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Clinical Correlates of Working Memory Deficits in School Going Children with and Without ADHD in Ahemdnagar

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Abstract

Both working memory and attention-deficit/hyperactivity disorder (ADHD) have been associated with educational deficits. Since working memory deficits are prevalent in children with ADHD, the main aim of the present study was to examine whether educational deficits are driven by working memory deficits or driven by the effect of ADHD itself. Participants were referred children with (N=100) and without (N=100) ADHD ascertained from pediatric and psychiatric sources. Education deficits were defined as grade retention or placement in special classes, and were assessed using interviews and written rating scales. Working memory was assessed using the WISC-R Freedom from Distractibility (FFD) factor based on digit span, arithmetic and coding. Results were significantly more youth with ADHD had working memory deficits than controls (31.9% vs. 13.7%, $p < 0.05$). In ADHD children, working memory deficits were significantly (p no other differences were noted in other areas of functioning. Although working memory deficits also had some adverse impact on educational and cognitive correlates in non ADHD controls, these differences failed to attain statistical significance. Conclusion was that working memory deficits significantly and selectively increase the risk for academic deficits and cognitive dysfunction in children with ADHD beyond those conferred by ADHD. Screening for working memory deficits may help identify children with ADHD at high risk for academic and cognitive dysfunction.

Keywords: Attention Deficient Hyperkinetic Disorder; Working Memory.

Introduction

Attention-deficit/hyperactivity disorder (ADHD) is a prevalent, persistent, and impairing neurobiological disorder estimated to affect up to 7% of children and 5% of adults worldwide [1]. Among the most prominent ADHD-associated adverse outcomes are educational deficits, which include academic under-attainment, increased needs for academic support, and high rates of placement in special classes [2]. ADHD is one of the most prevalent childhood behavioral disorders, and estimates suggest that some where between 4.2% and 6.3% of children meet criteria for this disorder [3] with the boy to girl ratio ranging between 2:1 and 9:1. Children with ADHD often experience significant impairment in major areas of functioning including peer relations, family life, and school. Each of these areas of impairment may affect the media habits of children with ADHD [4].

The academic impairment associated with ADHD is no less insidious. Children with ADHD are more than twice as likely as children without the disorder to be in need of academic tutoring, to repeat a grade, to be placed in special education, and to be diagnosed with a reading disorder [5]. These academic difficulties suggest that, when at home, these children are less likely to engage in reading or homework. Nonetheless, ADHD is frequently associated with executive function deficits (EFDs) in general [6], and working memory (WM) deficits in particular, which are also associated with academic dysfunction (Alloway, Elliott, & Place, 2010; Barkley & Murphy, 2010). This raises questions as to whether academic problems in ADHD are due to ADHD, WM deficits or both [7].

The main aim of the present study was to assess the clinical correlates of working memory deficits in children with and without ADHD. In our study we included children with and without ADHD of

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both sexes. These children were comprehensively assessed in multiple, non-overlapping domains of functioning. Considering the critical importance of working memory for optimal functioning, we hypothesized that working memory deficits would be associated with impairments in multiple areas of functioning.

Material and Method

Hundred (100) children of both gender were selected for the study. 100 known case of ADHD and 100 control of same age were selected.

Psychiatric assessments relied on the Kiddie Schedule for Affective Disorders and Schizophrenia-Epidemiologic Version (K-SADS-E), (Orvaschel, 1994) conducted directly and individually with the mothers and the children. We used the Freedom from Distractibility (FFD) Factor from the WISC-R to assess working memory. The initial conceptualization of working memory in the revision of the Wechsler Intelligence Scale for Children–Revised was termed the Freedom From Distractibility (FFD) Factor and it was devised from a factor analysis of the Arithmetic, Digit Span, and Coding subtests of the Wechsler scale (Kaufman, 1979). Although the coding subtest was removed in the third edition of the Wechsler Intelligence Scale for Children (Wechsler, 1991), the term FFD Index was kept until the advent of the fourth edition (Wechsler, 2003) where it was replaced with that of "Working Memory (WM) Index" defined the same way (Kranzler, 1997). However, the significant correlation of 0.72 between the Freedom From Distractibility Factor and the Working Memory Index of the WISCIV renders the use of FFD Factor scores an appropriate proxy for WM Index.

We classified participants as having WM deficits using the following rules: 1) participants with a full scale IQ of 120 or less if their Freedom from Distractibility (FFD) score was 1 SD (15 points) lower than their full scale IQ. This method is based on the work of Biederman et al. (2004) indicating that individuals with scores in executive functioning 1 SD below the norm is indicative of poor academic outcomes; or 2) any participant with a FFD of ≤ 85. Based on the Wechsler Scales, a score of 85 is considered 1 SD below average falling at the 16th percentile; or 3) any participant with full IQ ≥ 120 with a FFD 1.5 SDs (22.5 points) below their full IQ. The predicted score method (vs. simple discrepancy) was employed so that individuals with high IQs would not be under-identified as not having working memory deficits. This method is often used in the identification of learning disability in high IQ individuals. We chose the FFD subscale because it has been considered by others to be a useful measure of WM (Bowden, Petrauskas, Bardenhagen, Meade, & Simpson, 2013). Statistical Analysis Because significant differences in cognition between children with ADHD and Controls have been well documented (Castellanos, Sonuga-Barke, Milham, & Tannock, 2006), our analytic approach focused on pairwise comparisons within the ADHD and Control groups stratified by the presence or absence of WM deficits. For continuous variables, pairwise ttests were conducted. For categorical variables a chi-squared test was carried out; if the number of participants in any group was below 10 we used Fisher's exact test. All analyses were conducted using the R programming language (R Core Team, 2014). All tests were two tailed. Due to the many comparisons conducted, the alpha level was set at 1%.

Result

There were no significant within group pairwise comparisons for age, sex, SES, or intactness of the family. There was a significant difference between the two ADHD groups in mean number of symptoms of ADHD ($p = 0.008$). However, the observed effect size, though statistically significant, was small with the ADHD+WM group having on average 0.7 more symptoms. There were no meaningful differences between the two groups in the mean duration and age of onset of ADHD. Likewise, there were no meaningful differences between ADHD children with and without WM deficits in number of CBCL Total Problems, social functioning (SAICA) or GAF scores. There was however, a significant difference in the CBCL school competence score between the two ADHD groups with and without WM deficits. The rate of WM deficits was significantly higher in children with ADHD compared to controls (32% vs. 14%, $p < 0.001$). Within group comparisons were made between ADHD children with (ADHD+WM Deficits: N=88) and without (ADHD: N=188) WM deficits and Controls with (Controls+WM Deficits: N=33) and without (Controls: N=208) WM Deficits.

Cognitive Outcomes WISC-R subtest scores for Arithmetic, Digit Span, and Digit Symbol were significantly worse in both ADHD and Control participants with WM deficits than in those without WM deficits, as was expected based on the definition of WM . Likewise, composite scores for both the ADHD and Control groups were significantly worse for those with WM deficits for WISC-R FFD and WRAT Arithmetic, but WRAT Reading was more impaired in ADHD+WM children only. School Outcomes As shown in the rates of grade retention and placement in special classes were significantly more prevalent in children with ADHD with WM deficits than in those without WM deficits. Although the need for extra help was significantly higher in ADHD children with WM deficits than in those without, this difference did not reach threshold for statistical significance.

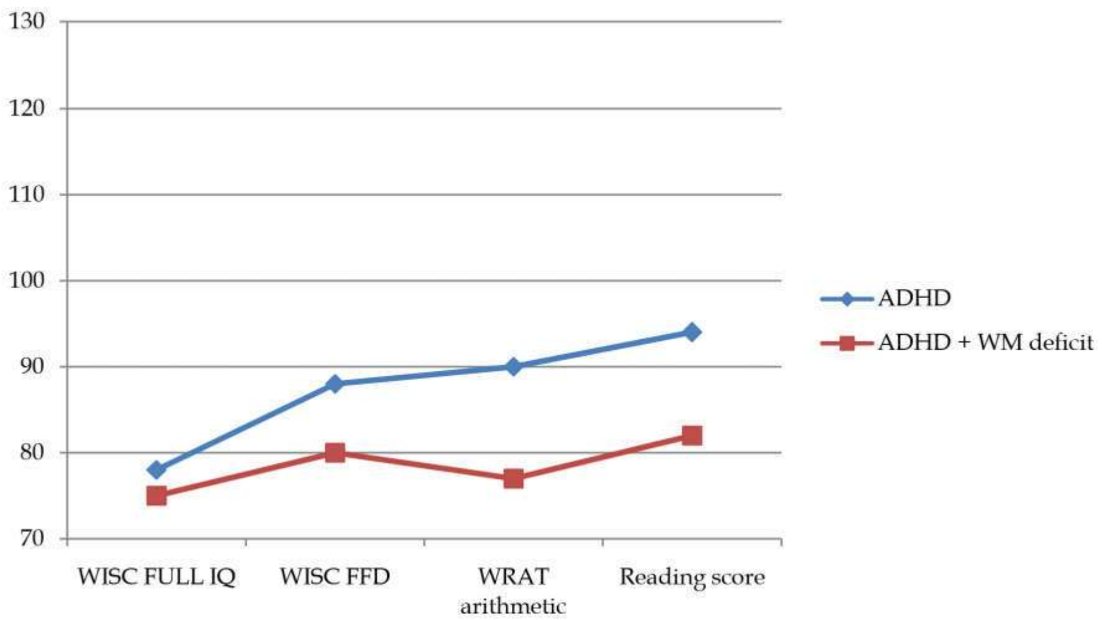

Fig. 1:

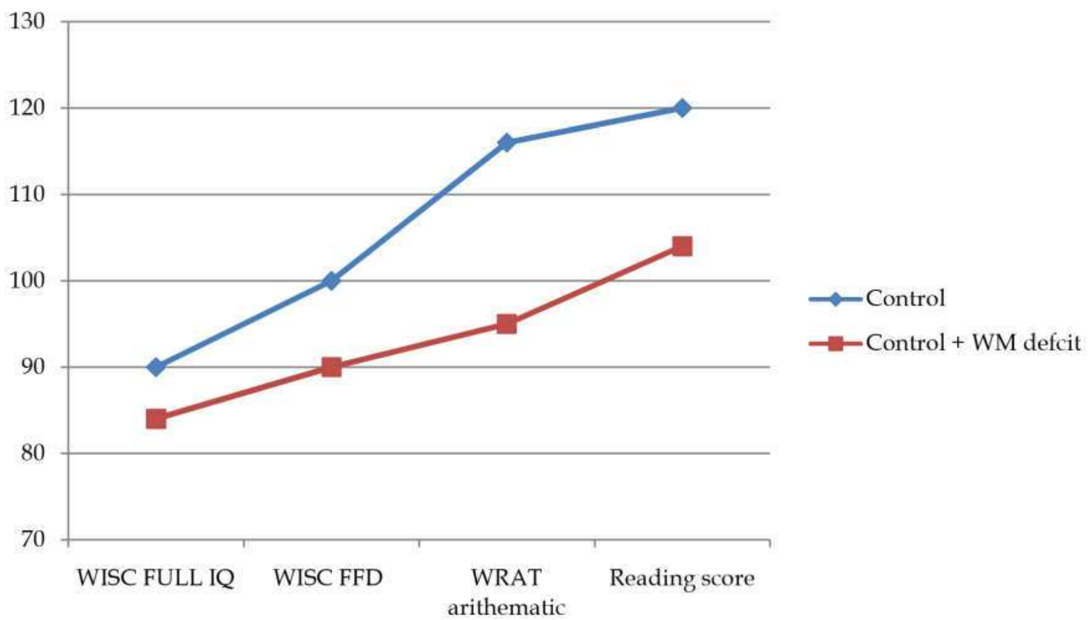

Fig. 2:

Discussion

From our study in children with and without ADHD randomly selected from pediatric and psychiatric sources, we observed that the presence of WM deficits in ADHD children significantly increased the risk for poor scholistic performance, placement in special classes and lower academic achievement in both reading and problems in calculations. Even with stringent statistical controls the results were significantly evident. These deficits could not be accounted for by differences in the clinical features of ADHD [8].

In non ADHD Controls the adverse findings related to education and cognition were found, with the exception of mathematic dysfunction, these findings did not succeed to reach our a priori threshold for statistical significance. These results differed from findings reported by Etchepareborda and Abad-Mas (Etchepareborda & Abad-Mas, 2005) in a non ADHD sample, showing that impaired WM had a negative impact on influenced academic learning processes [9].

The cognitive and academic burdens associated with WM deficits in the have significant clinical conclusions. Clinically, the presence of WM deficits significantly affects the already compromised cognitive an scholistic performance of ADHD children beyond that due to ADHD itself [10]. As the presence of WM deficits can only be documented through cognitive testing, screening for such deficits can help identify a subgroup of ADHD children at very high risk for scholistic performance.

In our study relied on the Freedom From Distractibility Factor from the WISC-R to assess Working Memory, which is not considered a true measure of WM, this index has documented very high correlation with WM index in the WISC-III revision (Wechsler, 1991). Although to a lesser extent, WM deficits also had a adverse effect on educational, scholistic performance and cognitive correlates in non ADHD Controls [11,12,13]. Screening for WM deficits will aid in identifying children at high risk for scholistic performance.

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