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EXECUTIVE FUNCTIONING IN CHILDREN AND ADOLESCENTS WITH MAJOR DEPRESSIVE DISORDER

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Abstract

The present investigation examined neurocognitive functioning, focusing on executive functioning (EF), in 39 children and adolescents with Major Depressive Disorder (MDD) and 24 healthy control subjects all ages 8 to 17 years. The Wechsler Intelligence Scale for Children-Third Edition along with several measures of executive functioning including the Wisconsin Card Sorting Task, Trail Making Test, Controlled Oral Word Association Test, and the Stroop Color Word Test were administered. The neurocognitive profiles for the group of depressed children and adolescents were grossly intact as most scores on intellectual and EF measures fell within the average range and did not differ from the comparison group. Mental processing speed was decreased in the MDD versus normal control group and 27% of the depressed group performed below average on the Trail Making Test. This investigation provided a good base from which to compare future literature on EF in outpatients with early-onset MDD.

Keywords

Childhood depression; Neuropsychology; Executive functioning; Major depressive disorder; Neuropsychological impairment

INTRODUCTION

Major depressive disorder (MDD) is estimated to occur in up to 8.3% of children and adolescents (Burke, Burke, Rae, & Reiger, 1991). Among hospitalized populations the rates of MDD increase to 20% in children and 40% percent in adolescents. Early-onset of a mood disorder may also be the most critical and severe form of a mood disorder (Kessler, Avenevoli, & Merikangas, 2001). These children and adolescents are likely to have increased family problems, academic failure, substance abuse, truancy, and suicidal behavior (Kessler et al.). For some of these children and adolescents the disorder continues into adulthood, and the probability of recurrence is 40% by two years and 70% by five years (Rao et al., 1995; Wickramaratne, Weissman, Leaf, & Holford, 1989).

Despite the considerable research being conducted on the pathophysiology of this mental disorder, MDD frequently remains undetected and untreated in the child and adolescent

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population. Current neurobiological theories include dysfunction of neuroendocrine regulation and secretion processes as well as depletion of neurotransmitters such as serotonin. There is evidence of a strong genetic link in MDD (Wickramaratne & Weissman, 1998); although scientific research is far from isolating a specific genetic vulnerability to the disorder. Additionally, neuroimaging studies point to abnormalities in the left prefrontal and frontal cortices, portions of the temporal lobes, the amygdala, and the cingulate gyrus (Baxter, 1991; Drevets et al., 1992; George, Keller, & Post, 1993).

Clearly, there is considerable theoretical attention focused upon identification of potential biological markers for MDD; yet there has been less attention to possible neurocognitive correlates such as executive functioning (EF). EF is a term used to refer to a broad range of cognitive processes encompassed in the four domains of volition, planning, purposive action, and effective performance (Lezak, 1995). Given the neuroimaging findings of prefrontal and frontal cortex abnormalities, the area of EF stands out as a likely neurocognitive manifestation of these abnormalities. Further, individuals who suffer from clinical depression often complain of attention and concentration problems as well task initiation trouble, which are considered executive function traits. There is concern that a protracted, untreated childhood depression could consequently affect overall IQ performance as well.

In addition to these clinical symptoms and the neuroimaging findings pointing to EF, there may be a cognitive link between depression and executive functions. Specifically, Beck's cognitive model of depression describes the cyclical process of an individual's automatic negative thoughts leading to negative feelings and depressed behavior (Beck, Rush, Shaw, & Emery, 1979). This cognitive model of depression also describes the cognitive distortions (e.g., pessimism, catastrophizing, etc.) depressed individuals have, which are a major focus in the cognitive-behavioral treatment of depression. Recent research has suggested that the anterior cingulate regions of the brain may play a role in the selective attention and mood regulation that could predispose a person to cognitive distortions (Serra-Mestres & Ring, 2002). Therefore, examining EF in persons with MDD stems from neurobiological and cognitive models of depression, as well symptom presentation.

In the adult literature a number of studies provide evidence of executive dysfunction in depressed adults (Channon, 1996; Degl'Innocenti, Argen, & Backman, 1998; Dunkin et al., 2000; Elliott et al., 1996; Fossati, Amar, Raoux, Ergis, & Allilaire, 1999; Franke et al., 1993; M. M. Grant, Thase, & Sweeney, 2001; Henderson & Welch, 1988; Keilip et al., 2001; Merriam, Thase, Haas, Keshavan, & Sweeney, 1999; Oren & Boone, 1991; Robertson & Taylor, 1985; Silberman, Weingartner, & Post, 1983; Trichard et al., 1995). To date, though, no published research has directly investigated executive functioning in children and adolescents diagnosed with MDD. Examining the possible link between MDD and executive functioning can contribute to the understanding of neurocognitive complaints of children and adolescents with this disorder, as well as improve upon the neurobiological and cognitive models of depression.

The primary purpose of this study was to examine EF and possible relationships with symptom severity in a sample of children and adolescents with MDD.

The hypotheses are as follows; (a) Subjects in the MDD group will have lower Full Scale IQ scores using the Wechsler Intelligence Scale for Children, 3rd edition (WISC-III; Wechsler, 1997) than the control group; (b) Subjects in the MDD group will perform poorer on academic measures than the control group; and (c) Subjects in the MDD group will perform poorer on the specific measures of executive functioning than the control group.

METHOD

Participants

All subjects were selected from an ongoing (National Institutes of Mental Health [NIH-R01-MH39188-09], Graham J. Emslie, Principal Investigator) study of depression and sleep architecture in children and adolescents ages 8 to 17 years, who met *Diagnostic and Statistical Manual,* 4th edition (*DSM-IV*; American Psychiatric Association, 1994) criteria for symptomatic, nonpsychotic, MDD single or recurrent episode. The studies were conducted at the University of Texas Southwestern Medical Center at Dallas and Children's Medical Center (CMC). MDD diagnosis was made using a structured diagnostic independent interview of the child and parent(s), mood self-report measures, and a consensus diagnosis by experienced research clinicians. In addition, a cutoff score of 40 or higher was required on the Children's Depression Rating Scale – Revised (CDRS-R; Poznanski & Mokros, 1996) to be in the MDD group. Out of the 39 MDD subjects, 21 had comorbid diagnoses that are as follows: 8 subjects diagnosed with MDD and attention deficit/hyperactivity disorder (ADHD); 2 subjects diagnosed with MDD, ADHD, and dysthymia; 7 subjects diagnosed with MDD and dysthymia; 1 subject diagnosed with MDD and oppositional defiant disorder; and 3 subjects diagnosed with MDD and generalized anxiety disorder. All patients were medically healthy as determined by physical and neurological examination as well laboratory tests to rule out medical conditions that may present as MDD. In addition, all patients were unmedicated for a period greater than two weeks prior to beginning the study and all subjects had normal intelligence as clinically assessed. Participants in this study were recruited from the outpatient clinic at CMC in Dallas, Texas, as well as various community professionals such as school personnel, pediatricians, psychiatrists, and psychologists. Exclusionary criteria were as follows: Bipolar I or II disorder (lifetime), psychotic depression (lifetime), current use of antidepressant or psychotherapy services, significant previous or concurrent general medical illness, independent/intrinsic sleep disorder based on history and polysomnogram, alcohol or substance abuse (in last six months), anorexia or bulimia (lifetime), history of head injury or unconsciousness for over 5 minutes (lifetime), abnormal laboratory tests, and a history of learning disability (defined as academic performance that is two standard deviations below intellectual ability) and/or mental deficiency (i.e., IQs less than 70).

Twenty-four participants ages 9 to 17 were in the comparison group. There was no evidence of psychopathology (current/lifetime) or family history of psychopathology in first-degree relatives of this group. The previous stated exclusionary criteria applied for these individuals as well. For the normal control subjects, a monetary incentive was given to help recruit subjects. These subjects were recruited by staff members as well as from the community at large via radio advertisements and brochures.

Measures

Depression measure—The selected measure of depressive symptom severity was obtained during the initial evaluation.

Children's Depression Rating Scale-Revised (CDRS-R; Poznanski & Mokros, 1996): The CDRS-R is a 17-item clinician-rated instrument designed to provide an index of depression severity and a depressive symptom profile. The first 14 items are rated on the basis of an interview and the remaining items are evaluated using the child's nonverbal characteristics. Raw scores range from 0 to 113. A score of 40 is typically used as a cutoff for MDD and denotes depressive symptoms in the mild range. Scores of 50–65 depict moderate symptom severity and scores greater than 65 are considered evidence of severe depressive symptoms.

Intellectual measures

Wechsler Intelligence Scale for Children-Third Edition (WISC-III; Wechsler, 1991): The WISC-III is the most widely used instrument for assessing the intellectual ability of children and adolescents ages 6 through 16 years and 11 months. The 13 subtests are organized into two groups: the Verbal and Performance (perceptual-motor) tests. Performance on the various subtests yields three composite index scores, Verbal IQ, Performance IQ, and Full Scale IQ. All index scores have a mean of 100 and standard deviation of 15 (Wechsler, 1991).

Wechsler Adult Intelligence Scale-Third Edition (WAIS-III; Wechsler, 1997): The WAIS-III is also a measure of overall intellectual functioning and included in this study for those subjects age 17, as the WISC-III is only for ages 6 to 16 years and 11 months. The WAIS-III is similar to the WISC-III in construct and subtests. It yields a Full Scale IQ, Verbal IQ, Performance IQ, as well four factor scores that are the same as the WISC-III: Verbal Comprehension Index, Perceptual Organization Index, Working Memory Index (similar to Freedom from Distractibility Index), and Processing Speed Index. Psychometric properties are similar to the WISC-III and the WAIS-III is considered the gold standard of adult intellectual measures.

Achievement measure

Wide Range Achievement Test-Third Edition (WRAT-3; Wilkinson, 1993): The WRAT-3 is a three-part test used to assess the basic skills needed for reading, spelling, and arithmetic. This achievement test is administered to those ages 5 through 74 years and 11 months and has two forms (blue and tan). For this study the tan form was administered.

Executive functioning measures—Several measures of EF were included in the neuropsychological battery to address the range of abilities that encompass this cognitive domain. Additionally, using multiple measures of EF allows for a convergent pattern of results that will increase the validity and reliability of the conclusions drawn about EF as a whole. Intellectual and achievement tests were administered to rule out mental deficiency and/or learning disabilities.

Wisconsin Card Sorting Task (WCST; D. A. Grant & Berg, 1948): The WCST was designed to assess abstract reasoning and the ability to shift cognitive strategies to changing contingencies. It consists of four stimulus cards and 128 response cards that depict four different shapes (triangle, star, cross, or circle), colors (red, green, yellow, or blue), and numbers of figures (one, two, three, or four). With the four stimulus cards placed before the subject, he or she is instructed to match the response cards one at a time to one of the four stimulus cards, whichever one he or she thinks it matches. The subject is only given feedback as to the correct or incorrect nature of the response and is never told the sorting rule. Once the subject makes 10 consecutive correct matches, then the sorting principle changes without the subject's knowledge. The task proceeds in this manner until the three possible sorting categories (color, number, and shape) have been completed twice each (Heaton, Chelune, Talley, Kay, & Curtiss, 1993). The *T*-scores for the total number of perseverative responses, the number of completed categories, and the raw number of losses of set were examined in this investigation.

Controlled Oral Word Association Test (COWAT; Benton & Hamsher, 1976): The COWAT is a common measure used to assess the ability to verbally produce words restricted to a designated letter. For this task, the participant is asked to generate as many words as possible that begin with the letters "f," "a," and "s" during three separate trials lasting one minute. Several investigations have demonstrated tests of verbal fluency to relate to other tests that are considered to assess verbal initiation, organization, and planning, which are all part of

executive functioning. Additionally, frontal lesions generally result in reduced scores (Miceli, Caltagirone, Gainotti, Masullo, & Silveri, 1981; Perret, 1974). For this investigation, the *T*-scores for the total number of words produced and the raw number of losses of set were examined.

The Trail Making Test (TMT; Reitan & Wolfson, 1985): TMT was originally part of the Army Individual Test battery (1944) and is a two-part task involving a connect-the-dots procedure. On TMT part A, a set of numbers in small circles are scattered across one piece of paper. The subject is to connect the dots in sequence as quickly as possible. TMT part B is similar but includes letters as well as numbers. The subject is to connect the letters and numbers in order by alternating number then letter (e.g., 1, A, 2, B). This task requires sequencing, shifting of mental set, and planning. Normative data for ages 9 to 14 were obtained from Spreen and Gaddes (1969). For ages 15 to 17, normative data was used from Tombaugh, Kozak, and Rees (1996). The *T*-score for completion time on part B and the number of errors were examined in the investigation.

Stroop Color Word Test (SCWT; Stroop, 1935): The SCWT is a three-part task requiring the subject to read aloud as quickly as possible the words or colors printed on the protocol. Each task consists of 100 items to be read and has a 45-second time limit. The first part consists of the words “Red,” “Green,” and “Blue” repeated in random order on the page. The second page consists of a group of “x”s on each line that is printed in the colors red, green, or blue. The subject must name the color as quickly as possible until the time limit expires. The last task, which is the most difficult, has the words “Red,” “Green,” and “Blue” printed in different colors of ink that are incongruent with the actual word. The subject is asked to name the color of the ink and not the actual word that is printed. Any errors on the three trials are corrected immediately by the test administrator, and the person continues the task. The raw score of number of items are used to transfer into *T*-scores for each subtest. Then a mathematical calculation is used to determine the “interference score” that reflects the child’s ability to control for the interference of their language/reading ability in the last task. This last task and corresponding interference score are thought to reflect executive functioning abilities and this *T*-score was used for comparisons in this investigation.

Procedure

Prior to recruitment for the neuropsychological investigation, all possible subjects completed the initial procedures for the primary sleep study including a diagnostic interview, written informed consent by parent(s) and the patients, and a physical and neurological exam (for MDD subjects). Additionally, they slept two consecutive nights in the University of Texas Southwestern Medical Center (UTSW) Sleep Study Unit where electroencephalographic (EEG) readings were recorded. These initial procedures are identical to Armitage et al.’s (2000) procedures and can be referred to for further information.

Once subjects slept in the UTSW Sleep Study Unit, they were referred for an optional neuropsychological evaluation that initially took three to four hours. Parents of the depressed child or adolescent were contacted by telephone and given information regarding the neuropsychological evaluation. If they reported being interested in this testing, an appointment was made for the child or adolescent to come to the UTSW Child and Adolescent Psychiatry Research outpatient building and to participate in the assessment. All but two of the subjects with MDD completed this neuropsychological evaluation before they began psychotropic medication, and the two who did not complete the evaluation prior to beginning treatment had been on the antidepressant (fluoxetine) for one week or less.

Neuropsychological Assessment

All children and adolescents received the same core neuropsychological battery in one session. The evaluation did include some memory and motor tests that were not essential to this particular study. However, these tests were removed from the evaluation for the second half of the subjects in order to shorten the time required and to promote study participation. Testing breaks were given frequently and the subjects were instructed to ask for a break if needed. The testing was performed in one of two testing rooms at the CMC outpatient building or the UTSW Child and Adolescent Psychiatry Research Department assessment room. Both rooms were quiet and free from distractions. The testing apparatus was also the same for each subject.

Statistical Analyses

All data were entered into a database and analyzed using SPSS 11.0. The database was double checked for correct entry of scores. Multiple independent *t*-tests, one-way and two-way analysis of variance (ANOVA), one-way analysis of covariance (ANCOVA), and Pearson product moment correlations were conducted. When appropriate, the Bonferroni correction was used to prevent an increased likelihood of a Type I statistical error. Eta squared calculations were also computed for all independent *t*-tests.

RESULTS

Analysis of the Data

Forty subjects were in the MDD group and 25 comprised the normal control group. One subject in each group was excluded based on their intellectual functioning scores, which fell in the mentally deficient range. Ten subjects in the MDD group had a comorbid diagnosis of ADHD and were kept in this group as no significant differences were found between this subgroup and the remaining MDD subjects on all EF measures.

In the MDD group 51 % ($n = 20$) of the subjects were male. Seventy-one percent ($n = 31$) were Caucasian, 3% ($n = 1$) were African American, 5% ($n = 2$) were Hispanic, 5% ($n = 2$) were Asian, and 7% ($n = 3$) fell in the “Other” category. Ages ranged from 8 to 17 years ($M = 12.79$, $SD = 3.05$) and length of illness ranged from 3 to 86 months ($M = 15.22$, $SD = 19.65$).

In the normal control group 46% ($n = 11$) were male. Sixty-six percent ($n = 16$) were Caucasian, 30% ($n = 7$) were African American, and 4% ($n = 1$) were Hispanic. Ages ranged from 9 to 17 years ($M = 13.08$, $SD = 2.77$).

Table 1 summarizes the demographic variables for the MDD and control groups. No significant differences were observed for age or Full Scale IQ. However, there was a significant difference between groups for race, $\chi^2(4, N = 63) = 11.71$, $p = .02$. Specifically, there were more African Americans in the comparison group than the MDD group.

Preliminary Analyses for Potential Covariates with EF

Race was further examined as a possible confound in the normal control group, since statistical analyses revealed the group to have significantly more African Americans than the MDD group. The normal control group was subdivided into Caucasian and non-Caucasian groups for analyses. Multiple independent *t*-tests for all of the dependent variables were conducted to determine the possible differences based on race. Results indicated no differences on measures of EF or CDRS-R scores.

Length of illness was also examined in relation to performance on the measures of EF. Pearson *r* correlations were calculated for length of illness and each dependent variable. Results

indicated that there were no significant relationships between the length of the depressive illness and scores on EF measures.

Hypothesis 1—Independent *t*-tests were used to examine the intellectual performance for the two groups. Table 2 summarizes the results. There were no significant differences revealed for the FSIQ scores between the two groups. A significant difference was revealed between groups for the processing speed index (PSI) score on intellectual testing, $t(53) = -2.12$, $p = .038$, indicating that those in the MDD group had decreased PSI compared to the normal control subjects. Looking at the subtests of the intellectual testing, no significant differences were observed.

Hypothesis 2—Independent *t*-tests were also conducted to examine the academic performance of each group. No significant differences were found for the mean reading, spelling, and arithmetic scaled scores or corresponding grade equivalencies, which were all within the average range.

Hypothesis 3—Subjects with MDD were hypothesized to perform poorer on the measures of EF than normal control subjects. Independent *t*-tests were used to examine the performance for the two groups. No significant differences were found between the MDD and normal control group on any of the measures of EF (see Table 3).

Although there were no differences between groups on these measures, some of the specifics regarding the performance on the TMT part B and the COWAT are worth noting. On the TMT part B, 8 of the MDD subjects (27%) performed below average (based on T-scores below 40) in terms of completion time with 2 subject's performance falling in the mildly impaired range (*T*-score 35–39), 1 in the mildly to moderately impaired range (*T*-score 30–34), 3 in the moderately impaired range (*T*-score 25–29), 1 in the moderately to severely impaired range (*T*-score 20–24), and 1 in the severely impaired range (*T*-score < 20). In contrast, only 3 (14%) of the normal control subjects fell below the average range on this task. One subject performed in the mildly to moderately impaired range (*T*-score 30–34), 1 in the moderately impaired range (*T*-score 25–29), and 1 in the severely impaired range (*T*-score < 20). However, a percentage of subjects in both groups performed well above average on this task creating a wide range of scores with large standard deviations. Thus, no statistical difference was observed between groups on this task. Likewise, errors on the TMT part B ranged from 0 to 1 and did not differ significantly between the two groups.

On the COWAT, almost a third of the subjects in each group performed below average with the total number of words produced. Based on *T*-scores, performance on this task ranged from severely impaired to well above average in the MDD group, and from the moderately to severely impaired range to well above average in the normal control group.

Secondary Analyses

A small subset of the MDD group ($n = 10$) also had a comorbid diagnosis of ADHD. Comparisons of the means of all the EF measures and the CDRS-R scores for those with MDD and ADHD, MDD without ADHD, and the normal controls were performed using multiple one-way ANOVAs (see Table 4). No significant results were found across the three groups for the measures of EF.

DISCUSSION

The first hypothesis regarding intellectual scores on the WISC-III was not supported.

This group of children and adolescents with MDD demonstrated grossly intact neurocognitive functioning with few significant differences on any of the intellectual tasks compared to the normal control group. Mean FSIQ scores fell in the average range for both groups as did all of the factor and subtest scores. Statistical analyses revealed that the PSI score was significantly lower in the MDD group than the comparison group. The subtests that comprise PSI are Coding and Symbol Search. The decreased mental processing speed in the MDD group could be attributed to psychomotor retardation, which is a symptom of MDD. Both subtests are written and scored for speed and accuracy that can be negatively affected by psychomotor retardation. It is unlikely that poor attention and concentration contributed to slowed task performance given that there was no significant difference between groups on the FDI score, which requires simple attention demands. Thus, speed of mental processing and subsequent motor response may be negatively affected in children and adolescents with MDD.

It is unclear if decreased PSI in children and adolescents with MDD is a consistent finding in the literature since no research has clearly focused on this index score in the MDD population. Further, it should be noted that although the PSI was significantly lower in the MDD group than the normal controls, the mean PSI for the MDD group fell within the average range. Therefore, this sample of MDD subjects was not seriously impaired on this neurocognitive domain but may have suffered a relative weakness in this ability due to their MDD symptoms. Finally, this motor processing speed aspect in MDD could be further analyzed in future research by including more rudimentary motor tests to further illuminate this finding.

The second hypothesis was not supported, as academic functioning was similar between the subjects with MDD versus normal controls. This finding, though, contrasts the decline in school performance, which is often a symptom of childhood depression. It is likely that poor concentration and attention lead to poor school performance, but the basic academic skills are intact. Yet, in a chronic episode of MDD, the overall academic skills may be negatively affected with a compounding effect of concentration difficulties linked to poorer learning.

Hypothesis three was generally not supported. The subjects in the MDD group did not perform significantly worse on measures of EF; although some qualitative differences were observed on TMT part B and the COWAT. Subsequent power analyses revealed that 4,000 to 43,000 subjects would have been needed for adequate power to detect a difference between groups. These results are largely in contrast to the existing literature in adults with MDD as assessed by a variety of EF tests (Austin et al., 1992; Degl' Innocenti et al., 1998; Elliot et al., 1996; Franke et al., 1993; Henderson & Welch, 1988; Merriam et al., 1999; Robertson & Taylor, 1985; Trichard et al., 1995). However, these studies included inpatients or outpatients with psychotic/bipolar types of MDD, which likely depict a more severe depressive episode. Thus, less severe episodes of MDD in general may not be associated with EF deficits as assessed by these measures. This point is a positive clinical finding, in that children with MDD may not have neurocognitive impairment in this domain.

Looking at the subgroup of MDD subjects with a comorbid diagnosis of ADHD, it is interesting to note that secondary power analyses revealed that this subgroup may have performed significantly worse on the WCST and TMT part B than the subjects with MDD without ADHD. Subsequent power analyses revealed that a slightly larger sample size could have detected a difference between the two clinical subgroups (MDD without ADHD and MDD with ADHD) for the WSCT and TMT part B *T*-scores. At 80% power with $p = .05$, 36 and 31 subjects, respectively, would have been required. Looking at the means, those with a comorbid diagnosis of ADHD performed worse on these tests compared to those with MDD without ADHD.

Conclusions

The neurocognitive profiles were grossly intact for this sample of children and adolescents with MDD compared to a group of healthy controls. No significant differences were observed for academic performance or measures of EF. However, a significant difference was found between groups for PSI on the WISC-III. Thus, this group of MDD subjects had a motor processing speed deficit compared to normal controls.

It is difficult to compare these findings to the literature since the majority is based on adult populations and the results vary greatly across studies, which is likely due to differences in methodology. However, there does appear to be a trend towards impairment in EF that the findings of the current investigation do not support. Yet, much of the literature was based on inpatient populations that likely have more severe forms of depression.

It should also be noted that EF in a multidimensional domain and true EF deficits may still exist in this group with moderate MDD; however, it may be that these deficits currently elude our ability to reliably detect them in an artificial laboratory setting. Support for this notion includes reports of the subjects in the MDD group who complained of difficulties attending and concentrating in school and dropping school performance. Assessment data clearly demonstrate that as a group none of the subjects with MDD would be expected to have significant school performance problems. However, as mentioned, the reliability of the EF measures to depict functioning outside of a controlled laboratory may be poor in children and adolescents with moderate MDD.

This investigation and its findings contribute to the literature in that no published studies exist specifically focusing on the EF in children and adolescents with MDD. In addition, the sample size is larger than those in most of the literature found on EF in the adult MDD literature. The normal control and MDD groups were generally equal in terms of gender and the normal control group was more diverse in terms of race than is typically the case in the literature. Although few significant differences were found in this investigation, it provides a good base from which to further examine EF in outpatient children and adolescents with MDD.

Limitations

EF is a broad and heterogeneous neurocognitive domain, making it difficult to assess. Current EF measures may not be sensitive enough to fully evaluate this neurocognitive area. It may also be the case that these neuropsychological measures do not have good ecological validity. For instance, children and adolescents with MDD may be able to perform well on these tests but still have difficulty with problem solving, planning, initiation, etc. in his or her daily life where multiple demands may be placed upon them.

Implications for Future Research

Although this study found few significant differences on measures of EF for MDD and normal control groups, this topic warrants further investigation. Future research could focus on developing new and more sensitive measures to assess EF. Further, measures of adaptive functioning could be administered in conjunction with the neuropsychological evaluation to gain a more accurate picture of the subject's difficulties. Finally, these subjects could be retested after their MDD episodes remit to further assess their neurocognitive functioning and determine if they had in fact suffered from relative declines in EF.

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Table 1

Demographic Comparison of Study Groups.

	MDD Subjects Mean ± *SD* Or Numbers	NC Subjects Mean ± *SD* Or Numbers	Statistics	Eta Squared (η^2)*
Number of Subjects	39	24		
Mean Age	12.79 ± 3.05	13.08 ± 2.77	$t(61) = -0.37$, $p = .707$	.00
Age Range	8–17	9–17		
Gender	20M, 19F	11M, 14F	$\chi^2 = 0.17$, $p = .674$	
Ethnicity	31W, 1B, 2H, 2A, 3O	17W, 7B, 1H	$\chi^2 = 11.71$, $p = .02$	
Full Scale IQ	105.29 ± 14.28	107.52 ± 13.12	$t(56) = -0.60$, $p = .55$	.01
CDRS- *R* Scores	58.44 ± 10.11	18.75 ± 1.91	$t(61) = 18.96$, $p = .00$	.85
Length of Illness (months)	15.22 ± 19.65	–		
Length of Illness Range	3–86	–		

* $\eta^2 = .01$: small effect; $\eta^2 = .06$: medium effect; $\eta^2 = .14$: large effect.

W = Caucasian; B = African American; H = Hispanic; A = Asian; O = Other.

Table 2

Comparison of IQ's and Index Scores Between MDD and Normal Control Groups.

	MDD Subjects Mean ± *SD* (n = 39)	NC Subjects Mean ± *SD* (n = 24)	Statistics	Eta Squared (η^2)**
Full Scale IQ (FSIQ)	105.29 ± 14.28	107.52 ±13.12	$t(56) = -0.60$, $p = .55$	.01
VIQ	106.31 ± 15.25	108.00 ± 12.99	$t(56) = -0.43$, $p = .665$	.00
PIQ	103.29 ± 13.99	106.13 ± 13.01	$t(56) = -0.77$, $p = .433$	.01
VCI	106.91 ± 14.72	108.09 ± 13.87	$t(56) = -0.30$, $p = .763$	.00
POI	104.43 ± 13.29	105.57 ± 13.61	$t(56) = -0.31$, $p = .753$	.00
FDI	105.13 ± 16.40	108.96 ± 15.59	$t(53) = -0.87$, $p = .387$	.01
PSI	101.38 ± 13.80	108.91 ± 11.72	$t(53) = -2.12$, $p = .038$*	.08

* significant at the .05 level (two-tailed).

** η^2 = .01: small effect; η^2 = .06: medium effect; η^2 = .14: large effect.

VIQ; Verbal IQ; PIQ: Performance IQ; VCI: Verbal Comprehension Index, POI: Perceptual Organization Index, FDI: Freedom from Distractibility Index, PSI: Processing Speed Index.

Table 3

Comparison of Executive Functioning Scores Between MDD and Normal Control Groups.

	MDD Subjects Mean ± *SD* (*n* = 39)	NC Subjects Mean ± *SD* (n = 24)	Statistics	Eta Squared (η^2)*
FDI	105.13 ± 16.41	109.18 ± 15.92	$t(53) = -0.90$, $p = .370$	.01
WCST Persv. Errors *T* -scores	55.63 ± 7.26	55.14 ± 10.03	$t(52) = 0.20$, $p = .836$	.00
WCST categories	5.88 ± 0.42	5.73 ± 0.93	$t(52) = 0.78$, $p = .435$	.01
WCST LOS	0.63 ± 0.79	0.59 ± 0.73	$t(52) = 0.16$, $p = .874$	.00
TMT B Completion Time; *T*-score	47.80 ± 14.01	50.42 ± 11.79	$t(52) = -0.73$, $p = .468$	.01
TMT B errors	0.43 ± 0.72	0.25 ± 0.73	$t(52) = 0.91$, $p = .365$	.01
COWAT Total *T*-score	43.06 ±11.71	42.75 ± 11.04	$t(53) = 0.10$, $p = .920$	.00
COWAT LOS	0.48 ± 1.23	0.46 ± 0.83	$t(53) = 0.08$, $p = .931$	.00
SCWT Interference *T*-score	51.87 ± 6.90	53.14 ± 9.09	$t(49) = -0.57$, $p = .571$	.00

* $\eta^2 = .01$: small effect: $\eta^2 = .06$: medium effect; $\eta^2 = .14$: large effect. All nonsignificant.

Table 4

Comparisons of EF and CDRS-R Scores for the MDD, MDD and ADHD, and Normal Control Groups.

	MDD w/o ADHD Subjects Mean ± *SD*	MDD/ADHD Subjects Mean ± *SD*	NC Subjects Mean ± *SD*	Statistics	Significance	Eta Squared(η^2)*
FD	104.96 ± 17.69	105.63 ± 12.75	108.96 ± 15.59	$F(2, 52) = 0.37$	$p = .687$	.14
WCST *T*-Scores	56.75 ± 7.32	52.25 ± 6.29	55.14 ± 10.03	$F(2, 51) = 0.87$	$p = .423$	.04
WCST # cat	5.96 ± 0.20	5.63 ± 0.74	5.73 ± 0.93	$F(2, 51) = 1.04$	$p = .359$	.03
WCST Los	0.54 ± 0.78	0.88 ± 0.84	0.59 ± 0.734	$F(2, 51) = 0.57$	$p = .565$	.02
TMT part B *T*-scores	50.35 ± 11.85	39.43 ± 18.09	50.42 ± 11.79	$F(2, 51) = 2.25$	$p = .115$	.08
TMT part B #errors	0.35 ±0.71	0.71 ± 0.75	0.25 ± 0.73	$F(2, 51) = 1.09$	$p = .341$	.41
COWAT *T*-scores	42.27 ± 11.36	45.00 ± 13.02	42.75 ± 11.04	$F(2, 52) = 0.18$	$P = .832$	.00
COWAT Los	0.45 ± 1.30	0.56 ± 1.13	0.46 ± 0.83	$F(2, 52) = 0.03$	$p = .969$	.00
SCWT *T*-scores	52.43 ± 6.77	50.00 ± 7.57	53.14 ± 9.09	$F(2, 48) = 0.41$	$p = .663$	.02

*η^2 = .01: small effect; η^2 = .06: medium effect; η^2 = .14: large effect.

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