, and aid in the management of ADHD.

Follow-up studies of ADHD children have indicated that in adolescence and adulthood the disorder is associated with psychiatric comorbidity, impaired social relationships, low self-concept, and education and occupational disadvantages (Ingram, Hechtman & Morgenstern, 1999; Manuzza, Klein, Bessler, Malloy & Hynes, 1997). Although many adults in follow-up studies exhibited fewer symptoms of the disorder than were endorsed in childhood, significant impairment was frequently reported that continued to interfere with daily functioning.

Research conducted on clinic-referred adults with ADHD has also started to demonstrate a pattern of psychiatric comorbidity, cognitive and adaptive impairment that is clinically significant and fairly similar to that seen in children and adolescents with ADHD (Biederman et al., 1993; Biederman et al., 1994; Johnson et al., 2001; Murphy & Barkley, 1996c; Murphy et al., 2002; Seidman, Biederman, Weber, Hatch & Faraone, 1998; Spencer et al., 2001). These studies require replication, however, as many of them used DSM-III-R criteria rather than DSM-IV, many did not include a clinic-comparison group of adults, and many did not control for potentially confounding variables such as IQ and learning disabilities.

Research using clinic-comparison groups who do not have ADHD are important to determine the specificity of problems to adult ADHD, and whether meaningful

differences exist between adults meeting full DSM-IV criteria for ADHD and adults who may not meet the DSM-IV symptom thresholds for the disorder. Considering the controversy about the validity of symptom thresholds for adult ADHD, differentiating ADHD from other behavioural problems and determining the appropriate boundary between the normal population and those with ADHD is an important issue related to diagnosis (NIH, 2000). Control over possible confounding variables, such as IQ and/or learning disabilities, is necessary to rule out the possibility that impairments might be explained by a priori differences in variables aside from ADHD symptomatology.

The present study examines some of the impairments in functioning most commonly associated with ADHD in children/adolescents in a sample of adults being assessed for ADHD who do, and do not, meet DSM-IV symptom thresholds for the disorder. The aim of the study was to replicate and extend earlier studies comparing psychiatric comorbidity, cognitive, academic and driving impairment in ADHD and clinic-comparison groups of adults (Biederman et al., 1994; Murphy & Barkley, 1996c; Roy-Byrne et al., 1997). Unlike the majority of previous studies, the present study used DSM-IV criteria to diagnose ADHD, community control and clinic-comparison groups were included in the analyses, and potentially confounding variables were statistically controlled for.

Before further addressing the present empirical investigation, however, it is necessary to first provide an overview of the research conducted by investigators within the field of ADHD over the past thirty years. The introduction will review the following seven issues: (a) the changing conceptualizations of ADHD over time, (b) current criteria

for diagnosing the disorder according to the DSM-IV, (c) the diagnostic features and assessment of ADHD in children and adolescents, (d) the longitudinal evidence suggesting the persistence of ADHD across the life-span, (e) ADHD in clinic-referred adults, (f) the developmental appropriateness of DSM-IV criteria for adults, (g) the functional impairments associated with ADHD in childhood and the limited information regarding impairments associated with ADHD in adults. The present investigation, an empirical study that examined the functional impairments of a sample of clinically referred adults presenting for assessment for ADHD using DSM-IV diagnostic criteria will then be described.

The Changing Conceptualization of ADHD

Although the core features of inattention and hyperactivity have consistently appeared as primary behavioural symptoms in the diagnosis of ADHD, the relative importance of each has fluctuated over time. The conceptualization of the disorder has changed frequently, and as a consequence the selection criteria for ADHD, as they have appeared in the DSM-II, III, III-R, IV, and DSM-IV-TR[1] have changed. The changing criteria make it difficult to summarize and compare research findings concerning ADHD because studies often used different selection criteria (Barkley, 1997b).

What we now consider to be ADHD was first conceptualized in the DSM-II as "hyperkinetic reaction of childhood" and was labelled as such. As reflected in the label, motor restlessness was a main feature in this conceptualization. The disorder was characterized by "...over-activity, restlessness, distractibility, and short attention span, especially in young children" (DSM-II, APA, 1968, p.50). Explicit behaviourally based

definitions to promote diagnostic reliability were lacking in the DSM-II because the diagnostic approach was theoretically based (APA, 1994; Faraone, 2000).

The DSM-III introduced an empirically based framework for diagnosis of mental disorder in general, and markedly improved diagnostic reliability by including explicitly defined criteria. Hyperkinetic reaction of childhood was renamed Attention Deficit Disorder, since inattention was recognized as the primary deficit accompanying the disorder (APA, 1980). Two subtypes of the disorder were proposed, namely Attention Deficit Disorder with Hyperactivity (ADDH) and Attention Deficit Disorder without Hyperactivity (ADD W/O), even though there was no clear empirical evidence at the time supporting this distinction. Three core symptom clusters were outlined (inattention, impulsivity and hyperactivity), with clearly defined examples provided for each cluster. Diagnostic thresholds for the disorder were established by requiring the presence of a specific number of symptoms within each cluster to make the diagnosis. To obtain a diagnosis of ADDH at least three of six inattentive symptoms, three of six impulsivity symptoms, and two of five hyperactivity symptoms were required. The diagnostic criteria for ADD W/O were the same as those for ADDH except that the individual never had signs of hyperactivity. In addition to ADDH and ADD W/O there was a category in the DSM-III named Attention Deficit Disorder, Residual Type. ADD, Residual Type was the first category that hinted at the continuation of symptoms over time, and that this continuation could be impairing, although individuals may not meet full diagnostic criteria (APA, 1980).

Research based on the DSM-III highlighted the cognitive features in both ADDH and ADD W/O, including difficulty maintaining attention and effort, inhibiting impulsive behavior, modulating arousal levels, and delaying immediate gratification (Douglas, 1983). The scope of research was thus broadened with the DSM-III, and inattention became as central to the disorder as hyperactivity-impulsivity (Barkley, 1997b).

Subsequent researchers argued that there was minimal support to substantiate the distinction between ADD W/O and ADDH. Hyperactivity and impulse control, rather than inattention, appeared to be the factors differentiating the disorder from other conditions, and appeared to be predictive of later risks as well (Wender, 1995). The DSM-III-R collapsed the three symptom groups into a single list and a unitary condition was defined that was renamed Attention-deficit Hyperactivity Disorder (ADHD). The display of at least eight of fourteen symptoms related to inattention, hyperactivity, and impulsivity were required for diagnosis. ADD W/O was renamed Undifferentiated Attention-deficit Disorder and was placed apart from ADHD in the DSM-III-R. It was defined as "a residual category for disturbances in which the predominant feature is the persistence of developmentally inappropriate and marked inattention that is not a symptom of another disorder" (APA, 1987 p. 95). The DSM-III-R indicated that research was necessary to determine if Undifferentiated Attention-deficit Disorder was a valid diagnostic category and, if so, how it should be defined (APA, 1987).

Research conducted between 1987 and 1994 documented that ADD without hyperactivity does indeed exist and that there was a basis for its return to the DSM (Lahey & Carlson, 1991). Based on reviews of the empirical literature and extensive field trials,

two separate lists of items were created for the DSM-IV diagnostic criteria of ADHD, one list for inattentive symptoms and another for hyperactive-impulsive symptoms. The difficulty in distinguishing or separating hyperactivity and impulsivity symptoms via factor analysis resulted in combining this factor into hyperactivity-impulsivity (L. Hechtman, personal communication, March 20, 2002; Lahey et al., 1994).

DSM-IV Diagnostic Criteria: Attention-Deficit/Hyperactivity Disorder

The DSM-IV (APA, 1994) currently provides the most widely accepted diagnostic criteria for ADHD. Eighteen symptoms comprise the item list for ADHD. Nine items are listed under the core symptom of inattention, and nine are listed under the core symptom of hyperactivity-impulsivity. Inattention symptoms include: the inability to pay close attention to details or making careless mistakes, difficulty sustaining attention, not listening, not following through, difficulty organizing, dislike and avoidance of tasks requiring sustained concentration, losing things, being easily distracted, and forgetting things. There are six hyperactivity symptoms: fidgeting, being out of seat when remaining seated is expected, running or climbing excessively, difficulty engaging in leisure activities quietly, being "on the go" or acting as if driven by a motor, and talking excessively. The three impulsivity symptoms are blurting out answers inappropriately, interrupting others, and finding it difficult to await one's turn.

DSM-IV diagnosis of Attention-Deficit/Hyperactivity Disorder includes the following additional criteria. At least some symptoms must have been present before the age of seven years. The symptoms endorsed must be inconsistent with developmental and intellectual level and must have been present for at least six months. Significant

impairment must exist in two or more settings, causing problems in social, academic or occupational functioning. The diagnosis of ADHD should not be made if symptoms appear exclusively in the presence of a pervasive developmental disorder, schizophrenia, or other psychotic disorder, or if they are better accounted for by another psychiatric disorder (APA, 1994).

At least six of nine symptoms, from at least one of the symptom lists, are required to meet the diagnostic threshold for the disorder. The DSM takes a categorical approach to diagnosis. If the individual meets a required number of symptoms, and the other diagnostic criteria (e.g., age of onset, impairment), the diagnosis is met; if they have one less symptom, the syndrome is absent (Weiss et al., 1999; Wender, 1995). Thus, even if the individual presents with five symptoms from each of the two symptom lists the diagnosis of ADHD cannot be made.

As mentioned above, the DSM-IV does indicate that for individuals (especially adolescents and adults) who currently have symptoms that no longer meet full criteria, "In Partial Remission" should be specified. Additionally, the DSM-IV provides an ADHD Not Otherwise Specified (ADHD NOS) category. ADHD NOS is defined as a category for disorders with prominent symptoms of inattention or hyperactivity-impulsivity that do not meet criteria for ADHD (APA, 1994). No diagnostic symptom thresholds are provided for it, however, and very little has been documented about its use or validity as a category. The DSM-IV-TR provides the following examples for ADHD NOS: (a) individuals whose symptoms and impairment meet the criteria for ADHD, Predominantly Inattentive Type, but whose age at onset is 7 years or after, (b) individuals with clinically

significant impairment who present with inattention and whose symptom pattern does not meet the full criteria for the disorder, but have a behavioural pattern marked by sluggishness, daydreaming, and hypoactivity (APA, 2000).

The DSM-IV recognized three subtypes of ADHD: (a) Predominantly Inattentive Type (ADHD-I) – defined by the display of at least six of nine inattention symptoms for the past six months, (b) Predominantly Hyperactive-Impulsive Type (ADHD-H) – defined by the display of at least six of nine hyperactive-impulsive symptoms for the past six months, and (c) Combined Type (ADHD-C) – defined by the display of at least six of nine inattention and at least six of nine hyperactive-impulsive symptoms for the past six months.

The DSM-IV conceptualization of three subtypes of ADHD was a departure from the DSM-III listing of two subtypes of the disorder (ADDH and ADD W/O), and the DSM-III-R's unitary approach to the condition (ADHD). Caution is therefore required when considering research findings from samples using different versions of the DSM. The DSM-IV ADHD-Predominantly Inattentive Type is not directly comparable to the DSM-III subtype of ADD W/O, nor to the DSM-III-R Undifferentiated Attention-deficit Disorder. Similarly, DSM-IV ADHD-Combined Type is not directly comparable with DSM-III ADDH or the DSM-III-R category of ADHD (Goldstein, 1997; Paternite, Loney & Roberts, 1996).

Because of the changes in the DSM diagnostic definition of ADHD, Lahey et al. (1994) compared the overlap in case identification resulting from the application of the current DSM-IV and earlier DSM definitions. When DSM-III and DSM-III-R were

compared with DSM-IV, small increases in prevalence of individuals diagnosed with ADHD were associated with the DSM-IV version. The resulting increases in case identification from DSM-III to DSM-IV, and DSM-III-R to DSM-IV were 23.2%, and 15%, respectively (Lahey et al., 1994). The authors indicated that DSM-IV is more successful in identifying impaired girls and preschool children than DSM-III-R. Importantly, the new cases identified as exhibiting ADHD by DSM-IV were more than twice as likely to be female than those who met DSM-III-R criteria, with most of the newly identified girls being in the Predominantly Inattentive Type. Preschool children were also more successfully identified as ADHD using DSM-IV criteria. The authors suggested that it may be that many of the children who qualified for the Predominantly Hyperactive-Impulsive Type, and who would not have met criteria for the disorder in earlier versions of the DSM, do not exhibit maladaptive levels of inattention because they are in preschool and have not yet faced the demands on attentional capacity imposed by school.

Limited research, aside from the DSM-IV field trials, has examined the validity of the new framework for diagnosis of ADHD. Studies that have been completed using the DSM-IV subtypes in clinic-based samples have shown that the combined subtype is the most prevalent, followed by the inattentive subtype, and the hyperactive-impulsive subtype (Carlson, Shin, & Booth, 1999). The majority of children and adolescents meet criteria for a subtype of ADHD with inattention (Lahey et al., 1994; Millstein et al., 1997).

The new diagnosis of ADHD-Predominantly Hyperactive-Impulsive Type and the reinstatement of the category of attention deficit disorder without hyperactivity remain particularly controversial among researchers and clinicians in the field. Disagreement concerning the diagnosis of ADHD-Predominantly Hyperactive-Impulsive Type, which has no counterpart in the DSM-III or III-R, centers on the infrequency of this subtype in clinically referred individuals presenting for an assessment of ADHD, and the limited number of features that have been shown to differentiate the hyperactive-impulsive and combined subtypes (Paternite et al., 1996).

Debate surrounding the inattentive subtype of ADHD has been ongoing since its inception in the DSM-III as ADD W/O. ADD W/O was immediately controversial because there was no empirical literature supporting its existence. In the past two decades, however, research completed with children meeting criteria for DSM-III ADD W/O, and factor analytic studies of ADD symptoms in large samples, have provided evidence of attention deficit disorder without hyperactivity (Brown, 1995; Lahey et al., 1987). It is now accepted that among children referred for evaluation and treatment there are those suffering predominantly from symptoms of inattention. However, it has been suggested that the pattern of features associated with attention deficit disorder without hyperactivity are quite distinct from those associated with attention deficit with hyperactivity. Indeed, there has been disagreement about whether ADHD - Predominantly Inattentive Type should fall within the larger condition of ADHD or have a distinct diagnostic category (Lahey, Carlson & Frick, 1997).

In summary, since its inception, the definition of what is currently known as ADHD has evolved considerably. Substantial empirical literature has now documented clear evidence of the disorder, yet controversy still surrounds certain aspects of it. Disagreements remain as to the applicability of symptoms throughout the lifespan, the threshold for the diagnosis, and the value of making distinctions among subtypes. There is need for research to further examine DSM-IV diagnostic criteria and to provide additional justification for the reconceptualization of ADHD.

Although controversy remains surrounding the use of DSM-IV diagnostic criteria for ADHD, the procedures for assessing the disorder in children and adolescents are now fairly well established, as are the clinical characteristics associated with ADHD in childhood and adolescence. An understanding of ADHD as it presents in childhood and adolescence is necessary in order to understand ADHD as it presents in adulthood.

Assessment of Children and Adolescents with ADHD

Parameters for the assessment of children with ADHD suggest that initial evaluation for the disorder should include an interview with parents covering the child's birth and developmental history, DSM-IV symptoms of ADHD and their development, context and level of impairment, DSM-IV symptoms of possible alternate or comorbid psychiatric diagnoses, past treatment for ADHD, areas of strength, and a medical review. A family history should also be completed considering psychiatric, developmental and learning disorders, coping style, stressors, resources available to the family, and methods of parental intervention (AACAP, 1997; Hechtman, 2000). Additional information prior to, or following the initial interview may be provided by standardized rating scales such

as the Child Behavior Checklist (Achenbach, 1991) and the Conners' Parent and Teacher Rating Scales (Conners, 1969; Goyette, Conners, & Ulrich, 1978).

An interview with the referred child should cover symptoms of ADHD; and consider oppositional and aggressive behavior, mood, anxiety, obsessions and compulsions, thinking processes, motor coordination, tics, speech and language. A physical evaluation should be completed, and referral for additional evaluations made if indicated.

Psychoeducational testing, using the Wechsler Intelligence Scale for Children – III (WISC-III) to assess intellectual functioning and standardized measures of academic achievement such as the Wide Range Achievement Test-III (WRAT-III; Wilkenson, 1993), is also indicated in order to screen for learning disabilities, and to assist with educational planning. School reports are a final essential component of the childhood assessment. Rating scales, verbal reports of learning and behavior, report cards, and observations at school may offer valuable insight into the child's behavior and symptom presentation (AACAP, 1997; Trapani, 2000).

ADHD is a clinical diagnosis. No diagnostic tests are available (Solanto, 2001). Although computerized tasks assessing attention and persistence may provide useful behavioural information through observation of inattentive and/or hyperactive-impulsive behavior during task performance, the tests are generally low in specificity and sensitivity (AACAP, 1997). They should not be used for diagnostic purposes.

Course of the Disorder

Although ADHD was once perceived as a childhood disorder that was outgrown with age, research and clinical work over the past two decades has refuted this by documenting the continuation of ADHD symptoms into adolescence and adulthood (Barkley, Fischer, Edelbrock & Smallish, 1990; Biederman et al., 1994; Fischer, Barkley, Edelbrock & Smallish, 1990; Hansen, Weiss & Last, 1999; Klein & Manuzza, 1991; Manuzza et al., 1997; Stein & Roizen, 2000; Weiss & Hechtman, 1993; Weiss et al., 1999). When the disorder's core features of inattention and hyperactivity-impulsivity are identified early in life they often appear to continue into adolescence and adulthood. Although childhood has been the focus of the vast majority of studies on ADHD, there is an emerging body of longitudinal research examining the adult outcomes of children with ADHD. This research can be divided into studies that use retrospective versus prospective designs.

Retrospective Studies

"Catch-up retrospective studies" have examined ADHD in adults by using behavioral/symptomatic descriptions, found within old childhood psychiatric or child guidance clinic charts, to establish the diagnosis of what appears to have been ADHD in childhood. Individuals identified with what descriptively resembled the disorder in childhood were then traced and interviewed as adults to determine whether core features of the disorder remained symptomatic. Although methodologically imperfect, these studies determined that many adults who exhibited problems with attention and/or hyperactivity-impulsivity in childhood, continued to report symptoms of ADHD,

suggesting that some characteristics of the disorder do not diminish with age (Weiss & Hechtman, 1993, Wender, 1995).

"Follow-back studies" identified adults with current psychiatric syndromes (e.g., alcohol abuse/dependence) who also currently exhibited signs of ADHD including impulsivity, poor attention and restlessness. Retrospective diagnoses of ADHD were subsequently obtained from these individuals using screening instruments to evaluate childhood histories. Symptoms of ADHD in childhood were prevalent, further suggesting that symptoms of the disorder persist into adulthood, as well as predispose individuals to the development of other psychiatric disorders (Weiss & Hechtman, 1993; Wender, 1995). Methodological limitations of retrospective and follow-back studies included the uncertain validity of retrospective diagnoses, the non-standard diagnosis applied to patients in different studies, the lack of control groups, and the lack of consideration given to psychopathology aside from ADHD (Ingram et al., 1999; Weiss & Hechtman, 1993).

Prospective Studies

Prospective longitudinal studies are generally considered the most important source of information about the developmental trajectory of a disorder. Three major prospective studies that followed children diagnosed with ADHD for more than fifteen years into adulthood have been completed.

Weiss and Hechtman (1993) evaluated hyperactive individuals 15 years after they were first assessed in middle childhood (6 - 12 years of age) as suffering from pervasive restlessness and poor concentration at home and school. The investigators believed that

all of the participants would have met the diagnosis for what is now considered to be ADHD, and that many had some associated conduct problems. Weiss and Hechtman (1993) found that two thirds of individuals diagnosed with ADHD in childhood continued to report moderate to severe impairment as adults related to one of the core symptoms of inattention, hyperactivity or impulsivity. In contrast, only seven percent of a matched comparison group with no childhood evidence of ADHD reported such symptoms in adulthood (Weiss & Hechtman, 1993). The authors concluded that a majority of children with ADHD will continue to show impairment as adults in at least one of the three core symptom areas.

A problem with this study was that only 66% of the initial hyperactive cohort was evaluated at 15 year follow-up. It has been demonstrated that research participants lost as a result of attrition are more likely to show psychopathology as adults. Therefore, the most severely impaired individuals may not have been included in their results. It is possible that even greater differences might have appeared between the ADHD and the normal comparison group had more of the original participants cooperated in the follow-up study.

Manuzza, Klein, Bessler, Malloy & LaPadulla., (1993) completed a 16-year long-term longitudinal study that retained 88% of the original cohort. The boys in the study had originally been referred to a psychiatric clinic during middle childhood because of behavioral problems, and were diagnosed with the DSM-II diagnosis of hyperkinetic reaction of childhood. As adults, only 11% of those presenting with ADHD in childhood continued to report full ADHD criteria, indicating a marked decrease in the presence of

hyperactive-impulsive behaviors since childhood and/or the limitations of current ADHD criteria for adults. Still, the probands did report significantly more impairment than normal controls.

At first glance, the two studies suggest significantly different results. However, it is important to recognize that Manuzza et al. (1993) examined full ADHD criteria at follow-up, whereas, Weiss and Hechtman (1993) reported continued problems based on the continuation of at least one disabling symptom of the disorder in adulthood. The Weiss and Hechtman study included certain design features, however, that may have made it more likely to have accurately assessed the life-course of ADHD. Clinical investigators were involved with the participants throughout the duration of their study. The investigators had knowledge of their participants, were aware of their patterns of symptoms over time, and played a role in diagnosing the disorder in both childhood and adulthood. Many parents in the Weiss and Hechtman study also continued to be involved at the time of follow up and offered input into daily functioning of their children as adults. By contrast, investigators in the Manuzza et al. study did not have direct contact with, or knowledge of the children and their parents over time. Diagnosis in adulthood was reliant on the participants' reports of ADHD, and supplementary information was less likely to be elicited from other informants. Clinicians' and parents' role and input in the diagnostic process was restricted in the Manuzza et al. study (Wender, 1995).

Manuzza and colleagues acknowledged that reliance on self-report may have caused an underestimation of ADHD symptoms in their clinical adult sample. They proposed that inaccurate self-perception of ADHD individuals may have contributed to

the report of fewer symptoms in adulthood. In fact, Manuzza et al. (1993) stated that their adult rate of ADHD should probably be doubled because of the absence of reports by "others" in making the diagnostic formulation. Rates of full diagnosis of ADHD in their adult sample would therefore be closer to 22%. The rate of significant impairment may in fact be considerably higher. Reviewing the results and methodological differences from the two longitudinal studies, Wender (1995) concluded that it is safe to assume that at least one third of children with ADHD will continue to show significant symptoms of the disorder in adulthood.

The third major prospective follow-up study, the Milwaukee follow-up study (Barkley, 1997a), found further evidence of the problems created when only self-reports are used to evaluate individuals for ADHD in their young adult years. In follow-up evaluation (mean age 20-21 years), investigators determined that using DSM-III-R criteria, only 3% of the young adults in their sample met full criteria for the disorder according to self-report. Using parent report resulted in at least 58% of the young adults being classified as still having ADHD by the same DSM-III-R criteria (Barkley, 1997a). The source of the information was crucial in determining persistence of the disorder.

Fischer et al. (1990) have suggested that the lack of consensus regarding the criteria for the diagnosis of ADHD in early longitudinal studies may have contributed to the fairly low rate of impairment for children with ADHD followed into adulthood. The authors suggest that less explicit and less reliable diagnostic criteria employed at the start of long-term prospective studies likely resulted in including children in the ADHD samples who had what may now be considered marginal ADHD. Children with less

severe symptoms of ADHD may have a considerably more positive outcome than might have been found if the research criteria presently available for diagnosing ADHD had been utilized. Additionally, the possibility that the symptoms used to define ADHD in children are not sensitive measures of ADHD in adulthood, may affect estimates of the persistence of ADHD into adulthood (Faraone, Biederman, Feighner et al, 2000).

In summary, retrospective and prospective studies of ADHD suggest that ADHD symptoms may continue into adulthood, although rates of impairing symptoms will likely decrease with increasing age (particularly hyperactivity). Reliance on self report of current ADHD symptoms may result in fewer impairing symptoms than would be obtained in reports by a clinician or knowledgeable informants such as parents and peers.

Combining the prevalence estimates of 3-5% for childhood ADHD with the long-term follow up data reviewed above results in an estimated prevalence of approximately 1-2% for ADHD in the adult population (Wender, 1995). An estimated one in three individuals who were first diagnosed with ADHD in childhood will show symptoms of ADHD in adulthood that are severe enough to warrant treatment.

ADHD in Clinic Referred Adults

Despite existing retrospective and prospective evidence, many clinicians are reluctant to assess individuals for ADHD. Child clinicians and researchers do not usually follow up ADHD children into adulthood, and clinicians assessing adults often do not consider the diagnosis of ADHD for individuals presenting with attentional difficulties (Biederman et al., 1995; Shaffer, 1994; Weiss et al., 1999). Additionally, limited research

has been completed with clinically referred adults being assessed for ADHD and disagreement remains regarding its presentation and diagnosis.

In the last several years however, there has been a dramatic increase in the number of adults seeking evaluation and treatment for what is believed to be ADHD (Murphy & Barkley, 1996a; Roy-Byrne et al., 1997). This increase has likely resulted from the appearance of best-selling books such as Hallowell and Ratey's (1994) *Driven to Distraction*, as well as from extensive media coverage and the emergence of advocacy organizations such as CHADD – Children and Adults with Attention Deficit Disorder. The dramatic increase in the number of adults in the general population seeking evaluation and treatment for the disorder has created a clear need for a better understanding of the phenomenology of ADHD as it presents in adults (Biederman et al., 1994; Millstein et al., 1997; Roy-Byrne et al., 1997).

Although several assessment tools are available to aid in the diagnosis of adult ADHD, no single diagnostic method to date has gained widespread acceptance and/or validation among clinicians and researchers. One of the most widely used sets of diagnostic criteria for adult ADHD was developed by Paul Wender (1998). Wender's "Utah criteria" require an established history of the childhood ADHD, persistent motor activity, and attention deficits that are continuously present from childhood to adulthood. Additionally, problems with affective lability, inability to complete tasks, impulsivity and stress intolerance must be present (Ward, 1993; Wender, 1998). The Brown Attention-Deficit Disorder Scale for Adults is a more recent assessment tool that focuses on cognitive, attentional, and organizational symptoms, and common affective impairments

rather than hyperactivity or behavioral symptoms (Brown, 1996). The Conners' Adult ADHD Rating Scale (CAARS) is a standardized self-rating scale that provides data corresponding to (a) Inattention/Executive Functioning, (b) Hyperactivity/Restlessness, (c) Impulsivity/Emotional Lability, and (d) Problems with Self-Concept (Conners et al., 1999; Erhardt, Epstein, Conners, Parker & Sitarenios, 1999).

The Developmental Appropriateness of DSM-IV Criteria for Adults

The DSM-IV (APA, 1994) currently provides the most widely accepted diagnostic criteria for ADHD in children and adults. A problem with the diagnosis of adult ADHD, however, is that the diagnostic criteria used in the DSM-IV are based on field trials that used only children and adolescents. It has been proposed that the diagnostic criteria established on children may not be easily generalized to use with adults (Murphy & Barkley, 1996a).

The DSM-IV states that six of nine inattentive symptoms or six of nine hyperactive-impulsive symptoms are appropriate thresholds for use with both children and adults. However, there are no data to support the validity of this assumption for adults (Murphy & Barkley, 1996a). Indeed, it has been suggested that DSM-IV criteria may be too restrictive for use with adults. There is inadequate research to conclude that adults who report fewer than six of nine symptoms do not have the disorder. The natural progression, developmental stages, and manifestation of the disorder across time are not sufficiently understood, particularly with respect to DSM-IV criteria.

Although the DSM-IV includes the categories of ADHD "In Partial Remission" for individuals (especially adolescent and adults) who currently have symptoms of

ADHD but no longer meet full criteria, and ADHD NOS for individuals with prominent symptoms of inattention or hyperactivity-impulsivity that do not meet criteria for ADHD, diagnostic symptom thresholds have not been provided for these categories, and little has been documented about their use.

Murphy and Barkley (1996a) have strongly argued that the DSM IV item sets are more pertinent to children than to adults, and that the item sets become less sensitive to the disorder with age. They have stated that the child-based guidelines cannot be extrapolated to the diagnosis of current ADHD in adults without considering age and gender. The criteria of six of nine inattention symptoms and six of nine hyperactive-impulsive symptoms sets a deviance threshold that is quite extreme and may result in only the most severe cases qualifying for the diagnosis in adulthood. (Murphy & Barkley, 1996a). Age referenced thresholds have been proposed as an alternative to thresholds fixed across the lifespan to aid in the diagnosis of ADHD in adults (Murphy & Barkley, 1996b).

In one of the only studies examining age related reporting of DSM-IV ADHD criteria in the general population, Murphy and Barkley (1996a) found that applying the cut-off of six of nine current symptoms for ADHD resulted in 1% of adults meeting criteria for a current diagnosis. The few individuals within their sample of the general population who met the diagnostic threshold were reporting a number of symptoms that was about 3 standard deviations above the mean of their group (above the 99th percentile). Traditionally the 93rd percentile (or 1.5 standard deviations) has been used in childhood

research on ADHD as the threshold for establishing deviance. Therefore, use of DSM-IV symptom thresholds resulted in diagnosis of adult ADHD only in very extreme cases.

Murphy and Barkley (1996a) have also suggested that when fewer symptoms are reported in adulthood than are required to meet diagnostic thresholds it may be the result of developmentally inappropriate item wording of the symptom lists rather than indicating decreasing prevalence of the disorder from childhood to adulthood. For example, items such as "runs about or climbs excessively", and "often leaves seat when remaining seated is expected," are unlikely to be endorsed by adults because they are so atypical for this stage of life. Adherence to six of nine DSM-IV criteria for diagnostic purposes in adults may therefore result in adults not receiving a diagnosis when they truly may have the disorder.

Murphy and Barkley's (1996a) study of ADHD symptom reporting within the general population of adults provided preliminary evidence suggesting that the DSM-IV item sets are too extreme for current diagnosis of the disorder, and that ADHD may be better viewed as a norm-referenced rather than a criterion referenced diagnosis. This issue also was addressed by Faraone, Biederman, Feighner, et al. (2000) using a combination of logistic regression and ROC analysis to examine how varying symptom thresholds might affect evidence of familial transmission of ADHD. From a familial perspective, results from Faraone, Biederman, Feighner, et al.'s study indicated that different points could be used as a symptom threshold to define adult ADHD. Their findings were in line with the idea that ADHD could be viewed as a dimensional trait, rather than a discrete category. Faraone, Biederman, Feighner, et al. did not suggest, however, that clinical symptom

thresholds be chosen soley on familial data. The authors highlighted the need for future research to examine the optimal symptom threshold for adult ADHD in more detail.

In summary, if DSM IV diagnostic criteria are used to make decisions as to whether or not adults should receive treatment for ADHD, it seems likely that many individuals with substantial impairment may not receive services that should be rendered. However, further studies are needed to provide justification, or modification, for DSM-IV ADHD criteria in adults, especially in populations of adults referred specifically for the diagnosis of ADHD. Research has not adequately addressed the appropriateness of DSM-IV criteria within the population of adults referred specifically for the diagnosis of ADHD. Research has also not addressed the DSM-IV categories of ADHD "In Partial Remission" and ADHD NOS and their usefulness for adults who do not meet strict symptom thresholds for the disorder.

An additional problem with the use of DSM-IV criteria has been raised with respect to the age-of-onset criteria (AOC) in the assessment of adult ADHD. Although there is support for viewing ADHD as a disorder that typically has its onset of symptoms during childhood, the DSM-IV diagnostic criteria requires that sufficient symptoms that have caused impairment must have arisen prior to 7 years of age. When applying the AOC to adult clinical referrals the question has been raised about whether adults can reliably recall a precise AOC for symptoms. No support has been demonstrated to exist for the selection of the specific age of onset of seven years for symptoms producing impairment as part of the diagnostic criteria for ADHD. Barkley & Biederman (1997) proposed that until empirical justification is found for a precise AOC for ADHD the AOC

should be abandoned or generally broadened to include onset of symptoms during the entire childhood years.

Functional Impairments Associated with Adult ADHD

Functional impairments such as psychiatric comorbidity, cognitive deficits, academic and adaptive impairments, although not diagnostic of ADHD, are commonly observed in children diagnosed with the disorder (AACAP, 1997; Barkley, 1998a). These impairments are associated with considerable long-term costs to society, including the disproportionate share of resources and attention allocated to ADHD individuals from the health care system, criminal justice system, schools, and other social service agencies (NIH, 2000). Although many studies have documented impairments in ADHD children, much less is known about the functional impairments and impact associated with these impairments in adult ADHD.

Determining whether the pattern of impairments associated with the adult diagnosis matches the pattern of impairments that has been clearly established in the literature examining children with ADHD is important in providing further information about the persistence, and the outcome, of the disorder into adulthood. Understanding the clinical picture of adult ADHD also will enable health care providers to provide the most effective care and treatment strategies for individuals, and aid in the management of ADHD.

Longitudinal studies of children with ADHD have identified impairments including low self-esteem, poor academic performance, poor interpersonal skills, antisocial behavior and substance abuse in late adolescence and adulthood. These adults

may exhibit fewer symptoms of ADHD, but continue to have functional impairments of ADHD (Ingram et al., 1999). Limited research conducted on clinic-referred adults with ADHD has also started to demonstrate a pattern of psychiatric comorbidity, cognitive and adaptive impairment that is clinically significant and fairly similar to that seen in children and adolescents with ADHD (Biederman et al., 1993; Biederman et al., 1994; Johnson et al., 2001; Murphy & Barkley, 1996c; Murphy et al., 2001; Murphy, Barkley & Bush, 2002; Rucklidge & Kaplan, 1997; Seidman et al., 1998). These studies require replication, however, as many of them used DSM-III-R criteria rather than DSM-IV, many did not include a clinic-comparison group of adults, and many did not control for potentially confounding variables such as IQ and learning disabilities.

The following section will review some of the impairments in functioning most commonly associated with ADHD in children (e.g., psychiatric comorbidity, cognitive and adaptive functioning) and the limited information on impairments associated with adult ADHD.

The purpose of this review of functional impairments is to provide background for the present empirical study comparing these clinical characteristics in adults referred for assessment of ADHD who did and did not meet the DSM-IV ADHD diagnostic criteria.

Psychiatric Functioning

When two or more disorders are co-occurring in the same individual, the conditions are considered to be comorbid. The conditions may or may not interact, and may or may not be treated in consideration of one another.

Co-occurring psychiatric conditions in children with ADHD are considerable and varied, and have been reliably documented in recent years (Biederman, Newcorn & Sprich, 1991; Biederman, Newcorn & Sprich, 1997; Jensen, Martin & Cantwell, 1997; Szatmari, Boyle, & Offord, 1989, Biederman et al., 1998). Comorbid psychiatric conditions exist in as many as two thirds of clinically referred children with ADHD (AACAP, 1997). Empirical evidence has established that comorbidity is a real and unavoidable characteristic of psychiatric disorders, and is not simply a product of methodological problems (Angold, Costello & Erkanli, 1999).

Comorbidity with ADHD is not just an effect of referral bias in individuals presenting to specialty treatment settings, as data from general population studies indicate that comorbidity is also present in individuals with psychiatric disorders who do not present for treatment (August, Realmuto, MacDonald, Nugent & Crosby 1996). It is not the result of information collection strategies as comorbidity with ADHD is seen with self-report questionnaires, parent report questionnaires about children, and interviews with parents and with children (Barkley, 1990; Szatmari et al., 1989). Although some symptoms are shared by both ADHD and comorbid psychiatric conditions (e.g., concentration problems in ADHD and depression), ADHD is also not an artifact of overlapping symptoms. The majority of individuals with both ADHD and a comorbid psychiatric disorder maintain their diagnosis once symptoms shared by two disorders are removed (Milberger, Biederman, Faraone, Murphy & Tsuang, 1995).

The high level of comorbidity within ADHD does not invalidate the diagnosis of the disorder (Biederman, Faraone, Keenan & Tsuang, 1991). Comorbid conditions may

indicate different levels of seriousness of disorder, with some comorbid conditions resulting in higher degrees of impairment, and a more chronic course, than single conditions (Newman et al., 1996; Newman, Moffitt, Caspi & Silva, 1998).

To advance our understanding of ADHD, comorbidity patterns must continue to be examined (Hinshaw, 1987; Jensen et al., 1997; Weiss et al., 1999). Studies have examined the nature and occurrence of comorbidity with ADHD, and research is now tackling how participants differ as a function of comorbidity (Biederman et al., 1991; Jensen et al., 2001). It is particularly important to determine whether the impairments ascribed to ADHD are in fact confined to the comorbid conditions with ADHD, or are a feature of ADHD itself. Evidence of specificity to ADHD requires direct comparisons between ADHD and at least one other clinical group (ideally controlling for comorbidity) tested under the same conditions and with the same measures. When comorbidity is not carefully delineated conclusions regarding one condition may in fact be due to the presence of a second, co-occurring condition (Russo & Beidel, 1994).

This review will focus upon the comorbid conditions of oppositional defiant disorder and/or conduct disorder (ODD/CD) and internalizing disorders (mood and/or anxiety disorders) with ADHD as they are the most frequently examined conditions that co-occur with ADHD.

ADHD+ODD/CD in Children

Oppositional defiant disorder is identified by a recurrent and persistent pattern of negativistic, defiant, disobedient and hostile behavior towards authority figures. Conduct disorder is identified by the recurrent and persistent violation of societal norms, or rules

and the basic rights of others (APA, 1994). Empirical evidence has demonstrated that symptomatology, and some clinical correlates, differ between ODD and CD (Loeber, Burke, Lahey, Winters & Zera, 2000; Schachar & Wachsmuth, 1990). However, the common vulnerabilities between children with ODD and CD; and the finding that many individuals with CD have met criteria for ODD, have led many researchers and clinicians to group the disorders of ODD and CD together within a conduct problems category (Clark, Prior & Kinsella, 2000; Kuhne, Schachar & Tannock, 1997; Lahey et al., 1992; Newcorn & Halperin, 2000). It should, however, be stressed that only a small proportion of children with ODD go on to develop CD.

Oppositional defiant disorder (ODD) and conduct disorder (CD) are frequently comorbid with ADHD (Biederman et al., 1987; Biederman, Mick, Faraone & Burback, 2001; Hinshaw, 1992). Although comorbidity rates are generally higher in clinical samples compared to epidemiological samples, all studies have found high rates of comorbidity of ODD/CD with ADHD, regardless of informant/instrument (Biederman et al., 1987; Jensen et al., 1997). Findings from epidemiological and community based studies suggest that among children with ADHD, between 43% and 93% also meet criteria for conduct/oppositional disorders (Marks, Newcorn & Halperin, 2001).

Children with ADHD comorbid with ODD/CD generally have a more serious clinical course and outcomes of increased severity and persistence compared to those with ADHD only (Biederman et al., 1991; Jensen et al., 1997). Higher numbers of ADHD symptoms -- particularly ratings of hyperactivity-impulsivity, higher parent and teacher rated aggression and anxiety, lower self-perceived competence, more severe

underachievement, higher rates of impaired family functioning, and higher rates of parental psychopathology have been linked with the comorbid condition of ADHD+ODD/CD vs. ADHD alone (August et al., 1996; Hinshaw, Lahey & Hart, 1993; Kuhne et al., 1997; Newcorn et al., 2001; Reeves, Werry, Elkind & Zametkin, 1987). ADHD + ODD/CD has also been associated with a higher risk of school suspension, expulsion and dropout and significantly higher use of cigarettes and marijuana compared to ADHD alone groups (Barkley, 1990). The impact of comorbid ODD/CD beyond the impact of ADHD alone is also apparent on driving skill deficiencies, including the number of license suspensions/revocations, the number of motor vehicle crashes, and number of traffic citations (Barkley et al., 1993). Impairment on neuropsychological tasks, particularly tasks measuring verbal skills, may also be significantly greater in children with symptoms of both ADHD and conduct problems than ADHD alone (Dery, Toupen, Pauze, Mercier & Fortin, 1999; Nigg, Hinshaw, Carte & Treuting, 1998). However, conduct problems do not seem to exacerbate problems in executive functioning that are associated consistently with ADHD (Clark et al., 2000; Pennington & Ozonoff, 1996).

In summary, the comorbidity of conduct problems with ADHD generally increases the seriousness of the disorder. Family functioning is more impaired, there is more aggression and poorer peer relations, and antisocial behavior is more likely to persist into adulthood. School suspensions and expulsions and substance use may be more likely in ADHD+ODD/CD individuals. Impairments in verbal performance may

also be more frequent when ADHD is comorbid with conduct problems than when ADHD or conduct problems appear alone.

ADHD+Internalizing Disorders in Children

Although the majority of research on comorbidity in ADHD has focused on conduct and learning disorders, comorbidity between ADHD and internalizing disorders is also common (Jensen, Shevrette, Xenakis & Richters, 1993). Approximately 30-40% of clinic referred ADHD children will meet criteria for a comorbid anxiety disorder and 20-30% for cormorbid mood disorders (Broitman, Robb & Stein, 2000; Jensen et al., 1997; Spencer, Wilens, Biederman, Wozniak & Crawford, 2000; Tannock, 2000).

ADHD+Anxiety in Children.

Research considering children with ADHD+anxiety has indicated that children with these comorbid conditions tend to report more stressful life events, such as separation and divorce, and psychiatric problems within the family, than children with ADHD-only (Jensen et al., 1993; Tannock, 2000). ADHD+anxious children may also show greater impairments in adaptive functioning in school, peer relations and home life than those with ADHD-only (Biederman et al., 1993; Tannock, 2000). It seems possible, however, that these impairments may be associated with comorbid ADHD in general.

Considering cognitive correlates of comorbid ADHD+anxiety, less impairment has been observed in ADHD+anxious children vs. ADHD-only children on reaction time tasks involving response inhibition such as the continuous performance task, and a stop signal task (Jensen et al., 1997; Tannock, 2000). More impairment has been shown on cognitively complex tasks involving working memory, such as the serial additions task,

Trailmaking Test B, and complex display of memory scanning tasks. The effect of anxiety in ADHD appears to decrease difficulties on tasks requiring response inhibition, but to increase difficulties with working memory and effortful processing (Tannock, 2000).

ADHD+Mood Disorders in Children.

Few studies have directly compared ADHD children with and without mood disorders on clinical or cognitive variables. Little is known about how the presence of depression in ADHD affects the expression of ADHD. Biederman et al., (1996) in a four-year follow-up study of children with ADHD and control children revealed depression at baseline predicted lower psychosocial functioning on the Global Assessment of Functioning Scale and a higher rate of hospitalization (14% vs. 0%) than in children with noncomorbid ADHD. They concluded that children with ADHD + mood disorders are at a higher risk for developing a wide range of impairments affecting multiple domains of psychopathology and interpersonal and family functioning. Biederman et al., (1992) compared ADHD children and ADHD children with comorbid major depression and found that comorbid children had higher rates of placement in special classes at school than ADHD only children (53% vs. 20%). However, comorbid probands did not have higher rates of learning disabilities, repeated grades and academic tutoring, or lower WISC-R scores than the noncomorbid probands.

With respect to ADHD and Bipolar Disorder (BPD), considerable controversy exists. Whereas some researchers have reported that a majority of children with BPD have comorbid ADHD (Wozniak et al., 1995), others have stated that the proposed

evidence for validity of childhood mania in ADHD is lacking (Klein, Pine & Klein, 1998). The high diagnostic overlap between ADHD and BPD has made the clinical picture confusing. Child psychiatry has yet to decide whether children with overlapping symptoms of ADHD and BPD have mania, ADHD, or both.

ADHD+ODD/CD vs. ADHD+internalizing (anxiety/mood disorders).

Recent research from children with ADHD participating in the NIMH Collaborative Multisite Multimodal Treatment Study of Children with ADHD (MTA) found significant differences between children with ADHD+internalizing disorders and children with ADHD+ODD/CD on clinical, family functioning and treatment variables (Jensen et al., 2001). Head-to-head comparisons of the two singly comorbid subgroups revealed that ADHD+ODD/CD children were more impaired than ADHD+internalizing children on the severity of hyperactive-impulsive symptoms, overall impairment, and parent-child relations. ADHD+internalizing children were more impaired on baseline academic performance scores and the likelihood of having a learning disability (Jenson et al., 2001; Newcorn et al., 2001). Considering treatment response, the ADHD+internalizing group of children generally responded equally well to behavioural and medication treatments. Medication was indicated in the treatment of children with ADHD-only and ADHD+ODD/CD. A combination of medication and behavioral treatments was suggested to be most effective for children presenting with ADHD+ODD/CD+internalizing problems, suggesting some justification of separate classification from ADHD+internalizing children. The findings suggested that more

precise matching of patients to treatment using their comorbidity profiles might produce larger treatment gains for specific patients.

Importantly, many children with ADHD and comorbid anxiety disorders may also be diagnosed with ODD or CD. It has been suggested that the simultaneous presence of anxiety disorders in children with ADHD and comorbid conduct problems may reduce the level of impulsive behavior. The presence of anxiety may serve as a protective factor against the high level of impulsivity seen in children with ADHD and comorbid conduct problems (Newcorn & Halperin, 2000).

In summary, children with ADHD, irrespective of comorbidity, have high levels of core symptoms of the disorder (Jensen et al., 2001; Newcorn et al., 2001). There are differences, however, in clinical presentation and treatment responsiveness as a function of comorbidity (Jensen et al., 2001; Newcorn et al., 2001). Children with ADHD+ODD/CD may show more severity in ADHD symptomatology, more impairment in social functioning, and more impairment on cognitive tasks involving a verbal component than ADHD-only children. Children with ADHD+internalizing disorders may be somewhat less impulsive, may show more academic difficulties, more trouble with working memory, and more positive response to behavioral interventions than ADHD-only children. Children with ADHD+ODD/CD+internalizing disorders may show less impulsivity than ADHD and ADHD+ODD/CD children. Although further research is needed, it appears that conditions comorbid with ADHD may be distinct enough from "pure" ADHD that it may be useful to consider their own subtypes (Jenson et al., 2001; Newcorn et al., 2001).

Psychiatric Functioning in Clinic-Referred ADHD Adults.

ADHD+ODD/CD in Adults

Individuals given a clinical diagnosis of ADHD, for the first time as adults, also frequently meet criteria for lifetime occurrence of ODD and/or CD. The reported rates are typically below those reported in ADHD children (Biederman et al., 1993), but are significantly higher than those reported in normal, non-referred adults (Biederman et al., 1993; Biederman et al., 1994; Murphy et al., 2002). Approximately 19-45% of clinic-referred adults diagnosed with ADHD have ODD and 3-33% have CD either currently or over the course of their life (Biederman et al. 1993; Biederman et al. 1994; Murphy &Barkley, 1996c; Murphy et al., 2002). Rates that are closer to those in childhood are found when considering adult relatives of ADHD children who also meet criteria for ADHD. Fifty-three percent have had ODD, and 33% have had CD sometime in their lives (Biederman et al., 1993).

One of the only studies comparing ADHD adults and a control group of patients referred to the same clinic as ADHD adults who did not meet criteria for the disorder (Murphy & Barkley, 1996c), also found that significantly more adults with ADHD had experienced conduct disorders (17% vs. 0.0%), and oppositional defiant disorder (29.6% vs. 6.7%) compared to subthreshold adults.

Approximately 7-18% of adults diagnosed with ADHD in adulthood qualify for a diagnosis of Antisocial Personality Disorder (Biederman et al., 1993; Murphy et al., 2002). Antisocial Personality Disorder is a pattern of disregard for, and violations of, the rights of others that begins in childhood or early adolescence and continues into

adulthood (APA, 1994). For the diagnosis to be given, the individual must be at least 18 years of age and have had a history of some symptoms of conduct disorder before 15 years of age. The diagnosis of Conduct Disorder is appropriate for individuals older than 18 years, if the criteria for Antisocial Personality Disorder are not met. The diagnosis of Oppositional Defiant Disorder is appropriate for individuals, if the criteria for Conduct Disorder or Antisocial Personality Disorder are not met.

ADHD+Internalizing Disorders in Adults

The reported rates of anxiety and mood disorders among clinic-referred ADHD adults are typically higher than those reported in ADHD children (Biederman et al., 1993), and significantly higher than those reported in normal, non-referred adults. Approximately 8-50% of clinic-referred adults diagnosed with ADHD have anxiety disorders and 13-58% have mood disorders either currently or over the course of their life (Biederman et al. 1993; Biederman et al., 1994; Murphy &Barkley, 1996c; Murphy et al., 2002; Roy-Byrne et al., 1997; Spencer et al., 2000).

When comparing clinic-referred ADHD adults and clinic-referred adults who do not meet criteria for ADHD, however, the rates of internalizing disorders have been approximately equal (Murphy & Barkley, 1996c; Roy-Byrne et al., 1997). Murphy and Barkley (1996c) reported that within their ADHD group 17.6%, 31.6% and 31.6% of adults reported having experienced Major Depressive Disorders, Anxiety Disorders and/or Dysthymia, respectively. Fairly consistent with these rates, adults who were subthreshold for ADHD reported rates of 20%, 43% and 33.3% for Major Depressive Disorder, Anxiety Disorder and/or Dysthymia, respectively. Similarly, Roy-Byrne et al.,

(1997) found that within their ADHD group, 50% of adults reported having experienced Major Depressive Disorder, whereas 58% of adults with subthreshold ADHD reported having experienced MDD. Research has demonstrated that clinic-referred populations are more likely than other populations to have multiple disorders (Barkley, 1998a). Comparing clinic-referred populations of adults who did and did not meet criteria for ADHD, the rate of anxiety and mood disorders was no higher among ADHD adults than the rate reported in clinic-referred adults seen at the same clinic who did not have ADHD (Murphy & Barkley 1996c; Roy-Byrne et al., 1997). It is likely that adults seen in general psychiatric outpatient clinics have a higher than normal community rate of internalizing disorders.

In summary, clinic-referred adults with ADHD appear to have comparable comorbid psychiatric diagnoses as do ADHD children followed into adulthood. Their level of anxiety and mood disorders may be somewhat higher, and their conduct problems may be somewhat lower, than in ADHD children (Barkley, 1998a). Compared to normal comparison groups of adults, ADHD adults report higher rates of internalizing and conduct problems (Biederman et al., 1993; Biederman et al., 1994; Murphy et al. 2002). Compared to clinic-comparison groups of adults, being assessed for problems with inattention and/or hyperactivity-impulsivity, who do not meet criteria for ADHD, ADHD adults report higher rates of conduct problems but do not differ significantly in rates of reported internalizing disorders (Murphy & Barkley, 1996c).

Further research is needed examining the conditions that overlap with ADHD, as well as how complex symptom presentations should determine treatment options.

Because comorbid conditions are highly associated with ADHD, research must include patients who have ADHD and other comorbidities, ADHD alone, and patients who have other conditions but not ADHD to more clearly understand the syndrome and how it interacts with other conditions (Moffitt, 1993; Weiss et al., 1999).

Cognitive Functioning and School Failure

Although cognitive correlates associated with ADHD do not provide evidence about the presence or absence of ADHD symptoms, they are important to consider in the evaluation of ADHD because they are not subject to biases arising from self-reports such as recall bias or halo effects, and because they provide a direct measure of cognitive status that is useful in designing a treatment plan for an ADHD individual (AACAP, 1997; Trapani, 2000). Cognitive testing can provide information regarding intellectual functioning, academic achievement, learning disabilities, and memory problems.

The presence of impaired performance on measures of cognitive functioning, including standardized tests of intellectual, academic and neuropsychological functioning, among ADHD children is one of the most reproducible findings in studies of ADHD (Faraone et al., 1993; Faraone et al., 1998; Semrud-Clikeman et al., 1992). Findings must be viewed with caution, however, in view of the changing conceptualization of ADHD, and methodological limitations of many of the studies. Relatedly, many studies have failed to control for comorbidity (e.g., learning, oppositional, conduct, anxiety and mood disorders) and demographics (e.g., age). It is often unclear whether differences that exist between ADHD and comparison groups are attributable to ADHD or a co-occurring disorder. Concerning age and gender, the

majority of research has been conducted with school age boys with ADHD (Gaub & Carlson, 1997; Lahey et al., 1998). It is often unknown whether findings generalize across age and gender groups.

Some of the most consistent and reliable findings documenting cognitive impairment in ADHD participants have examined general intellectual functioning, Freedom from Distractibility as assessed by the 3rd factor of the WISC-III, and arithmetic calculation.

Intellectual Functioning in ADHD Children

Research has repeatedly demonstrated significantly lower overall performance on the Wechsler Intelligence Scales for Children (WISC) in ADHD children relative to normal control children (Barkley, 1997b; Goldstein, 1997; McGee, Anderson, Williams & Silva, 1986; Rucklidge & Tannock, 2001; Schwean & Saklofske, 1998). This finding holds for epidemiologic and clinic samples, across the life span, and for both girls and boys. The finding also generally holds when controlling for comorbid disorders (Faraone et al., 1993). Medium to large effect size differences are generally found between ADHD and normal comparison groups (Faraone et al., 1993; Krane & Tannock, 2001; Purvis & Tannock, 1997). According to Cohen (1992), a medium effect size represents an effect likely to be visible to the naked eye of a careful observer; a small effect size is noticeably smaller than medium but not so small as to be trivial; and a large effect size is the same distance above medium as small was below it. Although the overall intelligence quotient of ADHD children is generally within the average range, the score of ADHD children is

an average of 7 to 15 points below control children on standardized tests of intelligence (Barkley, 1998a; Faraone et al., 1993; Loge, Staton & Beatty, 1990).

It is unclear whether significant differences in scores comparing ADHD children and normal controls are due to a true difference in intelligence or a result of attention problems and impulsive test-taking behaviors that may interfere with information processing (Barkley, 1998a; Goldstein, 1997; Mealer, Morgan & Luscomb, 1996). Approximately 25% of ADHD children also have a learning disability involving reading, spelling, or math that may be contributing to the finding of lower overall IQ scores (Faraone et al., 1993). The few studies that have controlled for learning disabilities have continued to point to lower intelligence scores in ADHD-only children compared to normal control children (Barkley, Dupaul & McMurray, 1990; Barkley, 1998a). Differences between ADHD and normal controls on measures of intellectual functioning, therefore, cannot be attributed solely to the subgroup of ADHD children having a learning disability.

Despite consistent findings, lower intelligence is not a diagnostic indicator of ADHD. Findings refer to group data and may not hold for individual cases. Children with the disorder may fall anywhere within the spectrum of intellectual functioning, although most have IQ scores in the normal range.

Intellectual Functioning in ADHD Adults

The few studies examining intellectual functioning in ADHD adults have been less consistent than studies of ADHD children. Corresponding with results from pediatric samples, Biederman et al. (1993), found that adults with ADHD had significantly lower

estimated full-scale IQs than normal adults without the disorder. These differences remained when the data analyses were restricted to adults with uncomplicated ADHD in which there was no lifetime history of any adult psychiatric disorder, suggesting that the symptoms and impairments of adults with ADHD are not always attributable to other psychiatric disorders. Although the differences on cognitive measures between ADHD and control participants were significant, they were not large. Small effect size differences were observed. More recently, Murphy et al (2002) found significant differences in IQ scores comparing ADHD adults and normal comparison adults. Medium effect sizes were found in their comparisons.

In contrast, studies by Biederman et al. (1994) and Seidman et al. (1998) did not find significant differences between ADHD adults and control adults on estimated IQ scores that have been consistently reported in pediatric samples. Seidman et al. (1998) suggested that this discrepancy might be due to their sample of adults being a higher functioning subset of ADHD individuals than is found in the overall ADHD population. Seidman et al. proposed that the process of self-referral requires a degree of self-awareness and organizational abilities that may indicate less neuropsychological impairment than may otherwise be seen in ADHD adults.

It appears that when differences exist between ADHD and control adults on measures of intellectual functioning, the differences may be smaller than differences found in pediatric samples. However, few studies have carefully investigated this issue in ADHD adults, and more research is needed to clarify the findings.

The Third Factor - Freedom from Distractibility in ADHD Children

Four factor index scores can be derived from the WISC-III, namely, Verbal Comprehension, Perceptual Organization, Freedom from Distractibility, and Processing Speed. The names of the four factors were based on the presumed demands of the tasks they encompass (Reinecke, Beebe & Stein, 1999). While evidence acknowledging the validity of the first two factors exists, debate concerning the third and fourth factor continues. The third factor, Freedom from Distractibility (FFD), has been particularly controversial with respect to ADHD. The FFD factor is comprised of the Arithmetic subtest, requiring the individual to solve orally presented arithmetic word problems, and the Digit-Span subtest, requiring the recall of orally-presented number sequences, forwards and backwards.

The name of the index, "Freedom from Distractibility," implies that the primary construct being tapped is attention. Its title has contributed to examination by clinicians/researchers in the use of the third factor (FFD) as a measure of attention problems. Studies examining scores on the FFD have also consistently found low FFD scores in children with ADHD, with scores on the third factor often being significantly lower than the other three factors (Anastopoulos, Spister & Maher, 1994; Dickerson Mayes, Calhoun & Crowell, 1998; Mealer et al., 1996; Reinecke et al., 1999). Educators and clinicians have sometimes used scores from the FFD (in fact not always in conjunction with other findings) to make the diagnosis of ADHD. However, the psychological meaningfulness, and clinical information provided by the FFD is not so clear-cut (Krane & Tannock, 2001).

Research has recently indicated that FFD is not a valid index of attention. Evidence for the discriminative validity of the FFD factor as an indicator of attention problems has been weak. Frequently, scores on the FFD have not been significantly correlated with parent report measures of attentional functioning, and inconsistent results have been found between FFD and teacher report measures of inattention (Anastopoulos et al., 1994; Reinecke et al., 1999). One study reported no correlation between FFD and teacher reports of inattention once learning problems were controlled in the analysis (Lowman, 1996).

Significant positive bivariate correlations consistently have been found between FFD and academic achievement measures (Dickerson Mayes et al., 1998; Krane & Tannock, 2001). Math ability on both the Wechsler Individual Achievement Test (WIAT) and the WRAT, and reading ability on the WRAT have been associated with performance on the FFD, leading some authors to suggest that low FFD scores may indicate learning problems rather than attention problems (Reinecke et al., 1999). Additionally, children with learning disorders, who do not meet criteria for ADHD, have scored significantly lower on the FFD factor than normal controls, and do not differ significantly in their FFD scores from ADHD children (Dickerson Mayes et al., 1998; Prifitera & Dersh, 1993).

Most recently, research has suggested that the FFD may be associated primarily with arithmetic skills and verbal working memory (Krane & Tannock, 2001). In a mixed clinically referred sample of 275 children referred for problems with attention, behavior, and learning difficulties, and 26 normal comparison children, hierarchical linear regression analyses were used to explore the relationship between FFD and academic,

language, and behavioral measures. Results indicated that with general intelligence partialled out, parent- and teacher-rated attention problems and hyperactivity did not contribute significantly to performance on the FFD. Performance on the FFD was associated with arithmetic calculation (WRAT-Arithmetic measure) and language comprehension (CELF receptive language composite).

The significant contribution of arithmetic skills to performance on the third factor is not surprising considering that one of the subtests comprising the FFD is an Arithmetic subtest requiring skills in numerical operation and mathematics reasoning. The association between the receptive language measure (CELF receptive language composite), assessing the ability to listen and comprehend verbally presented information, and performance on the FFD was proposed to be due to the common underlying process of working memory required for both tasks. Working memory has been described as the ability to temporarily hold information in mind while performing some operation with that information (Baddeley, 1990). The FFD index and receptive language measures are both verbal auditory tasks requiring the ability to listen, comprehend and manipulate verbally presented information. Difficulties on the FFD task, therefore, have been proposed as reflecting primary deficits in working memory. Recent research supports the conceptualization of FFD as a Working Memory Index (Prifitera, Weiss, & Saklofske, 1998).

If FFD is interpreted as a measure of working memory, it is not surprising that ADHD children as a group tend to demonstrate lower scores on this measure relative to comparison groups. Evidence exists demonstrating working memory problems in ADHD

children (Barkley, 1998a; Mealer et al., 1996; Pennington & Ozonoff, 1996). This is also in line with Barkley's (1998a) theory of ADHD that specifies deficits in executive functions, one of them being a deficit in verbal working memory.

Although support for the conceptualization of FFD as a Working Memory Index has been put forward, and there is an established association between ADHD and working memory, more studies are needed to determine the extent to which ADHD itself, and not other comorbid problems, particularly learning disabilities, contributes to problems on the FFD factor (Krane & Tannock, 2001; Prifitera et al, 1998). In particular, findings need to be replicated with samples of clinic-referred children being assessed for disorders other than ADHD, including learning disorders, anxiety and depression.

In conclusion, it is likely that children with ADHD will have lower scores on the FFD than on the other factors of the Wechsler Intelligence Test. Generally, ADHD children as a group also will have significantly lower scores on the FFD measure compared to normal comparison groups. Medium to large effect size differences have been demonstrated (Faraone et al., 1993; Krane & Tannock 2001; Rucklidge & Tannock, 2001). Although low scores on the FFD do not signal attention problems or hyperactivity-impulsivity, low scores appear to indicate problems with working memory that are often associated with ADHD. The third factor cannot be used to rule in or rule out the diagnosis of ADHD. However, in conjunction with other information, low scores may provide evidence in support of an ADHD diagnosis, particularly if learning disorders have been ruled out.

Freedom from Distractibility in ADHD Adults

FFD in ADHD adults has been examined in three of the studies reviewed above investigating WAIS-R IQ differences between ADHD adults and control adults (Biederman et al., 1993; Biederman et al., 1994; Seidman et al., 1998). In all three studies comparisons between referred adults with ADHD and normal comparison adults did not reveal significant differences between groups on FFD scores. However, in the one study that also compared non-referred adult relatives with ADHD and normal comparison adults (Beiderman et al., 1993), significant differences in FFD scores were found. Clearly, more research is needed in this area. The discrepancy between cognitive findings in ADHD children and adults needs clarification.

Mathematical Performance in ADHD Children

Mathematical performance difficulties also are well documented in ADHD children and adolescents compared to normal controls (Ackerman, Anhalt, & Dykman, 1986; Benedetto-Nasho & Tannock, 1999; Fischer et al., 1990; Lindsay, 2000; Zentall et al., 1994). Medium to large effect sizes have been demonstrated (Benedetto-Nasho & Tannock, 1999; Fischer et al., 1990; Rucklidge & Tannock, 2001). Even within samples of ADHD children who do not have a specific mathematics disability the rate of productivity and accuracy on the number of computation problems completed has been significantly lower compared to non-ADHD peers (Benedetto-Nasho & Tannock, 1999).

Different explanations have been proposed for the math difficulties in children with ADHD. Converging evidence now suggests that difficulties in math do not appear to be attributable to deficient knowledge of arithmetic facts or IQ differences (Tannock,

in press). Math problems are related, in part, to carelessness and impulsive responses wherein the child does not take the time or make the effort to carefully make the computation but makes any response instead. Arithmetic problems in ADHD children also appear to be due to slow and inaccurate retrieval of arithmetic facts, which, in turn, increases the attentional load on working memory. Working memory problems may then interfere with learning more advanced computational procedures (Ackerman et al., 1986; Geary, 1993).

Examining the errors of ADHD children and non-ADHD peers matched in age, IQ, and arithmetic achievement, on a computational task, Benedetto-Nasho and Tannock (1999) found that ADHD children's performance differed when considering addition and subtraction problems separately. Examining addition problems, it was found that ADHD children were less productive, but as accurate as non-ADHD children. Considering subtraction problems, ADHD children were both less productive and less accurate than normal controls. Examination of the error patterns revealed that the process of "borrowing numbers" for subtraction was particularly difficult for ADHD children. The authors proposed that this error pattern may result from difficulties in both working memory and attention, difficulties that have been implicated in the cognitive profile of children with ADHD. It is likely therefore that ADHD children are at high risk to experience difficulties in arithmetic.

Mathematical Performance in Adult ADHD

In comparisons of ADHD adults and normal control adults on math performance Biederman et al. (1993) found significantly lower scores on the WRAT-R Arithmetic task

in his sample of ADHD adults compared with normal controls. A small effect size was demonstrated. A second study completed by Biederman et al. (1994) did not find significant differences in IQ or FFD between ADHD adults and normal comparison adults, but significant differences were found on the arithmetic subtest from the WAIS-R. Lower scores also were found in the ADHD group on the WRAT-R Arithmetic task but the differences were not significant. Seidman et al. (1998) also found that ADHD adults were significantly more impaired than control adults on the arithmetic subtest of the WRAT-R, however these results were attenuated when corrected by age, presence of learning disorders and comorbidity. Further studies are necessary, controlling for learning disorders, to determine whether the pattern of lower math performance in ADHD children also holds in ADHD adults.

School Failure in ADHD Children

Beyond cognitive/neuropsychological impairments, assessed using standardized measures, research and clinical findings have repeatedly demonstrated a significantly higher rate of school dysfunction in ADHD individuals compared to control groups. Studies have shown that participants with ADHD perform more poorly in school than controls as evidenced by higher rates of grade retention, placement in special classes, tutoring, worse than average grades, and performing below teacher expectations (Biederman et al., 1991; Goldstein, 1997; Murphy & Barkley, 1996c; Semrud-Clikeman et al., 1992). Investigations have indicated that classroom productivity and grades of ADHD children are almost always lower than would be expected. School performance remains unexpectedly poor when overall level of intellectual functioning and learning

disorders are controlled (Barkley et al., 1991). Studies have shown that up to 56% of ADHD children may require tutoring, 30% may repeat a grade, and 30-40% may be placed in special classes (Barkley, 1998a). Evidence of school failure is evident in males and females, among children and adults (Barkley, 1990; Denckla, 2000; Faraone et al., 1993; Weiss & Hechtman, 1993).

Poor academic performance has often been attributed to inattention, impulsivity, and restlessness in the classroom. Support for this interpretation comes from studies demonstrating significant improvements in academic productivity when ADHD children are given stimulant medication (Barkley, 1998a). Working memory problems may also have direct implications for academic achievement, particularly in the classroom where verbal information presented by teachers must be effectively processed for school success.

The majority of studies examining school failure have been studies of single disorders, however, and have not assessed their participants for psychopathologies other than the one under investigation. Clinic comparison groups, and the possible impact of comorbid disorders on school failure, have often not been considered. It is unclear therefore whether the rates of school failure consistently found in ADHD samples are unique to ADHD or characteristic of patient groups in general.

Faraone et al. (1993) compared children with pure-ADHD and comorbid ADHD+Conduct Disorder, ADHD+Major Depressive Disorder, and ADHD+Anxiety Disorders to determine whether impairments in school performance were core features of ADHD or epiphenomena of disruptive behavior or other psychiatric syndromes. Results

revealed no significant differences between the pure ADHD and comorbid ADHD groups on rates of tutoring, and repeated grades. However, each comorbid group had significantly higher rates of placement in special classes compared with the pure-ADHD probands. The authors hypothesized that factors additional to the child's school performance may affect classroom placement decisions. They suggested that psychiatric disorders in general might bring children to the attention of school personnel and result in placement in special classes. Despite higher rates of placement in special classes in the comorbid groups, however, pure-ADHD children did differ significantly from normal comparison children suggesting that ADHD alone also contributes to special placement.

Szatmari et al. (1989) in the Ontario Child Health Study, examined the taxonomic validity of ADDH, by investigating whether or not ADDH differed from other disorders on variables external to the diagnostic criteria. Although some of their results supported the distinction between ADDH and other disorders, their data examining school performance demonstrated that rates of grade retention, and the use of full-time remedial education were significantly higher in children with attention deficits compared to nondiagnosed agemates, but did not differ significantly from children with conduct disorders (Szatmari et al., 1989).

Reeves et al. (1987) also demonstrated that when teachers were asked to rate a child's classroom performance against their estimated ability, groups of anxious children, ADDH children, and ADDH+CD children were all rated as significantly underachieving with respect to control children. This finding was more marked in the ADDH and ADDH+CD participants, but was still significant in the anxious group of children.

Ratings of teacher expectations were significantly lower in the psychiatric groups, but did not suggest a valid distinctiveness, independent of defining symptomatology, to ADDH.

Although school problems have been considered a "hallmark" of ADHD, it is important to recognize that school problems may also be associated with disorders other than ADHD including learning disabilities, as well as internalizing and externalizing disorders (Hinshaw, 1992; Hodges & Plow, 1990). Researchers must be cautious when using school failure as a correlate of ADHD appropriate for external validation of the disorder. When looking for correlates, exclusion of the contribution to the correlations from co-existing other disorders is warranted. It is important to demonstrate that ADHD differs from other disorders on variables external to the diagnostic criteria (Szatmari, Offord, Siegal, Finlayson & Tuff, 1990).

School Failure in ADHD Adults

In contrast to the fairly inconsistent findings regarding IQ, FFD, and math performance in ADHD adults, studies examining school failure in ADHD adults have repeatedly demonstrated academic difficulties that are consistent with findings in the childhood literature. Compared with adults without the disorder, Biederman et al. (1993) revealed significantly higher rates of repeated grades, tutoring, placement in special classes, and reading disability. Biederman et al. (1994) found that adults with ADHD had a history of repeated grades, rates of tutoring, rates of placement in special class and rates of reading disability that differed significantly from control adults. Seidman et al. (1998), controlling for learning disabilities, found that ADHD adults were significantly more likely than controls to have repeated a grade, been in special classes, and received

extra help/tutoring in school. Murphy et al. (2001) found that significantly more ADHD adults reported having received special education services in high school, and were significantly less likely to have graduated from college than a control group of adults.

Importantly, the limited number of studies comparing clinic comparison adults without ADHD and adults with ADHD have also reported higher rates of school failure in ADHD individuals compared to adults with other problems leading to referral to a psychiatric clinic. Roy-Byrne et al. (1997) compared adults presenting for ADHD evaluation who (a) clearly met diagnostic criteria, (b) endorsed sufficient ADHD symptoms but lacked a defining feature of the diagnosis (i.e., persuasive childhood history), and (c) did not meet criteria. The mean number of positive responses to five screening questions (focal difficulties in grade school in reading or math, repeating a grade, being in special education classes, or being told they had a learning disability) was significantly greater in the ADHD group compared with the possible ADHD group and non-ADHD group. The higher prevalence of learning disability suggested by clinical report led the authors to propose that ADHD in adults may be disproportionately associated with learning problems. Data on intellectual functioning was not collected in this study, however.

Similarly, Murphy and Barkley (1996c) compared a group of adults diagnosed with ADHD with a group of adults referred to the same adult clinic who were not so diagnosed. Relative to the clinic-comparison group, the ADHD group showed a significantly greater prevalence of chronic school underachievement, below average grades in school, and teachers describing them as capable of doing better. They

concluded that a history of educational underachievement appears to be more specific to ADHD adults than to adults presenting to an outpatient clinic who are not so diagnosed and who mainly have anxiety or mood disorders.

In summary, on measures of intellectual functioning, FFD, math competence, and school performance, ADHD children as a group are more likely to receive significantly lower scores than non-ADHD peers, even after controlling for IQ and learning disorders. Although not diagnostic of ADHD, these functional impairments provide useful and important information in the assessment and treatment process.

The studies that have examined cognitive functioning and school impairment among ADHD adults are limited. Although the results examining IQ, FFD and math performance have been inconsistent, evidence of a history of impaired school functioning has repeatedly been demonstrated. It has been suggested that impaired school functioning may have a specific association with adult ADHD (Murphy & Barkley, 1996c). It is important that further research be conducted to clarify these findings, and to better understand the discrepancy between pediatric and adult samples until more valid diagnostic criteria are available. Studies need to be completed using DSM-IV diagnostic procedures and should be conducted with careful consideration of learning disabilities commonly comorbid with ADHD.

Adverse Driving

The US Department of Transportation Federal Highway Administration has considered ADHD as a psychiatric disorder with potential risk for driving performance problems (Barkley, Guevremont, Anastopoulos, DuPaul & Shelton, 1993). Studies have

indicated a pattern of high risk driving in adolescents with ADHD compared to non-ADHD peers. Findings have shown that driving without a valid license, speeding citations, license suspensions, motor vehicle crashes resulting in bodily harm, and reports of poorer driving habits are significantly more common in ADHD teenagers (as drivers) than in normal comparison adolescents (Barkley et al., 1996; Weiss & Hechtman, 1993).

Regardless of the length of time the adolescent has been driving, parents of teenagers and young adults with ADHD report that their children are less likely to use sound driving skills and habits than do parents of normal control participants. This implies that adverse driving behavior is not due to limited driving experience, and that it is unlikely to improve much by providing further experience (Barkley et al., 1996).

Differences between groups also do not appear to be the result of a difference in driving knowledge, motor vehicle operating procedures, or the actions to take in high risk driving situations as assessed by a videotape test of driving knowledge. ADHD adolescents appeared to know what to do, but did not apply their driving knowledge. It is the actual driving performance rather than driving knowledge that is the source of driving problems for those with ADHD. It has been suggested that behavioral performance and self-regulation, not knowledge or skills, are the more typical impairments involved in ADHD (Barkley et al., 1996). Importantly, one study found that young adults with ADHD who had received at least three years of treatment with stimulant medication reported being involved in fewer traffic crashes than ADHD individuals who had never received pharmacotherapy (Weiss & Hechtman, 1986).

It appears that the driving risks associated with ADHD may also be significant compared to a psychiatric control group. In a study comparing ADHD adults with those with mainly anxiety and mood disorders, ADHD adults reported significantly more motor vehicle crashes and speeding citations than the control group of psychiatric patients. Driving risks, therefore, may be more specific to ADHD than to general psychiatric outpatients having mainly anxiety/affective disorders (Murphy & Barkley, 1996c).

In a cohort of New Zealand adolescents comparing ADHD, anxious, depressed and conduct disordered individuals, adolescents in the ADHD and conduct groups were also more likely to commit a driving offense than the other groups. This applied to self reported offenses and offenses recorded in official traffic conviction records. ADHD was also more strongly associated with traffic crashes (Nada-Raja et al., 1997).

ADHD teenagers with ODD and/or CD have been found to be at the highest risk for deficient driving habits and negative driving outcomes (Barkley et al., 1993). The considerable comorbidity between ADHD and conduct problems makes it difficult, however, to conclude whether ADHD or ODD/CD are more likely to be associated with at risk driving. It appears justified, however, that individuals with a history of ADHD be forewarned that they are at a higher risk than their peers for driving dangerously (Nada-Raja et al., 1997).

Follow-up studies of children with ADHD and studies of adolescents with the disorder have consistently shown high risk driving compared to control groups. Driving risk has not been assessed within a clinic-referred adult sample of ADHD individuals assessed using DSM-IV criteria.

The Present Study

The review of the literature has revealed a paucity of information regarding the functional impairments associated with the diagnosis of adult ADHD. Information on adult ADHD that is available has typically not used DSM-IV diagnostic criteria, has not included a clinic-comparison group of adults, and has not controlled for potentially confounding variables such as IQ and learning disabilities. Given the controversy about the possible limitations of DSM-IV in diagnosing only the most severe cases of adults ADHD, the need for additional studies of referred adults who meet criteria for ADHD is indicated.

The objective of the current study was to fill this research void by using DSM-IV diagnostic criteria to assess ADHD and to examine whether there is a pattern of psychiatric, cognitive, academic and driving impairments that differentiates ADHD adults from community control adults and clinically-referred adults who do not meet ADHD diagnostic criteria. The inclusion of a clinic-comparison group allows us to determine whether functional impairments are specific to adults meeting DSM-IV criteria for ADHD, or perhaps are associated more generally with adults referred for psychiatric assessment of problems with attention and/or hyperactivity-impulsivity who do not meet DSM-IV criteria for ADHD. It is important to discover whether adult ADHD is associated with significant and relatively specific impairments, aside from ADHD symptomatology, that are consistent with impairments found in children with the disorder, and that may differentiate between a less-impaired and a more-impaired group.

Functional impairments highly associated with ADHD in children were examined in a clinically referred sample, using the most recent DSM diagnostic criteria for the disorder. Three groups of individuals were considered: (a) a group of adults meeting DSM-IV diagnostic criteria for ADHD, (b) a group of adults referred for a clinical assessment of ADHD who did not meet diagnostic criteria for the disorder (clinic-comparison group), and (c) a group of adults recruited as community controls.

Hypotheses

Given the results of a number of the studies reviewed above that have compared adolescents and adults meeting DSM criteria for ADHD with clinic-comparison and/or normal comparison groups (e.g., Barkley et al., 1991; Biederman et al., 1993; Biederman et al., 1994; Biederman et al., 1998; Murphy & Barkley, 1996c; Roy-Byrne et al., 1997; Rucklidge & Tannock, 2001), it was predicted that clinical characteristics found in children and adolescents to be highly associated with ADHD would differentiate adults diagnosed as meeting DSM-IV criteria for ADHD from clinic-referred adults and community control adults diagnosed as not meeting such DSM-IV criteria. The profile of clinic-referred adults without ADHD also was predicted to differ significantly from community control adults, as the former were expected to have more anxiety and mood disorders.

Adults diagnosed with ADHD on the basis of DSM-IV criteria (hereinafter referred to simply as "ADHD adults") were expected to show patterns of impairment on measures of psychiatric, cognitive, academic, and driving performance similar to the patterns reported in empirical studies of childhood/adolescent ADHD. High rates of

conduct problems (e.g., Conduct Disorder/Oppositional Defiant Disorder), low Freedom from Distractibility and math scores, school problems, and driving impairments were expected to be uniquely associated with the ADHD group of adults.

The clinic-comparison group was expected to show a pattern of functioning reflecting internalizing problems (anxiety and depression) similar to the ADHD group, but significantly more impairment than the community control group. Performance of the clinic-comparison group on measures of FFD and math, school problems, and driving impairment was also predicted to be similar to the community comparison group, and to differ significantly from the ADHD group, which was expected to show more impairment in these domains.

On the basis of the results reviewed in the Introduction (e.g., Barkley et al., 1991; Biederman et al., 1993; Biederman et al., 1994; Biederman et al., 1998; Murphy & Barkley, 1996c; Roy-Byrne et al., 1997; Rucklidge & Tannock, 2001) a number of specific a priori hypotheses were generated for testing: (a-i) Rates of lifetime comorbid conduct problems (i.e., Conduct Disorder/Oppositional Defiant Disorder) would be significantly higher in ADHD adults than in clinic-comparison and community control adults, who would not differ significantly from one another. (a-ii) Rates of lifetime internalizing disorders (i.e., anxiety disorder and mood disorder) were not expected to differ significantly between ADHD adults and clinic-comparison adults, but were expected to be significantly higher than in community control adults; (b) measures of FFD/Math, and School Failure would significantly differentiate the ADHD group from the clinic-comparison and community control groups, which would not differ

significantly from one another; (c) measures of adverse driving would be significantly higher in ADHD adults relative to clinic-comparison and community control adults, who would not differ significantly from one another.

Method

Participants

One-hundred and twenty adults of both sexes were the participants of the present study. Ninety consecutive referrals presenting to an adult ADHD clinic located in a university-affiliated pediatric hospital, the Montreal Children's Hospital, were considered for inclusion in the study. Two groups of individuals were derived from the ninety adults referred to the hospital clinic: 47 individuals diagnosed with adult ADHD in terms of DSM-IV criteria, and 43 clinic-referred adults diagnosed as not meeting the DSM-IV criteria for ADHD. The conditions necessary to satisfy a diagnosis of ADHD in the present study are described below as"inclusion criteria." Referrals were accepted from family physicians, psychologists, psychiatrists, social workers, and counselors. Self-referrals were also accepted. This sample of clinic-referred adults, solicited between February 1997 and August 1999, is part of a larger on-going study of clinic-referred adults being assessed for ADHD that was approved by the ethics board of the Montreal Children's Hospital, McGill University.

Thirty comparison adults were recruited as a community control group (at the same time as recruitment of ADHD participants was taking place) through advertisements in community newspapers. The advertisements read: "seeking individuals and families to participate as control subjects in a study of adult functioning". Control participants were screened over the telephone, by the intake coordinator of the study, to be sure that they met inclusion criteria for the study (see below). Community control adults were reimbursed $50 each for their participation. If psychiatric or psychological

problems were identified, participants were informed of the results and received referrals for appropriate services. Psychiatric or psychological problems did not exclude participants from the study, as the control group was a community control group, and was expected to have some degree of impairment.

Ethnicity data was not collected in the present study; however the adults were predominantly Caucasian.

Inclusion criteria for ADHD, clinic-comparison, and community control adults were: (a) age between 20 and 49 years, (b) adequate command of the English language to be able to complete all interviews and questionnaires in English, (c) no evidence of schizophrenia or other psychoses, bipolar disorder, or current suicidality, (d) absence of epilepsy, history of significant head trauma warranting hospital treatment, or serious sensory or motor impairments, (e) absence of current drug use disorders (in the last 6 months), and (f) absence of current psychotropic medication use. Criteria (e) and (f) were necessary since these substances could have affected performance on computerized tests that were administered as part of the larger study from which these participants were selected. Participants who were currently taking psychotropic medications ceased taking these medications (with the permission and supervision of their prescribing physicians) for the duration of the testing.

Procedure

Each potential participant was contacted by telephone to describe the study and to determine whether they desired to participate. If so, they were mailed a packet of forms to complete, including the Patient's Behavior Checklist (Barkley, 1990) and the Conners'

Adult ADHD Rating Scale (CAARS; Conners, Erhardt, & Sparrow, 1995). The referred adults were initially screened for ADHD symptomatology based on self report and knowledgeable informant ratings on these two questionnaires. If the participants had at least one score indicating mild to moderate symptomatology on either self or knowledgeable informant ratings on the Patient's Behavior Checklist or the CAARS, they completed a comprehensive assessment at our clinic. These questionnaires were not used to establish a diagnosis of ADHD, and did not cover DSM-IV diagnostic criteria, but were simply used as an initial screen for potential ADHD.

Assessment of Adults

The clinic-referred adults and the community controls were evaluated using the same procedure. Each adult was seen twice for 2-4 hour sessions.

Psychiatric Assessments.

Initially, all participants met with one of the four board-certified psychiatrists or the psychiatry research fellow on the ADHD assessment team. The psychiatrists described the study in greater detail, answered any questions, and obtained signed consent. Using semi-structured interviews designed for this study, the psychiatrists assessed the presence (or absence) of ADHD symptoms, obtained information on past and current medical and psychiatric histories, and assessed current and past psychiatric status and adaptive functioning (e.g., educational history, employment, driving record).

During the remainder of the two sessions, each participant was assessed by one of three doctoral students in clinical psychology. The assessment by doctoral students covered: ADHD symptomatology using a structured clinical interview, lifetime

occurrence of Axis I psychopathology aside from ADHD, and a standardized cognitive test battery using subtests from the WAIS-R and WRAT-3. All tests were administered and scored by the three previously mentioned Ph.D. level clinical psychology graduate students.

ADHD Symptomatology.

For the purposes of the present study the full diagnosis of adult ADHD required the participant to: (a) self-report clinically significant numbers of impairing DSM-IV ADHD symptoms currently (for the past six months), including evidence of impairment in at least two settings, i.e., school, work, home, community; (b) have clinically significant ADHD symptomatology in childhood as evidenced by meeting DSM-IV criteria in retrospective childhood self-reports between the ages of five and twelve.

Given that no DSM-IV based structured interview exists for the determination of ADHD in adults, one was created for this project that explicitly set forth the precise 18 symptoms for ADHD. Information was also gathered about age of symptom onset and areas of impairment in major life activities. The participants' response to each item was recorded on the interview form. To meet current diagnostic criteria for ADHD, the participant was required to endorse at least six symptoms of inattention or six symptoms of hyperactivity-impulsivity as causing significant impairment presently.

The retrospective childhood interview for ADHD used the same 18 item scale and scoring procedure as above to determine whether an individual met or exceeded the thresholds for childhood ADHD, in terms of recalling the occurrence of DSM-IV symptoms between the ages of five and twelve. Although the DSM-IV criterion for onset

of symptoms is before seven years of age, the criterion was adjusted in the present study to between the ages of five and twelve, as recommended by Barkley and Biederman (1997). This adjustment was based on the fact that no empirical, historical, or pragmatic evidence exists that shows that the criterion of onset by age seven distinguishes valid from invalid cases of ADHD (Barkley & Biederman, 1997).

Thus, to be given a full diagnosis of adult ADHD, in accord with the criteria of DSM-IV, required: (a) the presence of at least six of nine symptoms of inattention and/or hyperactivity-impulsivity reported between the ages of five to twelve, (b) the current report of a least six of nine impairing symptoms of inattention and/or hyperactivity-impulsivity, (c) the persistence of symptoms from childhood into adulthood, and (d) impairment in at least two settings (e.g., home and school).

Axis I psychopathology.

Lifetime and current Axis I diagnoses other than ADHD were determined using the Diagnostic Interview Schedule for DSM-IV (DIS 4.0; Robins, Lottler, Bucholz & Compton 1995). The DIS 4.0 is a structured interview allowing a trained non-medical interviewer to arrive at a psychiatric diagnosis using DSM-IV criteria (Robins et al., 1995). The use of structured interviews has been shown to generate improved diagnostic reliability relative to less structured psychosocial intake interviews that are often used in clinic practice (Grove, 1987). Self-reported lifetime mood and anxiety disorders, oppositional defiant disorder, and conduct disorder were used as modules for the present study.

Standardized test battery.

A systematic cognitive assessment was performed using subtests of the WAIS-R, including vocabulary, block design, arithmetic, and digit span subtests. Using the methods of Sattler (1988), the block design and vocabulary subtests were used to estimate Full Scale IQ and are included in the descriptive analyses. These two subtests are frequently used for an IQ estimate, because their estimate of IQ correlates.90 with Full-Scale IQ based on all of the subtests (Sattler, 1998). Digit span, and arithmetic subtests of the WAIS-R were used to estimate FFD (Sattler, 1998). Academic achievement was assessed with the arithmetic and reading subtests from the WRAT-3.

In accord with current clinical research and practice concerning the assessment and diagnosis of individuals with learning disorders a learning disorder (LD) was defined by a standard score below 80 on either of the academic achievement measures (i.e, WRAT-3 Reading, or WRAT-3 Arithmetic). Given the most recent practice parameters for diagnosing learning disorders, an IQ-achievement discrepancy score was not used (Fletcher et al, 1998).

Dependent Measures

Three sets of dependent measures were used to assess the functional impairment associated with ADHD in adults compared to community controls and clinic comparison adults: (a) Psychiatric functioning, (b) FFD/Math and School Failure, and (c) Adverse driving.

Psychiatric Functioning

Axis I psychopathology other than ADHD was investigated in the present study using the DIS 4.0 because of the high rates of comorbid psychopathology known to be associated with ADHD, and because of the importance of differential diagnosis in the assessment of clinic-referred adults (Biederman et al., 1991; Jenson et al., 2001; Kuhne et al., 1997; Newcorn et al., 2001; Tzelepis, Schubiner & Warbasse, 1995). To reduce the number of dependent variables in the analyses, two variables were constructed categorizing psychiatric functioning, namely, "internalizing disorders" and "conduct problems".

Internalizing disorders: If an individual endorsed lifetime diagnostic criteria for either anxiety disorders or mood disorders on the DIS 4.0, an internalizing disorder was considered present.

Conduct problems: Conduct problems were considered present if an individual endorsed lifetime diagnostic criteria for conduct disorder and/or oppositional defiant disorder on the DIS 4.0.

FFD/Math and School Failure.

Separate assessment scores were calculated for FFD/Math and School Failure.

FFD/Math: Standard scores from the FFD index and the WRAT-3 Arithmetic task were selected as dependent measures of functional impairment because of their hypothesized association with working memory and their established association with ADHD. Difficulties with working memory have been specifically implicated in the cognitive profiles of children with ADHD and limited studies of adults with ADHD

(Barkley, 1998a; Murphy et al., 2001). On the basis of studies demonstrating significant positive correlations between FFD and math computation (Krane & Tannock, 2001; Reinecke et al., 1999), bivariate correlations were run between FFD and WRAT-Arithmetic standard scores to assess the strength of association between the two measures in the present study. Significant positive bivariate correlations between the FFD scores and WRAT-3 Arithmetic scores were found ($r = .615, p < 0.01$), and thereby justified the construction of a composite variable labelled "FFD/Math". The composite variable was constructed, as a method of data reduction, from the mean of the two standard scores, i.e., the standard score for the measure of FFD and the standard score for the WRAT-3 Arithmetic measure.

***School Failure*:** Given the consistent reports of school failure (i.e., repeated grades, special classes, tutoring) in ADHD children and adults, despite generally average standardized IQ scores, impairment in the school environment was assessed by means of a semi-structured interview completed by a psychiatrist. In the present study, "School Failure" was quantified as the number of positive responses to four screening questions (repeating a grade, being in special education classes, earning worse than average grades, performing below teacher expectations).

Adverse Driving

Adverse driving was examined in the present study by means of a semi-structured interview completed by a psychiatrist. Adverse driving was included as a dependent measure because of the evidence suggesting that young drivers and adults with ADHD have an increased number of car accidents and traffic violations compared to control

groups (Barkley et al., 1993; Barkley et al., 1996; Nada-Raja et al.,1997). Driving risk has not been examined previously in a clinic-referred sample of adults diagnosed using DSM-IV criteria. A composite variable labelled driving risk was constructed from the mean number of car accidents and traffic violations reported by adults in a psychiatric screening interview.

Plan of Analysis

Adults with ADHD were compared with clinic-comparison and community comparison adults on demographic variables, and the clinical variables of: (a) Psychiatric Comorbidity, (b) FFD/Math and School Failure, and (c) Adverse Driving.

The Statistical Package for Social Sciences was used for all analyses. The groups were compared using analysis of variance or chi square, as appropriate. All tests were two tailed and the level of significance was set at the 0.05 level for each test. Bonferroni adjustments were used in follow-up pairwise comparisons between the ADHD, community control, and clinic comparison groups as a control for possible Type I errors resulting from multiple comparisons ($p = 0.05/3 \sim 0.017$). Trends ($p < .05$) were also noted in pairwise comparisons because of the limited statistical power associated with the relatively small comparison groups. Effect size calculations were conducted within the analyses conducted using ANOVA or ANCOVA to determine the magnitude, and clinical significance, of the findings for each of the clinical variables. Post hoc estimation of power was also ascertained within the analyses conducted using ANOVA or ANCOVA to determine how well the analyses could detect an effect in the present study.

The first set of analyses analyzed demographic sample characteristics including age, income, education, and estimated IQ, using one-way analyses of variance for all tests. The effects of gender were examined using chi-square techniques.

Psychiatric Functioning

In a second set of analyses, chi-square tests were conducted to determine whether differences existed among the groups with respect to internalizing disorders (anxiety and mood disorders) and conduct problems (ODD/CD).

FFD/Math and School Failure

Separate one-way analyses of covariance were conducted to evaluate whether the means for the dependent variables of FFD/Math and School Failure, adjusted for differences on the covariate of IQ, differed across groups. IQ was used as a covariate in the analysis to guard against the possibility that differences among the groups in measures of FFD/Math and School Failure might be explained by a priori differences among the groups in general intellectual functioning, rather than ADHD symptomatology.

To control for the potentially confounding association between learning disabilities and performance on the FFD/Math and School Failure variables, the scores on the FFD/Math and School Failure variables were also subjected to a second analysis in which the scores of adults meeting criteria for a learning disorder (below 80 on either the WRAT reading or math subtests) were removed. This was done to assure that any observed differences among the three groups were not attributable solely to the subgroup of ADHD adults who had a learning disorder.

Adverse Driving

A one-way analysis of variance was conducted to evaluate whether the means for the dependent variable, Adverse Driving, differed reliably across groups.

Results

Demographic Characteristics

Table 1 displays the mean values for each of the three groups with respect to the demographic characteristics of age, income, level of education, IQ, and gender. Demographic characteristics were compared across groups using one-way analyses of variance for continuous variables and Pearson's X^2 test for categorical data. All Pearson X^2 values, F values, degrees of freedom, and levels of significance are reported in the table. The three groups did not differ significantly in their age, income, level of education, estimated IQ score, or gender representation. Considering gender representation, however, the ADHD group included more males than females, and the clinic-comparison and community control groups consisted of more females than males, but these differences failed to reach significance.

Psychiatric Functioning

Table 2 displays results of comparisons, using chi square analyses, among the ADHD, clinic-comparison, and community control groups for the dependent measures of prevalence of lifetime DSM-IV internalizing disorders (anxiety and depression) and conduct problems (ODD/CD). Significance was set at the .05 level. Bonferroni adjustments were used in follow-up pairwise comparisons between groups to control for multiple comparisons ($p = 0.05/3 \sim 0.017$).

Table 1
Demographic Characteristics of the Sample

	ADHD[a] (47)		Clinic-Comparison (43)		Community Control (30)				
Demo. Item	Mean	SD	Mean	SD	Mean	SD	FValue/ X^2 Value	Df	Overall Sig.
Age	34.11	(7.01)	35.95	(6.73)	37.47	(5.66)	2.47	2,117	.09
Income	33906	(20179)	36974	(27078)	32100	(21030)	1.91	2,117	.66
Edu. on a 1 to 9 scale	6.15[b]	(1.90)	6.35	(1.94)	6.80	(1.88)	1.08	2,117	.34
IQ	102.45	(9.54)	104.58	(10.96)	105.60	(10.58)	0.96	2,117	.39
Gender (male) (female)	62% 39 %		47% 54%		37% 63%		4.92	2	.09

[a] ADHD = Attention-Deficit/Hyperactivity Disorder

[b] 6.15 corresponds to having completed Cegep. In the province of Quebec Cegep is the equivalent to one additional year of schooling beyond grade twelve. All three groups had completed the equivalent of approximately 13 years of schooling.

Table 2

a) Patterns of DSM-IV Axis I Psychiatric Comorbidity in ADHD, Clinic-Comparison and Community Control Groups

	ADHD group N=47	Clinic-Comparison group N=43	Community control group N=30		
Disorders	**N %**	**N %**	**N %**	**X^2**	**Overall Sig.**
Internalizing Disorders	37[a] 78.7	35[a] 81.4	14 46.7	12.39	.002
ODD/CD Disorders	32[ab]68.1	19[a] 44.2	2 6.7	28.01	<.001

a = $p < .017$ for pairwise comparisons with community controls by Pearson's X^2 test

b= $p < .05$ trend for pairwise comparisons with clinic comparison group by Pearson's X^2 test

Internalizing Disorders

As table 2 shows, rates of internalizing disorders differed significantly among the groups. As expected, pairwise testing using Pearson's X^2 tests revealed significantly higher rates of internalizing disorders in the ADHD and clinic-comparison groups compared to the community control group. The number of internalizing disorders reported in the adult ADHD group did not differ reliably from the number reported in the clinic-comparison group. More than 78% of ADHD adults and 81% of clinic-comparison adults reported an incidence of lifetime internalizing disorders.

Conduct Problems

Rates of conduct problems also differed significantly among the groups as shown in table 2. Considering lifetime rates of ODD/CD, pairwise testing revealed, as expected, significantly higher rates of lifetime psychopathology for the ADHD adults than for the adults in the community control group. There was a trend towards ADHD adults showing significantly higher rates of ODD/CD compared to the adults in the clinic-comparison group. Unexpectedly, adults in the clinic-comparison group were significantly more likely than adults in the community control group to receive ODD/CD diagnoses.

These findings suggest that adults referred for assessment of ADHD, regardless of whether they do or do not meet criteria for ADHD, report significantly higher lifetime rates of both internalizing disorders and conduct problems than do community control adults. ADHD adults also show a trend towards reporting significantly more conduct problems than do clinic-comparison adults but do not differ in rates of reported internalizing disorders.

FFD/Math and School Failure

FFD/Math

A one-way analysis of covariance (ANCOVA) was conducted to evaluate differences in the means of the three groups on the dependent variable of FFD/Math (comprised of the mean score of the standard scores from the FFD index and WRAT-Arithmetic task). Estimated IQ score served as the covariate. For the composite variable labelled FFD/Math, the middle row of Table 3b shows the adjusted means, significant difference, and medium overall effect size (i.e., Partial Eta Square) observed among the groups. The ANCOVA for FFD/Math was significant, $F(2, 116) = 8.93$, $MSE = 57.95$, $p < .001$. The relationship between the independent variable of Groups and the dependent variable of FFD/Math was fairly strong, as assessed by a partial eta square, with the Groups factor accounting for 13 percent of the variance of the dependent variable, holding constant the estimated full scale IQ score. The pattern of means on the FFD/Math variable was as expected. The FFD/Math scores for all three groups fell within the average range. Pairwise comparisons were conducted to evaluate differences among the adjusted means ($p = .05/3 \sim .017$). As expected, comparison of the adjusted mean of the ADHD group and that of the community control group revealed a significant difference, as did the comparison between the ADHD group and the clinic-comparison group. The difference observed between the adjusted mean FFD/Math score of the clinic-comparison group and that of the community control group was not significant.

Table 3
FFD/Math and School Failure: Unadjusted Means and Means Adjusted for Estimated IQ

a) Unadjusted Means and Standard Deviations of Groups on School Failure and Cognitive Functioning Variables

	ADHD (47)	Clinic-Comparison (43)	Comm. Control (30)
Composite Variable	Mean SD	Mean SD	Mean SD
FFD/Math	93.83 (11.33)	100.14 (11.58)	103.50 (9.40)
School Failure	1.85 (1.15)	1.45 (.96)	.69 (.89)

b) Adjusted Means and Standard Errors of Groups on FFD/Math and School Failure Variables

	ADHD (47)	Clinic-Comparison (43)	Comm. Control (30)								
Comp. Variable	Mean SD	Mean SD	Mean SD	F Value	Df	Overall Sig.	Partial Eta Square	Partial Eta Square 1vs2[d]	Partial Eta Square 1vs3	Partial Eta Square 2vs3	Post-hoc overall power[e]
FFD/ Math	95.03[bc] (1.12)	99.69 (1.16)	102.27 (1.39)	8.93	2,116	<.001	.13	.07	.12	.02	0.93
School Failure	1.76[b] (.14)	1.48[b] (.15)	.78 (.17)	9.39	2,111[a]	<.001	.15	.02	.14	.08	0.94

[a]Missing data for some subjects; for school failure ADHD group $n = 46$, clinic comparison group $n = 40$, community comparison group $n = 29$.
[b] $p < .017$ for pairwise comparisons with community control adults
[c] $p < .017$ for pairwise comparisons with clinic comparison adults
[d]Partial Eta Square of .01, .06, and .14 represent small, medium, and large effect sizes, respectively
1vs 2 = ADHD group vs. Clinic-comparison group; 1 vs 3 = ADHD vs. Community control group; 2 vs 3 = Clinic comparison group vs. community control group.
[e] Reasonable power is generally considered to be ~ 0.80.

A medium effect size was found when the adjusted mean of the ADHD group was compared with that of the community control group, and when the adjusted mean of the ADHD group was compared with that of the clinic-comparison group. A small effect size was found when the adjusted means of the clinic-comparison group and the community control group were compared. The findings suggest that ADHD adults show weaker performance on the FFD/Math measure than do clinic-comparison adults, whose performance falls between the ADHD adults and community comparison adults.

To control for the established finding that learning disabilities are commonly comorbid with ADHD (Farone et al., 1993; Semrud-Clikeman et al., 1992) the data of individuals diagnosed with a learning disorder were removed from the sample and a one way ANCOVA was repeated. A learning disorder was defined by a standard score below 80 on either the WRAT-Reading or WRAT-Arithmetic measures. Given the most recent practice parameters for diagnosing learning disorders, an IQ-achievement discrepancy score was not used (Fletcher et al., 1998).

Sixteen adults, approximately 13% of the total sample, met the criteria for a learning disorder. Considering each group, 17% of the ADHD group, 16% of the clinic-referred group, and 3% of the community control group met LD criteria. Table 3c demonstrates that the pattern of significant differences did not change when the data of individuals with learning disorders were removed from the sample. Medium effect sizes remained between the ADHD and clinic-comparison groups and the ADHD and community comparison groups.

Table 3c

Adjusted Means and Standard Errors of Groups on FFD/Math and School Failure Variables with LD adults removed from the sample

	ADHD (39)	Clinic-Comparison (36)	Comm. Control (29)							
Comp. Variable	Mean SE	Mean SE	Mean SE	F Value	df	Overall Sig.	Partial Eta Square	Partial Eta Square 1vs2[d]	Partial Eta Square 1vs3	Partial Eta Square 2vs3
FFD/ Math	97.07[bc] (1.19)	102.75 (1.23)	103.96 (1.37)	8.79	2,100	<.001	.15	.10	.13	.01
School Failure	1.51[b] (.14)	1.27[b] (.15)	.65 (.16)	8.22	2,97[a]	.001	.15	.01	.14	.08

[a]Missing data for some subjects; for school failure ADHD group $n = 38$, clinic comparison group $n = 35$, community comparison group $n = 28$.

[b]$p < .017$ for pairwise comparisons with community control adults

[c]$p < .017$ for pairwise comparisons with clinic comparison adults

[d]Partial Eta Square of .01, .06, and .14 represent small, medium, and large effect sizes, respectively

1vs 2 = ADHD group vs. Clinic-comparison group; 1 vs 3 = ADHD vs. Community control group; 2 vs 3 = Clinic comparison group vs. community control group.

Thus, even after controlling for potential a priori differences among the groups in general intellectual functioning and learning disorders, ADHD continued to be independently associated with weaker scores on a measure of cognitive functioning when compared to clinic-comparison and community control adults.

School Failure

A one-way ANCOVA was conducted to examine differences among the groups on the dependent variable of School Failure. The bottom row of the lower portion of Table 3b displays the significant finding for the differences observed among the means of the groups on the School Failure variable. The School Failure variable was comprised of the number of positive responses to four questions (repeating a grade, being in special education classes, worse than average grades, performing below teacher expectations). The ANCOVA was significant, $F, (2,111) = 9.39$, $MSE = .86$, $p < .001$. There was a strong relationship between the independent variable of Groups and the dependent variable of School Failure, as assessed by a partial eta square, with the Groups factor accounting for 15 percent of the variance of the dependent variable, holding constant the initial estimated IQ score.

The pattern of adjusted means observed across the three groups for the School Failure scores was, for the most part, as expected: the ADHD adults obtained the highest scores on the measure of School Failure, followed by the clinic comparison adults obtaining somewhat lower School Failure scores, and the community control adults obtaining the lowest level of School Failure. Pairwise comparisons were conducted to

evaluate differences among the adjusted means (p = .05/3 ~.017). The difference between the adjusted mean of the ADHD group on the measure of School Failure and that of the community comparison group was significant. As expected, the ADHD group reported significantly more School Failure than the community control group. The finding of a reliable difference between the adjusted means of the clinic-comparison group and the community control group on the measure of School Failure was surprising. The clinic-comparison group reported significantly higher rates of School Failure than the community control group. The ADHD and clinic-comparison groups did not differ significantly from one another on the measure of School Failure.

A large effect size was found comparing the ADHD and community control groups, and a medium effect size was found comparing the clinic-comparison and community control groups highlighting the practical significance of these results. A small effect size was observed between the ADHD and clinic comparison groups, indicating that the ADHD group experienced slightly more difficulty in academic domains than did the clinic-comparison group.

As was the case for the analysis of the adjusted means of the FFD/Math scores, a re-analysis of the adjusted means of the School Failure scores was undertaken to control for the established finding that learning disabilities are commonly comorbid with ADHD (Faraone et al., 1993; Semrud-Clikeman et al., 1992). Hence, the data of individuals diagnosed with a learning disorder were removed from the sample of School Failure scores and a one-way ANCOVA was repeated. A learning disorder was again defined by a standard score below 80 on either the WRAT-Reading or WRAT-Arithmetic measures.

Once again, as demonstrated in Table 3c, the pattern of significant differences did not change when adults with learning disorders were removed from the analysis: A large effect size was found when the adjusted mean of the School Failure scores of ADHD adults without learning disabilities was compared with that of the community control adults without learning disabilities, and a medium effect size was found when the clinic-comparison adults without learning disabilities were compared with community control adults without learning disabilities. The adjusted mean of the School Failure measure of the clinic-comparison adults without learning disabilities was intermediate between those of the adults with ADHD and the community control adults.

These findings suggest that individuals who are clinically referred for an assessment of ADHD in adulthood, whether or not they actually receive an ADHD diagnosis recall significant problems in academic functioning compared to community control adults, independent of whether the referred adults do or do not actually receive an ADHD diagnosis. These findings cannot be attributed to differences in general intellectual functioning, nor to the sample having been negatively biased by the presence of the scores of individuals with a learning disorder, because the statistical analyses controlled for general intellectual functioning, and the results did not change when individuals meeting criteria for LD were removed from the sample.

Adverse Driving

In order to normalize the distributions of the Adverse Driving variable, a square root transformation was applied to each participant's driving risk score, which was comprised of the mean number of car accidents and traffic violations reported in a

screening interview with a psychiatrist. A one-way ANOVA was then conducted on the transformed scores to test for reliable differences among the groups. Table 4 shows the significant difference observed among the groups on the transformed driving risk variable. The ANOVA was significant, $F(2,91) = 3.93$, $MSE = 1.05$, $p = .02$. A moderately strong relationship was discovered between the independent variable of Groups and the transformed dependent variable of driving risk, as assessed by a partial eta square, with the Groups factor accounting for 8 percent of the variance of the dependent variable. The pattern of means observed across the three groups for the Adverse Driving scores was, for the most part, as expected: the ADHD adults obtained the highest scores on the measure of Adverse Driving, followed by the clinic comparison adults obtaining somewhat lower Adverse Driving scores, and the community control adults obtaining the lowest level of Adverse Driving. Pairwise tests were conducted to evaluate differences among the means of the transformed driving risk scores ($p = .05/3 \sim .017$). The difference between the mean of the ADHD group and the community comparison group was significant. As expected on the basis of the findings of previous studies of driving risk in ADHD and community adolescents (Barkley et al., 1993; Barkley et al., 1996), the group of ADHD adults reported reliably more driving risk than did the control group of community adults. The ADHD and clinic-comparison groups, and the clinic-comparison and community control groups did not differ significantly from one another on the transformed measures of driving risk.

Table 4

Means and Standard Deviations of Groups on Transformed Scores for the Composite Variable of Adverse Driving

	[a]ADHD (36)	Clinic-Comparison (35)	Comm. Control (23)								
	Mean SD	Mean SD	Mean SD	F Value	Df	Overall Sig.	Partial Eta Square	Partial Eta Square 1vs2[c]	Partial Eta Square 1vs3	Partial Eta Square 2vs3	Post-hoc overall Power [e]
Adverse Driving [d]	1.75[b] (1.16)	1.50 (0.97)	0.98 (0.86)	3.93	2,91	.02	.08	.01	.08	.04	0.69

[a]Missing data are due to administrative error considering driving risk in the ADHD, clinic comparison and community control groups (ADHD = 36, Clinic = 35, comm. = 23)

[b] $p < .017$ for pairwise comparisons with community control adults

Partial Eta Square of .01, .06, and .14 represent small, medium, and large effect sizes, respectively

[c]1vs 2 = ADHD group vs. Clinic-comparison group; 1 vs 3 = ADHD vs. Community control group; 2 vs 3 = Clinic comparison group vs. community control group.

[d] A square root transformation was completed on the scores for the composite variable of "Adverse Driving" to correct for a violation of homogeneity of variance. Mean scores are therefore transformed scores.

[e] Reasonable power is generally considered to be ~ 0.80.

A medium effect size difference was found comparing the ADHD and community control groups. Small effect size differences were observed in comparisons of the ADHD and clinic-comparison groups, and the clinic-comparison and community control groups, indicating slightly more driving risk in the ADHD group compared to clinic-controls, and in the clinic-controls compared to the community control group. It is possible, however, that nonsignificant results resulted from small sample size, therefore results must be interpreted cautiously. The power to detect significant differences was limited in the present analysis.

Discussion

The objective of the present study was to characterize some of the functional impairments of DSM-IV diagnosed ADHD adults in comparison with community control adults and clinic-referred adults reporting symptoms of inattention, hyperactivity and/or impulsivity who did not meet symptom thresholds for the disorder. Unlike the majority of previous studies, the present study used the most recent diagnostic criteria for assessing ADHD, included both a community-control and a clinic-comparison group of adults, and controlled for potentially confounding variables (i.e., IQ and learning disabilities).

It was expected that our sample of clinically referred adults meeting DSM-IV criteria for ADHD would differ reliably from our group of community control adults, and that the ADHD adults would exhibit a pattern of functioning in the domains of psychiatric, cognitive, academic behaviour, and driving behaviour that would be consistent with the well documented pattern of functioning that has been observed and reported in research and clinical accounts of children and adolescents with ADHD as well as in the existing few studies of adults with ADHD (Barkley et al., 1991; Biederman et al., 1999; Benedetto-Nasho & Tannock, 1999; Faraone et al., 1993; Faraone et al., 1998; Faraone, Biederman, Spencer, et al., 2000). Determining whether the pattern of impairment in ADHD adults matches the pattern of impairment in ADHD children is important in providing further information about the disorder over the lifespan, and in assisting health care providers in the management of ADHD across the lifespan.

Additionally it was expected, based on previous research, that the pattern of impairment observed in the ADHD group would differ reliably from the group of clinically referred adults not meeting DSM-IV symptom thresholds (the clinic-comparison group). Murphy & Barkley

(1996) found that adults with ADHD differed significantly from a comparison group, referred to the same clinic that did not meet full criteria for ADHD, in a number of areas of specific comorbidities and adaptive impairments that seemed to be specific to adults who did meet full criteria for ADHD.

Although the clinical picture of a disorder is often established by comparing the diagnostic group in some way with matched normal controls, such studies are limited in that they do not inform us of the specificity of the diagnosis, or the value of the diagnosis, with respect to a variety of problems generally associated with referral to outpatient clinics (Halperin et al., 1993; Werry et al., 1987). Studies using clinic-comparison groups (i.e., subjects referred to a clinic for a variety of reasons) are necessary to help determine the specific clinical features that may serve to differentiate cases of ADHD that meet DSM-IV criteria in both childhood and adulthood from cases that meet some, but not all, criteria for the disorder.

The present study attempted to determine which, if any, impairments in the domains of psychiatric, cognitive, academic functioning, as well as driving behaviour, are specific to the diagnosis of ADHD using DSM-IV criteria. Statements of distinctiveness beyond the defining symptomatology, such as clinical features, etiology and prognosis are necessary when attempting to differentiate a disorder from other behavioural problems (NIH, 2000; Werry et al., 1987).

On the basis of previous research (e.g., Barkley et al., 1991; Biederman et al., 1993; Biederman et al., 1994; Biederman et al., 1998; Murphy & Barkley, 1996c; Roy-Byrne et al., 1997; Rucklidge & Tannock, 2001), three sets of hypotheses were generated:

(a-i) Lifetime rates of conduct problems (conduct disorder/oppositional defiant disorder) would be significantly higher in ADHD adults compared to clinic-comparison and community control adults, who would not differ from one another. (a-ii) Lifetime rates of internalizing disorders (anxiety disorders and mood disorders) would not differ between ADHD adults and clinic-comparison adults, but would be significantly higher than the rates of internalizing disorders found in community control adults; (b) poor performance at school and on tasks assessing FFD/Math would significantly differentiate the ADHD group from the clinic-comparison and community control groups, who would not differ significantly from one another; (c) adverse driving behavior would be significantly higher in ADHD adults compared to clinic-comparison and community control adults, who would not differ from one another.

Functional Impairments Associated with Adult ADHD

Psychiatric functioning.

The present study used a structured diagnostic interview based on DSM-IV diagnostic criteria to examine the lifetime prevalence of internalizing disorders (anxiety and/or mood disorders) and conduct problems (ODD and or CD) in adults being assessed for ADHD.

Internalizing disorders.

Approximately 79% of ADHD adults in our sample reported having experienced internalizing disorders over the course of their lives. Lifetime rates of anxiety disorders and mood disorders in ADHD adults were 51% and 60% respectively. These findings are fairly consistent with lifetime rates reported in clinical samples of adults referred for

diagnosis of ADHD in studies examining comorbid psychiatric disorders (Biederman et al., 1993; Biederman et al., 1994; Shekim et al., 1990).

Compared to the rate of internalizing disorders generally reported in children with ADHD, the lifetime occurrence of internalizing disorders in ADHD adults in our study was fairly high. However, unlike disorders usually first diagnosed in childhood, the age of onset and course of anxiety and mood disorders is quite variable. Internalizing disorders may not develop until adolescence or young adulthood, and may wax and wane with time. Given the limited number of years, and reduced likelihood, for children to develop internalizing disorders, it is not surprising that our study found higher rates of lifetime internalizing disorders in ADHD adults compared to previous studies examining children with the disorder.

As hypothesized, significantly higher rates of lifetime internalizing disorders were reported in our ADHD sample compared to our community control sample. This result replicates the findings from earlier studies of children, adolescents and adults with ADHD (Biederman et al., 1993; Biederman et al., 1994; Biederman et al., 1999; Faraone et al., 1998; Jensen et al., 1993)

Within the clinic-comparison sample of adults who did not meet ADHD criteria, approximately 81% reported a lifetime prevalence of anxiety and/or mood disorders. The rate of internalizing disorders in our clinic-comparison group was significantly higher than in our community control group. The ADHD and clinic referred groups did not differ in the percentage of individuals reporting these disorders. This finding was expected, and replicates findings of Murphy and Barkley (1996c), who compared an

ADHD and a clinic-referred non-ADHD group both referred to the same clinic for problems with attention and/or hyperactivity/impulsivity. Their results, like the present, showed that adults with ADHD did not show a specifically elevated risk for mood and anxiety disorders beyond the risks generally associated with outpatient clinic referral.

These results imply that reports of internalizing disorders across the lifespan are likely to be seen in adults self-referred to outpatient psychiatry clinics for an assessment of ADHD. Although internalizing disorders are associated with ADHD, our findings indicate that high rates of lifetime internalizing disorders are not specific to adults diagnosed with ADHD. Lifetime rates of internalizing disorders are also high in adults with problems with attention, hyperactivity and impulsivity who do not meet full criteria for ADHD.

Conduct problems.

Sixty-eight percent of the ADHD adults in the present study endorsed DSM-IV lifetime criteria for conduct problems (either ODD and/or CD), a finding that is fairly consistent with previous studies examining conduct problems in both children and adults with ADHD (Barkley et al., 1990; Biederman et al., 1993; Biederman et al., 1994). The age of onset for conduct problems is typically within early-to-late childhood; thus the similarity between the rates of lifetime disorders found in the present sample of ADHD adults and the rates reported in previous childhood studies was not surprising.

As hypothesized, significantly higher lifetime rates of conduct problems were reported in the ADHD group of adults compared to community control adults. This result replicates earlier findings in children and adults with ADHD (Biederman et al., 1993;

Biederman et al., 1994; Biederman et al., 1999; Faraone et al., 1998). The present results also showed a trend towards the hypothesized significantly higher lifetime rates of conduct problems in the ADHD group of adults compared to the clinic-comparison group of adults. Our findings indicate that ADHD adults would be more likely to endorse criteria for conduct problems than clinic-referred non-ADHD adults.

It is notable, however, that the rate of conduct problems in the clinic-comparison group of adults was unexpectedly high. Approximately 45% of the adults in the clinic-comparison group endorsed sufficient criteria for conduct problems over the course of their lifetime. In contrast to the null effects hypothesized for the rates of conduct problems in the clinic-comparison group and the community control group, conduct problems in the clinic-comparison group were significantly higher than in the community control sample. Almost 50% of the adults in the clinic-comparison group endorsed sufficient criteria for conduct problems, whereas less than 7% of the adults in the community control group endorsed such criteria.

It is possible that the high rate of conduct problems reported in the clinic-comparison group may be linked with the high rate of internalizing disorders in the group. A review of community studies of comorbidity revealed significant associations between depressive disorders and conduct disorder (depressive disorders+CD) and anxiety disorders and conduct disorder (anxiety disorders+CD). In particular, depression was almost as strongly related to ODD/CD as it was to anxiety (Angold et al., 1999). Therefore it may be reasonable to suggest that the high rates of ODD/CD found in our clinic-referred group may be a consequence of the common association between anxiety

and mood disorder with conduct problems. In other words, the rate of ODD/CD found here in the clinic-referred sample may be comparable to the rate of ODD/CD found in psychiatrically referred groups with high rates of internalizing disorders.

Alternatively, the high rate of ODD/CD in the present clinic comparison sample may be associated with the ADHD symptomatology present in this group. Although clinic-comparison adults did not meet full criteria for ADHD they were referred for assessment of ADHD because of problems with attention, hyperactivity and or impulsivity. Conduct problems may be associated with the limited ADHD symptoms that were present in this group.

Further research is needed to examine the association between conduct problems and referral for assessment of ADHD. It is unclear whether the high rates of conduct problems observed in the present study in the clinic-referred group, relative to the community controls, were associated specifically with ADHD symptomatology, or with high rates of internalizing disorders, or both. Studies comparing ADHD adults without internalizing disorders, and clinic-referred samples of adults, without problems of attention, hyperactivity or impulsivity, who meet criteria for internalizing disorders, are needed to clarify whether comorbid ODD/CD is specifically associated with ADHD symptomatology or with psychiatric samples in general.

In summary, the psychiatric comorbidity of ADHD adults in our sample was generally consistent with findings from previous studies examining ADHD children, adolescents and adults. The profile of psychiatric functioning indicated high lifetime rates of internalizing disorders and conduct problems in ADHD adults. As hypothesized,

rates for both internalizing and conduct problems in the ADHD group were significantly higher than in the community control group, and there was a trend toward the rate of conduct problems being significantly higher in the ADHD group compared to the clinic-comparison group. As expected, the clinic-comparison adults also reported high rates of internalizing disorders. The rate of conduct problems in the clinic-comparison group was significantly higher than expected. Almost half of the adults in the clinic-referred non-ADHD group met lifetime criteria for conduct problems. Although ADHD adults showed the most psychiatric impairment, clinic-comparison adults fell in between the ADHD and community control groups. The psychiatric profile of many adults being assessed for ADHD who did not meet criteria for the disorder matched the psychiatric profile of ADHD adults. This suggests that although internalizing disorders and conduct problems are associated with ADHD, they are also associated with individuals referred for assessment who do not meet criteria for ADHD. Further examination is required to clarify the implications of these findings. Perhaps these findings reflect that these are similar populations and DSM-IV criteria are less than ideal.

In considering the findings of the present study with respect to psychiatric functioning and comorbidity with ADHD symptomatology, two specific methodological limitations should be addressed. First, the full spectrum of possible mental disorders was not assessed in the present study. To limit the number of statistical comparisons, and maintain power in our statistical analyses, only internalizing disorders and conduct problems were examined. These disorders were chosen because they are two of the most frequently co-occurring diagnoses with ADHD, and general population studies have

shown that their comorbidity is not an artifact of referral. However, group differences on other psychiatric disorders (e.g., personality disorders) that were not addressed in the present study may better differentiate ADHD and clinic-comparison groups. The second methodological limitation needing to be addressed, in relation to psychiatric functioning and comorbidity with ADHD, pertains to the fact that the current rates of internalizing disorders and conduct problems were not considered in the present study. In order to limit the number of statistical analyses completed only lifetime rates were evaluated. Given the variable course of internalizing disorders, together with the increased impairment in functioning associated with comorbid conduct problems, and the finding that ADHD adults are highly likely to experience internalizing disorders and conduct problems within their lifespan, researchers and clinicians involved in the assessment of ADHD either in the laboratory or the clinic, must be alerted to the importance of evaluating disorders that may be co-occurring with ADHD currently. The assessment of current psychiatric functioning is particularly important in light of recent findings indicating the possibility of differences in treatment responsiveness as a function of comorbidity (Jensen et al., 2001; Newcorn et al., 2001).

FFD/Math and School Failure

FFD/Math.

The performance of our ADHD adults on a composite variable, comprised from the mean of the standard scores of the FFD Index and the WRAT-3 Arithmetic subtest, was significantly lower than the performance of adults in the community control group. This finding could not be explained by an a priori difference in general cognitive

functioning (IQ) and did not change when individuals with learning disabilities were removed from the sample. Our results of the present study match the results of research on children and adolescents with ADHD in demonstrating that performance on the FFD index and on math tasks is generally lower than in comparison groups (Barkley et al., 1991; Benedetto-Nasho & Tannock, 1999; Faraone et al., 1993; Fischer et al., 1990; Mealer et al., 1996; Schwean, et al., 1993). The present findings also support a substantial literature documenting the cognitive deficits frequently associated with ADHD (Barkley, 1998a; Lindsay, 2000; Pennington & Ozonoff, 1996).

The limited number of studies that have examined the performance of ADHD adults on measures of FFD and mathematics calculation have reported results less consistent than those reported in pediatric samples. Two of three studies examining ADHD adults, diagnosed using DSM-III-R criteria, reported no significant impairments in FFD and math calculation compared to normal control adults (Biederman et al., 1994; Seidman et al., 1998). However, Seidman et al. (1998) speculated that the discrepancy between child and adult findings on measures of FFD and math calculation might be related to the samples of self-referred adults representing a higher functioning subset of the overall distribution of ADHD cases seen in childhood. The high level of educational achievement in the Seidman sample, as evidenced by approximately 15 years of schooling, was given as data to support this hypothesis. Seidman argued that highly impaired adult ADHD cases would not seek evaluation and treatment for ADHD due to their high degree of dysfunction and disability.

The level of educational achievement in the present sample of ADHD adults was approximately two years below that of the Seidman (1998) sample, which suggests that the ADHD adults in this study may have been functioning somewhat below the ADHD adults in previous studies.

In the present study, adults with ADHD also scored significantly lower on the FFD/Math composite measure than did adults in the clinic-comparison group. Medium effect sizes were found. Group comparisons revealed a specific association between adults with DSM-IV diagnosed ADHD and lower scores on the FFD/Math composite measure. This finding of significant group differences between adults diagnosed with DSM-IV ADHD and adults in the clinic-comparison group is potentially valuable. The finding that a measure of cognitive functioning (i.e., the score of the composite measure of FFD/Math) served to differentiate between individuals who do and do not meet the criteria for a DSM-IV diagnosis of ADHD (i.e., the ADHD adults versus the clinic-comparison adults) suggests that, aside from DSM-IV ADHD symptomatology, the two groups may be distinguished on the basis of underlying cognitive difficulties.

Within the present sample of ADHD adults, the score on the FFD/Math variable was more likely to be low when the symptoms of DSM-IV ADHD were persistent into adulthood. Individuals who endorsed some, but not all, criteria for ADHD were less likely to show these impairments, and did not differ significantly from the control group of community adults. It appears that our sample of adults meeting full DSM-IV criteria for ADHD may represent a sample of adults with a high degree of dysfunction and disability. The present findings are also consistent with the findings of previous reports

of cognitive impairments associated specifically with ADHD, and not secondary to its other clinical features (Frick et al., 1991; Frost, Moffitt & McGee, 1989; Faraone et al., 1993; Pennington & Ozonoff, 1996).

Previous evidence has suggested that the subtests comprising the FFD index and tasks requiring mathematics calculation may involve the process of working memory (Brown, 2000; Krane & Tannock, 2001; Mealer et al., 1996). Working memory is typically considered to be within the domain of executive functions that have been specifically implicated in the cognitive profile of children with ADHD (Barkley, 1997; Pennington & Ozonoff, 1996). The present results appear to extend these findings to adults meeting full DSM-IV criteria for ADHD. This is not to suggest that the present data provide conclusive evidence for a core working memory deficit in adults with ADHD; however, the data do encourage further research, hopefully aimed at replicating the present results and using more direct measures of working memory (e.g., Cantab).

It is important to recognize that the present findings do not support the use of FFD or lower math scores as a means for diagnosing ADHD in individual adults. Individuals may manifest ADHD without demonstrating low scores on FFD and math measures, and these scores for individuals with ADHD will frequently be within the average range. The present findings do suggest, however, that FFD and math calculation tasks may be a useful part of an assessment for ADHD. In the absence of intellectual impairment and learning disabilities, low scores on FFD and/or math tasks may provide support for the diagnosis of ADHD, and provide useful information concerning treatment strategies. Individuals with low scores on the FFD factor or math tasks may benefit from

programming strategies designed to consolidate math concepts and computational skills, and to facilitate on line, dynamic processing of verbally presented information (Krane & Tannock, 2001).

Notably, the findings associated with the composite FFD/Math score were based on standardized measures administered directly to participants. Unlike self-reports of symptoms, the data are not subject to biases related to recall and are a potentially important source of external support for the diagnosis of ADHD.

Although it appears that FFD and math tasks involve the process of working memory, and that research is beginning to indicate that ADHD individuals have problems associated with working memory, the present study did not include measures that directly assess working memory. It will be important for future research to incorporate a variety of measures that examine more directly the construct of "working memory". Given that cognitive tasks appear to differentiate DSM-IV diagnosed ADHD adults from comparison groups, further research is necessary using a broader variety of cognitive tasks that have been shown to differentiate ADHD children from other comparison groups (Rucklidge & Tannock, 2000).

School Failure.

Higher rates of School Failure were found among adults with ADHD compared to community control adults. Given that academic underachievement, placement in special classes, and need for tutoring have been called hallmarks of ADHD (Faraone et al., 1993), the consistency of our results with the high levels of school failure reported in earlier studies of children, adolescents, and adults with the disorder was not surprising

(Barkley et al., 1991; Biederman et al., 1993; Biederman et al., 1994; Faraone et al., 1993; Faraone et al., 2000; Fischer et al., 1990; Murphy & Barkley, 1996c; Semrud-Clikeman et al., 1992;). Again, impairments on the composite variable could not be accounted for by intellectual functioning or learning disabilities as differences observed among the groups remained after such possible confounds were controlled.

In order to clarify whether School Failure in ADHD samples is unique to DSM-IV diagnosed ADHD, as opposed to being characteristic more generally of individuals referred to outpatient psychiatry clinics for assessment of ADHD, School Failure was also considered in our clinic-comparison group. Somewhat unexpectedly, the present study found that the clinic-comparison group also differed significantly from the community comparison group in reported School Failure and did not differ significantly from the ADHD group. A medium effect size was found for the comparison of the clinic-comparison adults with community controls. As a group, clinic-referred adults who did not meet full criteria for ADHD recalled school difficulties that were similar to the problems reported by ADHD adults.

Evidence from the limited number of studies in the childhood literature that have considered more than a single disorder have indicated that certain aspects of school failure (particularly placement in special classes and performing below teacher expectations) may be characteristic of patient groups rather than specific to ADHD (Faraone et al., 1993; Szatmari et al., 1989; Werry et al., 1987). Within the clinical comparison group of the present study, approximately 80% of adults reported lifetime rates of internalizing disorders and 44% reported lifetime rates of conduct problems. The

high rates of School Failure in the clinic-comparison group therefore may be associated with the high rates of internalizing disorders and conduct problems reported in the samples of the present study.

It is possible that certain elements of the composite measure of school functioning may be associated with patient groups in general and may not be useful in differentiating ADHD from other behavioral problems. The present study's broad definition of School Failure (repeating a grade, being in special education classes, worse than average grades, performing below teacher expectations) may have resulted in the failure to identify any meaningful differences between the ADHD and clinic-comparison groups. Alternatively, the lack of differences between ADHD and sub-threshold ADHD adults on the School Failure composite may suggest that individuals referred for evaluation because of problems with inattention and/or hyperactivity-impulsivity, but who do not meet full diagnostic criteria for ADHD, may have a mild form of ADHD. Previous research has shown that school failure is evident in individuals with ADHD even when ADHD is not comorbid with any other psychiatric diagnosis in their lifetime (Biederman et al., 1993). The present findings indicate that school problems, in general, are not specific to individuals diagnosed with DSM-IV ADHD.

In summary, ADHD adults and clinic-referred adults reported significantly higher rates of school problems than did community control adults. Although reports of School Failure were associated with adults with ADHD, School Failure was also associated with adults referred for ADHD assessment who did not meet criteria for the disorder. The high rates of reported internalizing disorders and conduct problems in both ADHD and clinic-

referred samples makes it difficult to determine more explicitly the nature of the association between ADHD and school failure. Again, contrary to expectations, the clinic-comparison group was similar to the ADHD group. The possibility that DSM-IV criteria for ADHD may not be optimal (too severe) must not be overlooked.

Limitations in the examination of school problems included: (a) the use of a definition of school problems that may have been too broad and (b) the use of self-report of school problems. School report cards would have provided more objective and less biased information.

Adverse Driving

Adverse driving behavior was evaluated using a composite measure of driving risk that was comprised of the self-reported number of motor vehicle accidents and traffic violations. The results examining driving behavior in the present sample of ADHD adults replicated the findings of previous studies comparing ADHD adolescents and adults with normal controls (Barkley et al., 1993; Barkley et al., 1996; Nada-Raja et al, 1997). In the present sample, ADHD adults reported a significantly greater risk as drivers than did community control adults for motor vehicle accidents and traffic violations. A medium effect size was found for the comparison of these two groups.

Contrary to expectation, a significant difference was not found between ADHD adults and the clinic-comparison group of non-ADHD adults on the composite measure of driving risk. This finding that driving risk for the ADHD group was not significantly higher than driving risk for the clinic-comparison group contrasts with an earlier study that found adults with ADHD to be more than three times as likely to have had motor

vehicle crashes than a clinic-control group also referred for an ADHD assessment who did not meet criteria for ADHD, but who were diagnosed with predominantly anxiety or mood disorders (Murphy & Barkley, 1996c). The ADHD adults in that study also were significantly more likely than the clinic-control group to have received traffic citations for speeding.

The fact that in the present study more than 40% of individuals in the clinic-comparison group endorsed criteria for conduct problems may partly account for the driving risk findings. It has been previously demonstrated that symptoms of ODD and CD account for significant variance in driving-related outcomes (Barkley et al., 1993). Although it is clear that adults with ADHD are at greater risk for negative driving-related events than are community comparison peers, the high correlation of ADHD to symptoms of ODD/CD makes it difficult to determine whether driving risk is due directly to ADHD or to the overlap of conduct problems with ADHD (Barkley et al., 1996). It is possible that the lack of significant differences in driving risk between ADHD adults and clinic-comparison adults in the present study may be a function of the degree of conduct problems present in the clinic-referred group. If the clinic-comparison group had consisted primarily of mood and anxiety disorders, with fewer individuals meeting criteria for ODD/CD, the present findings may have been more consistent with the findings of Murphy and Barkley (1996c). The present results did not show that ADHD elevates driving risks beyond the level associated with referral to outpatient psychiatry clinics for ADHD symptoms.

However, pairwise comparison of the clinic-comparison group and the community control group also revealed no significant difference in driving risk between these groups. The relatively small sample sizes may have resulted in reduced statistical power to detect a reliable difference between the groups. The significant difference and medium effect size found between the ADHD and community control group, however, does suggest that the sample size may have been adequate. Small effect sizes were found in comparisons of the clinic-comparison group with both the ADHD and community control groups. Effect sizes are unaffected by the sample size. These findings indicated that adults in the clinic-comparison group fell in between community control adults and ADHD adults in reported driving risk.

In summary, the present findings concerning adverse driving correspond well with the findings from previous studies comparing ADHD adolescents and adults with normal control groups. ADHD adults reported significantly higher driving risk than did community control adults. Although it cannot be stated with certainty that ADHD is associated specifically with driving risk, the findings do indicate that a history of significant ADHD symptomatology and/or ODD/CD may place individuals at a higher risk for driving impairment. It is appropriate for ADHD adults to be cautioned about the increased driving risk associated with their disorder.

Further research must be conducted using comparison groups reporting a single disorder in order to further clarify these results. The high rate of comorbidity between ADHD and ODD/CD will make such research challenging, however. Again, the

similarity between the ADHD adults and the clinic-comparison adults may reflect limitations of DSM-IV, which separates these two groups that may be similar.

Two specific methodological limitations relating to the use of the composite measure of adverse driving behavior as a functional impairment of DSM-IV ADHD symptomatology should be addressed in any follow-up study aimed at replicating and/or extending the present findings. First, the current study used self-report of outcomes (e.g., motor vehicle accidents and traffic violations) deemed indicative of hazardous or unsafe driving habits to construct the composite measure of driving risk. The use of self-report measures of driving behaviour may provide less reliable or less accurate assessment of driving risk than would the use of official driving records from government and insurance company public documents related to citations, crashes, injuries and damages. Second, more extensive driver-related information should have been collected concerning, perhaps, the nature and extent of driver training subjects had received, number of years of driving experience, and the type of driving typically done by the subjects.

Overall Summary and Clinical Implications

The findings of the present study supplement the clinical picture of ADHD in clinic-referred adults diagnosed using DSM-IV diagnostic criteria. Our findings showed that adult ADHD is associated with significant impairments across a range of measures obtained from informants, even after potential confounds, such as IQ and learning disability, are controlled. ADHD adults clearly differed from community controls on all of the outcome measures included in the present study. In ADHD adults, compared to community control adults, performance was significantly lower on cognitive measures of

FFD/Math, and there were significantly higher rates of ODD/CD, internalizing disorders, driving impairment, and problems in school. The obtained profiles of functioning in the various domains that were examined corresponded well to the profiles of functioning found in earlier studies of ADHD children, adolescents and adults.

Unlike the majority of earlier studies, the present research included a clinic-comparison group of adults referred for assessment of ADHD, who did not meet DSM-IV criteria for the disorder. This group was included because of the lack of information regarding the specificity of problems found to be associated with a diagnosis of ADHD, and the lack of information examining the diagnostic symptom thresholds appropriate to employ with adults being assessed for ADHD. Unexpectedly, the present study found that ADHD adults clearly differed from clinic-comparison adults on only one of the outcome measures. The performance of ADHD adults on the cognitive measure of FFD/Math was significantly lower than the performance of clinic-comparison adults. This finding requires replication before results can be interpreted definitively. If the findings are replicated however, this could prove to be a measure which is sensitive to demands made upon working memory, and differentiates participants who meet full DSM-IV criteria from those who endorse some problems with attention, and/or hyperactivity-impulsivity, but who do not meet symptom thresholds for the disorder.

The finding of a specific clinical feature that differentiated between clinic-referred adults meeting and not meeting DSM-IV criteria for the disorder is important to consider in future research, particularly if ADHD is to be recast as a norm-referenced rather than a

criterion referenced diagnosis. It does not provide sufficient evidence, however, to suggest that DSM-IV symptom thresholds are appropriate for use in adult populations.

In fact, in line with the idea that ADHD may be better conceptualized as a dimensional category than a discrete category, significant differences between the clinic-comparison and ADHD groups were not found on the remaining outcome measures in the present study. Rates of internalizing disorders, driving impairment, and problems in school did not differentiate the ADHD and clinic-comparison groups, and rates of internalizing disorders, conduct problems, and problems in school were significantly higher in the clinic-comparison group compared to the community control group. The severity of functional impairments in the clinic-comparison group of adults fell in between adults with ADHD and community control adults, but resembled the ADHD adults more than the community control adults. Given that the clinic-comparison group was referred for inattentive, hyperactive, and impulsive symptoms, but did not meet full DSM-IV criteria, it may have been better conceptualized as a subthreshold ADHD group.

The finding that the pattern of psychiatric-, driving-, and school-difficulties experienced by clinic comparison adults so closely mirrored the pattern exhibited by ADHD adults raises the question of whether clinic-comparison adults, who do not meet full criteria for the disorder, do indeed manifest a mild form of ADHD, and whether DSM-IV criteria are too restrictive for use with adults. Clinicians well-recognize that there are clinically meaningful cases of ADHD that do not meet full criteria. To be sure, more studies comparing the clinical correlates of ADHD within ADHD adults and sub-threshold clinic-comparison adults are needed. Further information on potential sources of impairment related to severity of ADHD symptoms is required to clarify the implications of the present results for diagnosis and treatment.

Few child studies examining the clinical correlates of ADHD have included a sub-threshold clinic-comparison group (i.e., children/adolescents referred for assessment of ADHD who did not meet criteria for the disorder) in order to determine the specificity of problems to an ADHD diagnosis. It is possible that a study similar to the present study, but one which examined children/adolescents instead of adults, also would find only small, non-significant differences in domains of psychiatric functioning, academic problems, and adverse driving between children/adolescents with ADHD and children/adolescents with problems of attention, hyperactivity, and impulsivity who did not meet criteria for ADHD.

It is possible also that the lack of differences between the ADHD and clinic-comparison groups on variables assessing psychiatric, driving, and school problems reflects a higher-than-normal level of some general dysfunction factor that is common to both groups. As well, perhaps the differences observed between the ADHD group and the community control group were not a function of ADHD symptoms, but rather a function of differences between patients self-referred to psychiatric clinics in general and community adult controls (Reeves et al., 1987). Both groups of adults referred to the clinic for assessment of ADHD (i.e., the ADHD group and the clinic-referred comparison group) had a modest level of dysfunction, which might suggest that the dysfunction served as a general selection factor in individuals seeking ADHD evaluations. These findings imply that some of the impairments associated with ADHD may in fact be related to clinic-referred adults rather than to individuals reporting problems with inattention, hyperactivity and impulsivity. Further study is needed using psychiatric control participants (i.e., anxious

and/or depressed adults), rather than non-specific controls, to determine clinical features that are specific to ADHD, and differ between ADHD and non-ADHD adults. If similarities are found in the pattern of functional impairments within ADHD and subthreshold ADHD adult groups, yet differences are found between both groups and a group of anxious and/or depressed adults, we may be more confident in stating that the pattern of functional impairments found in the present study are specifically associated with adult ADHD rather than psychiatric conditions in general.

Although DSM-IV ADHD diagnostic criteria are capable of selecting a group of adults with ADHD, adults with some, but not all, features lie somewhere between adults who clearly do and do not have ADHD. The group of adults that meets some, but not all, criteria for ADHD will remain a diagnostic challenge, and must be handled on a case-by-case basis. If an individual does not meet symptom thresholds for ADHD, yet presents with many of the symptoms of ADHD, their clinical profile should be examined carefully. Individual evaluations of ADHD symptoms and comorbid conditions must guide treatment decisions. Clinicians need to be aware that, despite the failure to meet diagnostic thresholds for ADHD, subthreshold ADHD adults may have impairment in multiple domains of functioning that may warrant treatment. It would have been interesting to examine what level of DSM-IV ADHD symptoms corresponded to what level of functional impairment in our sample of adults. However, limitations in sample size did not allow this investigation.

For now, within clinical practice, the primary criterion for identification of ADHD in adults has to be impairment of function, rather than an arbitrarily determined cut-off of

symptoms on a list (Weiss et al., 1999). Our results are consistent with the argument that DSM-IV criteria may be too stringent as the criteria do not identify many adults who are deviant from the norm and show impairment warranting clinical attention (Heiligenstein, Guenther, Levy, Sevino & Fulwiler, 1999).

Until further information is available on the diagnostic criteria appropriate to employ with adults, the use of ADHD "In Partial Remission", and the DSM-IV category of Attention-Deficit/Hyperactivity Disorder Not Otherwise Specified (ADHD NOS), which have received very little attention in the research literature, may be most appropriate for adults with prominent symptoms of inattention and/or hyperactivity-impulsivity that do not meet full criteria for ADHD, but whose problems appear to be primarily associated with symptoms of ADHD. The use of ADHD "In Partial Remission" or ADHD NOS for individuals experiencing prominent symptoms of the disorder, but not meeting full symptom thresholds, allows clinicians and researchers to recognize the considerable impairment that may be associated with below threshold symptoms of inattention and/or hyperactivity-impulsivity. Advocating the use, in certain circumstances, of ADHD "In Partial Remission" or ADHD NOS implies that symptoms of ADHD fall along a continuum of severity, and signifies that treatment may be justified on a case-by-case basis depending on the degree of impairment. It also allows clinicians and researchers to acknowledge and further examine distinctions that may exist between ADHD and subthreshold groups of adults, such as differences in cognitive functioning.

Limitations

Our results must be considered in the context of some methodological limitations. The first limitation is that a clinical sample was used in the present study, which means that the results cannot be generalized to the general population. Individuals presenting to specialty clinics tend to have more severe symptomatology and more impairment, and are more likely to suffer from multiple disorders, than are individuals with the disorder in the general population (Angold et al., 1999). Clinic samples are necessary, however, for providing a data base with which to compare the results of other clinical samples.

A second limitation of the study is that the ratings of impairment were generally based on self-report, rather than parent report or reports from significant others. Adults seeking assessment for ADHD, perhaps in order to justify their life problems, may be biased to see ADHD symptoms in themselves. Alternatively, some adults simply may have been under-reporting symptoms.

A third limitation is that the relatively small size of the participant groups might have resulted in reduced statistical power, and the failure to detect significant differences between groups. However, it may be noted that effect sizes were calculated in the present study because they are unaffected by sample size, and may allow the findings, therefore, to be interpreted more confidently, but with due caution.

A fourth limitation of the present research is that the different subtypes of ADHD were not given consideration. It may well be the case that results would differ as a function of whether groups were comprised of individuals who met criteria for ADHD Combined Type, Predominantly Inattentive Type, or Predominantly Hyperactive-Impulsive type.

Given the sample size used in the present study, however, an analysis based on subtypes was not feasible.

A fifth limitation is that additional measures of functional impairment that are clearly and exclusively within the adult realm of functioning were not examined. Potential areas of exploration might include occupational problems, sexual-reproductive risks, and marital problems.

A sixth limitation is that although the present study included a clinic-comparison group of adults who did not meet the diagnosis for ADHD, the clinic-comparison group was non-specific and did evidence some ADHD symptoms. In fact the clinic-comparison group may have been more appropriately labelled a subthreshold ADHD group. It will be important for future research to compare ADHD adults with clinic-referred adults being assessed for disorders other than ADHD to determine whether patterns of functioning are specific to adults referred for assessment of ADHD or to adults referred to outpatient psychiatric clinics in general.

Although the foregoing limitations necessarily qualify interpretation of the results, it is noteworthy that the methods used in the present study were the same in many respects to the methods used by a number of prominent researchers in their investigations of adult ADHD (Biederman et al., 1993; Biederman et al., 1994; Murphy & Barkley, 1996c; Millstein et al., 1997; Roy-Byrne et al., 1997; Seidman et al. 1998; Shekim et al., 1990). Indeed, in certain respects the present study represents an advance over previous studies. The information available concerning adult ADHD typically derives from studies that have not used DSM-IV diagnostic criteria, have not controlled for potentially confounding

variables such as intelligence and learning disabilities, and have not used clinical comparison groups in conjunction with community control groups.

In conclusion, findings from the present study demonstrated significant functional impairments in ADHD adults diagnosed using DSM-IV diagnostic criteria. ADHD adults showed significantly greater impairment in psychiatric, cognitive, academic and driving domains compared to community control adults. Compared to clinic-comparison adults, ADHD adults showed significantly greater impairment on a cognitive variable involving working memory, and showed a trend toward higher rates of conduct problems. Despite some differences between ADHD and clinic-comparison adults, however, significant functional impairments, resembling the impairments of ADHD adults, were present in many adults exhibiting some but not all symptoms of the disorder. Our results highlight the importance of clinicians/researchers examining the disorder in a manner that attends to the potential reduced sensitivity of the DSM-IV symptom thresholds in adults (Faraone, Biederman, Feighner, et al., 2000). Future studies should seek to determine whether the number of symptoms, the severity of symptoms, and the selection of symptoms, should be different for different populations (children vs. adult) of individuals being assessed for ADHD (Weiss et al., 1999). For now, the categories of ADHD "In Partial Remission" and ADHD NOS may be appropriate for individuals with prominent symptoms of inattention, and/or hyperactivity-impulsivity who do not meet symptom thresholds for the disorder. Replication of the present findings is necessary using single-disorder psychiatric control groups (i.e, depressed or anxious patients), rather than non-specific clinic control groups, and further work assessing the relationship of cognitive measures to ADHD is encouraged.

Footnotes

1. Following the completion of data collection and analysis the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition-Text Revision was published (APA, 2000). Diagnostic criteria for Attention-Deficit/Hyperactivity Disorder have not changed with the revised edition of the manual.

2. As there was no significant difference in the demographic characteristic of gender compared across groups, gender was not an area of investigation in the present study. Preliminary analyses were completed, however, that determined that within the ADHD group, lifetime rates of internalizing disorders and conduct problems, as well as reports of problems in school, and scores on the FFD/Math variable did not differ significantly between males and females. There was a trend ($p<.08$) towards ADHD males reporting higher rates of adverse driving than ADHD females. Analyses within the clinic-comparison group showed no significant differences between males and females on lifetime rates of conduct problems, school failure, FFD/Math and adverse driving. Significant differences were reported on lifetime rates of internalizing disorders. Clinic-comparison females reported significantly higher rates of internalizing disorders than clinic-comparison males ($p<.01$). Because of limited sample size we did not do separate gender comparisons between the three groups.

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