Journal of Attention Disorders OnlineFirst, published on May 6, 2009 as doi:10.1177/1087054708326113

Journal of Attention Disorders
Volume XX Number X
Month XXXX xx-xx

10.1177/1087054708326113
http://jad.sagepub.com
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Executive Function Impairments in High IQ Adults With ADHD

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Objectives: To demonstrate that high IQ adults diagnosed with ADHD suffer from executive function (EF) impairments that: a) can be identified with a combination of standardized measures and self-report data; and b) occur more commonly in this group than in the general population. **Method:** 157 ADHD adults with IQ ≥ 120 were assessed with 8 normed measures of EF– 3 index scores from standardized tests of memory and cognitive abilities, and 5 subscales of a normed self-report measure of EF impairments in daily life. **Results:** 73% of subjects were significantly impaired on ≥ 5 of these 8 EF markers. On all 8 measures, incidence of these impairments was significantly greater than in the general population. **Conclusion:** High IQ adults with ADHD tend to suffer EF impairments that can be assessed with these measures; incidence of such impairments in this group is significantly higher than in the general population.

Keywords: *ADHD; executive functions; high IQ; memory*

In our clinical practice, adults with IQ scores in and above the superior range have sought evaluation and treatment for chronic difficulties with organizing their work, excessive procrastination, inconsistent effort, excessive forgetfulness, and lack of adequate focus for school and/or employment. They question whether they might have an attention deficit disorder, but often they have been told by educators and clinicians that their superior intelligence precludes their having ADHD.

Typically, these very bright individuals report that they are able to work very effectively on certain tasks in which they have strong personal interest or intense fear of immediate negative consequences if they do not complete the task at once. Yet they are chronically unable to make themselves do many tasks of daily life they recognize as important but do not see as personally interesting at that moment. When provided treatment appropriate for ADHD, these very bright individuals often report significant improvement in their ability to work effectively while their medication is active.

The chronic difficulties demonstrated by these very bright individuals when they are untreated illustrate how persons with ADHD may be very competent and talented, yet significantly impaired in their capacity to manage and deploy their abilities for many important tasks of daily life. They lack adequate self-management skills, as their executive functions are impaired. Each of these individuals might be compared to a symphony orchestra of very talented musicians who cannot produce adequate symphonic music because the orchestra lacks an effective conductor (Brown, 2005).

To date, this problem of ADHD in persons with high IQ has received little attention in the scientific literature. Antshel et al. (2007, 2008) described 49 high IQ (≥120) children who fully met diagnostic criteria for ADHD as per *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*; American Psychiatric Association, 1994) and showed a pattern of familiality, cognitive, psychiatric, and behavioral features typical of children with average IQ diagnosed with ADHD. However, little has been published about high IQ adults with ADHD, although these individuals provide an excellent example of how general cognitive abilities can be distinguished from impairments of executive functions typical in ADHD.

Neuropsychological studies have reported impairments of various executive functions among adults with ADHD, but there is significant controversy in the field about whether clinical neuropsychological tests of executive

functions (EF) adequately assess impairments of EF as they are manifest in daily life tasks (Barkley et al., 2008; Brown, 2006). Hervey, Epstein, and Curry (2004) reviewed 33 published studies and found that current neuropsychological tests are not sensitive enough to pick up ADHD symptoms in adults.

Biederman et al. (2006) used neuropsychological measures of EF to assess adults with and without ADHD. Defining impairment of EF as scoring 1.5 standard deviations (*SD*) or more below the mean (lowest 7th percentile) for the control group on any two of eight neuropsychological tests of EF they identified a subgroup of 31% of their ADHD group who were impaired on EF tests, whereas only 16% of the contol group showed such impairment. Adults with EF impairments owing to ADHD had significantly worse occupational outcomes on these psychometric measures than those with ADHD who did not have such impairments. This led the authors to conclude that psychometrically defined impairments of EF should be considered a comorbid problem present in about one third of adults with ADHD, compounding their already compromised workplace functioning.

Although such findings from neuropsychological tests of EF clearly identify individuals who suffer from severe impairments of EF, it is not clear whether such tests are sufficiently sensitive to pick up the full range of EF impairments that are characteristic of adults with ADHD. Investigators of executive functions in the elderly (Burgess, 1997; Rabbit, 1997) and researchers in ADHD (Barkley, 1997, 2008; Brown, 2000, 2005) have argued that the complex, multifaceted nature of executive functions is such that traditional neuropsychological tests of EF are not valid measures of EF impairments because they fractionate these integrative functions, and they have too low a ceiling to be sufficiently sensitive.

These limitations of neuropsychological tests of EF were shown by Shallice and Burgess (1991) who demonstrated that patients with frontal lobe damage were unable to perform everyday errands that required planning and multitasking adequately, even though they achieved average or well-above-average scores on traditional neuropsychological tests of language, memory, perception, and executive functions. Similar results from assessing EF impairments in more real life situations were reported by Alderman, Burgess, Knight, and Henman (2003) who assessed adults doing tasks in a shopping mall. Brown (2006) has summarized theoretical issues underlying these conflicting views of EF in ADHD.

Other researchers have found that EF impairments of ADHD are more adequately identified by self-report and clinical interviews that query about impairments of self-management in day-to-day adaptive functioning. Stavro, Ettenhofer, and Nigg (2007) demonstrated that symptoms of ADHD in young adults are associated with impairments of EF and adaptive functioning but found that neuropsychological tests of EF did not predict impairment independent of ADHD.

Biederman and colleagues (2006) did a controlled study of adults with and without ADHD using self-reported symptoms of EF on Barkley's Current Behavior Scale (CBS). They found that adults with ADHD who self-reported elevated levels of EF impairments on the CBS tended to be significantly more impaired on measures of global functioning, had more comorbidities, and held lower current socioeconomic status than did those with or without ADHD who scored below the median on that scale. Distribution of scores on the CBS showed very limited overlap between ADHD and control subjects; a factor analysis indicated that all 99 items on the CBS converged as a single latent variable. Their data showed that 90% of the ADHD subjects had scores above the cutoff score at the 93rd percentile of the controls.

These findings are consistent with results from Barkley, Murphy, and Fischer (2008) who used essentially the same scale to compare adults with ADHD to non-ADHD clinically referred patients, and to nonreferred community controls. Their research showed that questions regarding EF impairments such as distractibility, impulsiveness, poor concentration, lack of persistence, problems with working memory, and poor organization were most effective in differentiating adults with ADHD from those with other psychiatric disorders and from community controls.

Previous studies of EF impairments in adults with ADHD involved subjects with a wide range of IQ. They did not address the issue of whether adults with ADHD and high IQ demonstrate the same problems of EF as do those in the wider range of IQ scores. Also, most other studies did not administer a full IQ test to their subjects; they estimated IQ from just a few key subtests. This method is quite adequate for estimation of overall cognitive abilities, but it does not provide data necessary for comparing various combinations of subtests useful for assessment of a person's relative strengths and weaknesses in cognitive abilities (see Quinlan, 2000).

The study reported here used clinical interviews, a full Wechsler Adult Intelligence Scale–Third Edition (WAIS-III), the Brown ADD Scale, and a verbal memory subtest of the Wechsler Memory Scale–Third Edition (WMS-III) to assess adults with high IQ who met *DSM-IV* diagnostic criteria for ADHD, any type. With these data, we determined their relative impairment on standardized measures of three executive functions: working memory, processing speed, and short-term auditory verbal memory and on five clusters of executive functions

assessed by self-report using the Brown ADD Scale for Adults, a normed rating scale for ADHD-related impairments of executive functions that has been found effective in assessing adults (Kooij et al., 2008).

Sample

Charts of adults who came for evaluation in either of two ADHD clinics, one private, another in a university medical center, were reviewed to select patients aged 18 to 55 years diagnosed with *DSM-IV* ADHD who had high IQ as defined by WAIS-III index scores for verbal comprehension (VCI) and/or perceptual organization (POI) equal to or more than 120 (top 9% of population). These index scores were selected because they are measures of areas of cognitive abilities less sensitive to cognitive impairments associated with EF. Full-scale IQ, Verbal and Performance IQ on the WAIS-III would be less valid because they incorporate several subtests that assess working memory and processing speed.

Charts of all patients scoring 120 or more for VCI or POI were included. Of the 157 patients, 76% were men. The ADHD diagnoses for these patients, based on current impairments, were 67% predominantly inattentive type and 33% combined type. Within the sample, 36% were aged 18 to 19 years, 35% were aged 20 to 25 years, and 29% ranged from 26 to 53 yrs.

Measures

Each patient had been evaluated in a2-hr clinical interview by a licensed clinical psychologist experienced in assessing for ADHD. During this interview, the Brown ADD Scale for Adults (Brown, 1996) and Logical Memory subtest of the WMS-III (Wechsler, 1997b) were administered. Diagnosis of ADHD was made according to *DSM-IV* diagnostic criteria. In a separate session, the full WAIS-III (Wechsler, 1997a) was also administered to each subject according to published guidelines.

From the WAIS-III, index scores for working memory (WMI) and for processing speed (PSI) were selected to assess subjects' ability to hold in mind and manipulate numerical information (WMI) and to scan and output visual information under timed conditions (PSI). Seidman et al.(2004) have argued that these two index scores are most likely to be impaired in persons with ADHD. Rather than to compare group means on these measures, we compared each individual subject's WMI and PSI with the strongest of that individual's VCI or POI index scores on the WAIS-III. Kaufman and Lichtenberger (2006) have recommended a similar individual profile analysis approach as a valid and useful way to compare the individual's cognitive strengths against measures of executive functions necessary to deploy those strengths.

Working memory is not a unitary variable; different working memory functions are associated with different modalities and different types of information (Miyake & Shah, 1999; Baddeley, 2007). Often, working memory is assessed with the Digit Span test, which is not always sensitive to impairments of working memory for more complex verbal information. Quinlan and Brown (2003) demonstrated that ADHD adults, in comparison to the general population, tend to be impaired in their ability to recall two brief stories immediately after hearing each one; the sample of ADHD adults also showed greater impairment for recall of the complex narrative content of the stories than on recall of strings of digits, a component of the WAIS-III WMI.

In the present study of adults with ADHD and high IQ, we asked each subject to listen to each of the two 25-word unit stories of the WMS-III Logical Memory subtest and then scored their immediate recall according to scoring guidelines for the WMS-III as described by Quinlan and Brown (2003). The resulting score was then transformed to an IQ-like score (M = 100, SD =15) which was then subtracted from that individual's VCI score. In this way, we corrected for the correlation between overall verbal ability and the person's recall of the stories. This correction is necessary because the national standardization sample for the WMS-III (Wechsler, 1997b) found a .58 correlation between immediate auditory memory and verbal IQ.

To obtain a more comprehensive measure of each subject's EF impairment in multiple activities of daily life, the clinician administered the Brown ADD Scale for Adults (1996) orally to each patient during the initial evaluation. This normed and validated scale elicits self-report data regarding five clusters of ADHD-related EF: (a) organizing, prioritizing and activating to work; (b) focusing, sustaining, and shifting attention to tasks; (c) regulating alertness, sustaining effort, and processing speed; (d) managing frustration and modulating emotions; and (e) utilizing working memory and accessing recall.

Rather than merge data from all these clusters into one total score, we treated each cluster as a separate item. This provided a more detailed profile of each subject's reported level of EF impairment on each of these five clusters.

Method

From the chart of each individual entered in this study, we extracted scores for the three standardized measures and the five clusters of self-report data described above. This yielded eight different measures of EF. For each

measure, we defined a specific cut score to be taken as indication of significant impairment and another cut score to serve as a marker of severe impairment.

Each patient's WAIS-III score VCI or POI (whichever was higher) was compared against his or her scores for WMI and PSI on the same test. A WMI or PSI score 1 *SD* or even lower than the individual's VCI or PSI was considered a marker for significant impairment; 2 *SD* was considered a marker for severe impairment.

Each patient's score on the standardized story memory test (logical memory subtest) from the WMS-III (converted to a scale comparable to the IQ scales, $M = 100$, $SD = 15$) was compared with his or her VCI. A story memory score 1 *SD* or even lower than that individual's VCI was considered a marker for significant impairment; 2 *SD* was taken as indicating severe impairment.

Each patient's cluster scores on the Brown ADD Scale were compared with the scale's published norms to determine degree of impairment reported for that specific cluster of ADHD-related EF. A *t* score of 65 (1.5 *SD* above the mean), or greater, was taken as indicative of significant impairment.

Results were calculated in two ways. First, we determined how many of our eight EF measures were impaired in each of these high IQ subjects with ADHD. Although we did not expect that each individual would be impaired on every one of these measures, we predicted that most would be impaired on many of the eight measures.

Our second analysis of the data involved comparisons between the percentage of our high IQ subjects with ADHD scoring in the impaired range on each of our eight measures of EF relative to rates of comparable impairment in standardized groups for the respective measures. For the two index scores from the WAIS-III, we were able to compare with others in the same IQ range of 120 or more. For the WMS-III story memory task and the Brown ADD Scales for adults, we used norms for the general adult population because separate norms for those with superior IQ were not available.

Results

All patients in this study were selected because they demonstrated cognitive strengths on verbal and/or perceptual factors of the WAIS-III IQ tests that placed them in the top 9% of their age group in the general population. Significant impairment on the WAIS WMI was found in more than 74%, whereas severe impairment was found in 35% (Figure 1). The PSI was significantly impaired in more than 85% and was severely impaired in more than 44% (Figure 2). Figure 3 shows that more than 86% showed significant impairment on their Story Memory Index relative to their high VCI on the Wechsler IQ test, whereas more than 36% were severely impaired.

Analysis of each patient's scores on the Brown ADD Scale for Adults indicated that more than 70% of patients reported significant impairment on at least 4 of 5 clusters of symptoms on that scale (Figure 4).

Figure 1
Working Memory Index (WMI): Percentage of Subjects With WMI 1 and 2 *SD* Below Verbal Comprehension Index or Perceptual Organization Index

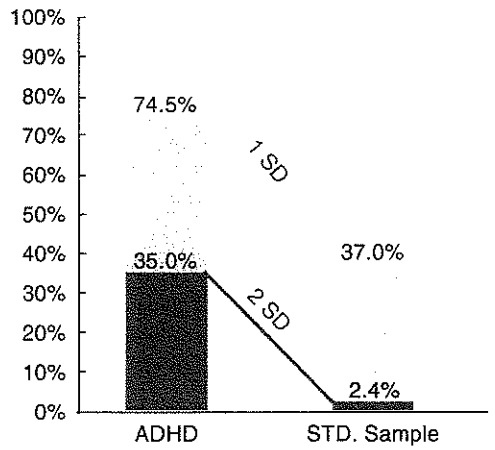


Figure 2
Processing Speed Index (PSI): Percentage of Subjects With PSI 1 and 2 *SD* Below Verbal Comprehension Index or Perceptual Organization Index

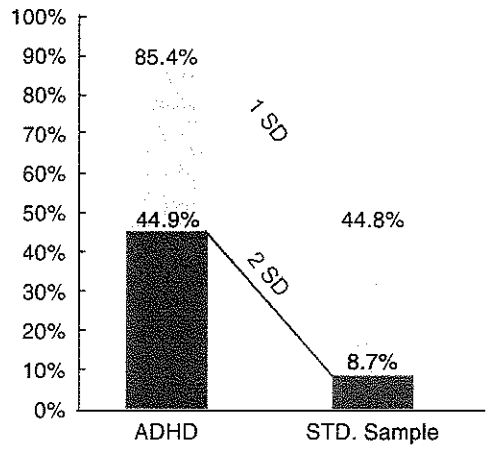


Figure 3
Story Memory Index (SMI): Percentage of Subjects With SMI 1 and 2 *SD* Below Verbal Comprehension Index or Perceptual Organization Index

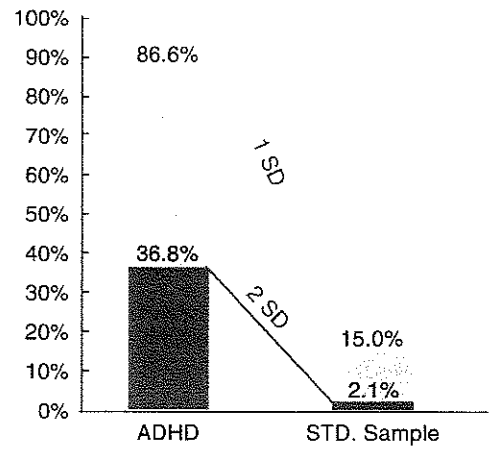
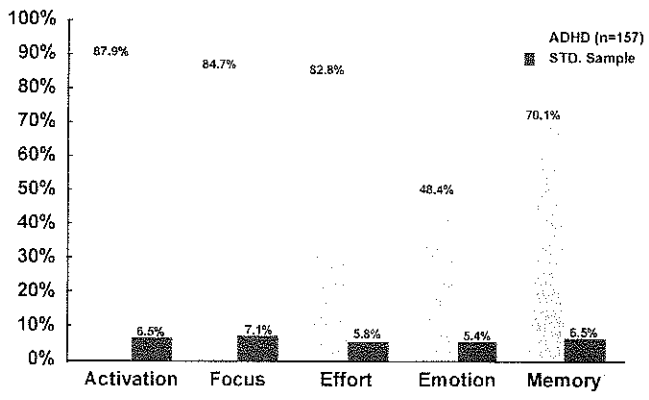


Figure 4
Clusters of Executive Function Impairments: Self-Report on Brown ADD Scales; Percentage of Subjects Scoring $t = \geq 65$



Figures 1 to 4 also show the percentage of individuals in the general population who score at similar levels of impairment, as reflected in published norms for these measures. For the two WAIS-III index scores, comparisons are with others whose IQ was 120 or more. For scores on the WMS-III Logical Memory and the Brown ADD Scales, comparisons are to the general population of adults sampled for published norms of those specific measures. On all eight measures of EF assessed in this study, the percentage of patients impaired was significantly greater than the percentage impaired in standardization samples for these measures (Figures 1-4) Moreover, in this sample 73% of individuals showed significant impairment in five or more of the eight markers of EF impairment, despite their high IQ. These multiple measures converge to indicate that this sample of adults with ADHD and high IQ show significant impairment on multiple measures of EF, despite their high IQ.

Discussion

This study provides evidence that among adults with high IQ are some who fully meet *DSM-IV* diagnostic criteria for ADHD. This study cannot provide any estimate of what percentage of persons with high IQ have ADHD, but it clearly demonstrates that having high IQ does not preclude the possibility that one might have ADHD.

We found strong support for the hypothesis that adults with high IQ who meet diagnostic criteria for ADHD tend to have significant weaknesses in working memory, processing speed, and auditory verbal working memory relative to their own cognitive abilities and that they tend to report more impairments in EF than are reported for a comparable age group in the general population. We feel that our within-subject analysis of these impairments is a more useful measure for clinicians than group means because group means tend to submerge individual variabilities.

Data in this study regarding impairments of auditory verbal memory in adults with ADHD are fully consistent with findings from the previously published study by Quinlan and Brown (2003) of 176 adults with ADHD whose IQ scores spanned the full normal range. This suggests that that individuals with high IQ diagnosed with ADHD suffer from similar impairments of executive function, at least for auditory verbal memory, as do others on the wider spectrum of IQ scores. High IQ clearly does not protect individuals from having impairments of ADHD.

Despite the high percentages of high IQ adults with ADHD impaired on these measures, the measures used in this study cannot be sufficient, singly or in combination, to make or rule out a diagnosis of ADHD. There are some with ADHD and high IQ who are not significantly impaired on these measures, and there are some impaired on these measures who do not qualify for a diagnosis of ADHD because their impairments are caused primarily by current substance abuse, anxiety disorders, mood disorders, and so on. Yet these self-report and neuropsychological measures, when combined with adequate clinical interview data to clarify levels of impairment and to ascertain other possible contributing factors or comorbid

disorders, may provide useful evidence to assist in identifying adults suffering from EF impairments of ADHD, particularly those whose high IQ may make their ADHD impairments more difficult to recognize.

Clinical interviews with patients in this study indicated that individuals with high IQ who have ADHD may be at increased risk of having recognition and treatment of their ADHD symptoms delayed until relatively late in their educational careers because teachers and parents tend to blame the student's disappointing academic performance on boredom or laziness, especially as they notice the situational variability of their ADHD symptoms.

Like most others with ADHD, these individuals have a few specific domains in which they have always been able to focus very well, for example, sports, computer games, artistic or musical pursuits, reading self-elected materials. Parents and teachers tend to assume that these very bright persons, could focus on any other tasks equally well, if only they chose to do so. These observers do not understand that although ADHD appears to be a problem of insufficient willpower, it is not (Brown, 2005).

Many also reported that they often demonstrated considerable prowess in performing specific tasks in which they had little positive personal interest but did experience considerable fear of immediate negative consequences if they did not complete that particular task by some external deadline. Often subjects described this as a character trait, "I'm just a severe procrastinator" or "I always work best under pressure."

The assumption that such self-management can readily be shaped by conscious intentions is being challenged by a number of researchers with studies demonstrating that cognitive self-control tends to operate in an extremely rapid, automatized manner, largely under the influence of less conscious emotional and cognitive motivational processes (Glaser & Kihlstron, 2005; Hassin, 2005; Phelps, 2005). Research is needed to test how these automatized processes are related to executive function impairments associated with ADHD.

Most of these high IQ adults were not evaluated for ADHD until high school years or beyond. In some cases, impairments were not noticed until the adult began university studies or employment where he or she was challenged by increased demands for EF. Most of those evaluated reported that during elementary school years they were able to function in ways that lived up to high expectations for academic success that were held by their parents, teachers, and themselves. It was only when they moved into middle school or junior high where they had to keep track of various homework assignments for many different teachers, without anyone to help them to prioritize and remember, that impairments of these high IQ individuals became apparent.

Some might question the validity of an ADHD diagnosis for individuals who do not manifest symptoms of the disorder before age 7 years as stipulated by the *DSM-IV*. Yet Faraone et al. (2006) have demonstrated that adults whose ADHD does not become apparent until well past the *DSM-IV* stipulated age of onset at 7 years do not differ in functional impairment, psychiatric comorbidity, or family transmission when compared to adults whose ADHD symptoms were apparent by age 7. High IQ individuals with ADHD may be at particular risk of protracted delays in having their ADHD impairments recognized, evaluated and treated.

In an unpublished study of 103 treatment-seeking adults with IQ 120 or more diagnosed with ADHD, Brown and Quinlan (1999) found that 42% had dropped out of postsecondary schooling at least once, although some did eventually return to complete a degree. Those data together with this present study suggest that individuals with high IQ and ADHD, despite their strong cognitive abilities, may be at significant risk of educational disruption or failure due to ADHD-related impairments of EF.

Strengths and Limitations of This Study

To our knowledge, this is, thus far, the largest sample of high IQ adults with ADHD in the published literature. This study demonstrates that adults with high IQ can fully meet *DSM-IV* diagnostic criteria for ADHD and that they tend to suffer significant impairments on executive functions measured by three standardized tests and five separate clusters of a normed self-report scale. Results of this study are fully consistent with findings from another study, currently in review, that used similar measures with a sample of 117 children and adolescents with high IQ and ADHD. Another strength is that our data include reports of percentages of subjects who scored above or below the stipulated score cut-points. This provides information that may be more useful to clinicians assessing individual patients than would be group means which may submerge individual differences.

One limitation of this study is that comparisons were made with published norms for the measures used rather than with a matched set of high IQ adults who did not have ADHD.

Another shortcoming is that although we were able to compare data from two of our standardized measures to norms for individuals with IQ in the same high range as those in our sample, comparisons for our other measures of EF were to normative samples of adults not specifically in the same range of IQ.

Despite these limitations, this study can serve to alert clinicians to the fact that some individuals with high IQ suffer from ADHD and that their ADHD-related EF

impairments can readily be assessed with measures used in this study.

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