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Does Executive Functioning (EF) Predict Depression in Clinic-Referred Adults?: EF Tests vs. Rating Scales

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Abstract

Background—Deficits in executive functioning (EF) are implicated in neurobiological and cognitive-processing theories of depression. EF deficits are also associated with Attention-deficit/hyperactivity disorder (ADHD) in adults, who are also at increased risk for depressive disorders. Given debate about the ecological validity of laboratory measures of EF, we investigated the relationship between depression diagnoses and symptoms and EF as measured by both rating scales and tests in a sample of adults referred for evaluation of adult ADHD.

Method—Data from two groups of adults recruited from an ADHD specialty clinic were analyzed together: Adults diagnosed with ADHD (N=146) and a clinical control group of adults referred for adult ADHD assessment but not diagnosed with the disorder ADHD (N=97). EF was assessed using a rating scale of EF deficits in daily life and a battery of tests tapping various EF constructs. Depression was assessed using current and lifetime SCID diagnoses (major depression, dysthymia) and self-report symptom ratings.

Results—EF as assessed via rating scale predicted depression across measures even when controlling for current anxiety and impairment. Self-Management to Time and Self-Organization and Problem-Solving showed the most robust relationships. EF tests were weakly and inconsistently related to depression measures.

Limitations—Prospective studies are needed to rigorously evaluate EF problems as true risk factors for depressive onset.

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Conflict of Interest
Dr. Barkley receives income from Eli Lilly as a speaker and consultant, from Theravance as a consultant, and from Guilford Publications. Dr. Knouse and Dr. Murphy have no conflicts of interest to report.

Contributors
Drs. Barkley and Murphy designed the study, wrote the protocol, and collected the data. Drs. Knouse and Barkley conducted the literature searches, analyses, and wrote the first drafts of the manuscript. All authors contributed to and have approved the final manuscript.

Conclusions—EF problems in everyday life were important predictors of depression. Researchers and clinicians should consistently assess for the ADHD-depression comorbidity. Clinicians should consider incorporating strategies to address EF deficits when treating people with depression.

Keywords

executive functioning; depressive disorders; attention-deficit/hyperactivity disorder; ADHD; neuropsychological tests; rating scales

Definitions of executive functioning (EF) emphasize self-regulatory processes operating over time to help people attain their goals (Barkley, 2012). EF deficits are implicated in many psychological disorders, including both Attention-Deficit/Hyperactivity Disorder (ADHD) and depression. The goal of the current study was to evaluate the extent to which EF as measured by two different methods—tests and rating scales—predicts depressive diagnoses and symptoms in a sample of adults referred for ADHD evaluation.

Major depressive disorder is associated with EF deficits linked to pathophysiology of the prefrontal cortex (Clark et al., 2005; Elliott, 1998; McClintock et al., 2010; Paelecke-Habermann et al., 2005; Siegle et al., 2007; Taylor Tavares et al., 2007). Theoretical formulations posit that alterations in the structure and function of PFC are associated with executive dysfunction and dysregulated emotional processing (Mayberg et al., 1999; Siegle et al., 2007). The EF-depression relationship may be bi-directional—EF deficits may be a risk factor for depression and worsening EF may accompany depressive onset. Ingram et al. (2008) concluded that impaired ability to shift attention away from negative emotional content might increase depressive risk and that interference resulting from this content might further tax inhibitory processing. Individuals with reduced executive capacity, then, may be more vulnerable experiencing dysphoric states that progress to depressive disorder, consistent with current models of depressive relapse (Segal et al., 2002). From a treatment perspective, the mechanism of action of cognitive therapy for depression may be the re-activation of executive cognitive control processes (Beck, 2008). Although prior studies support an EF-depression link, results are far from consistent (McClintock et al., 2010) and primarily rely on laboratory measurement of EF.

Studies consistently document increased risk for depressive disorders in adults with ADHD (Barkley et al., 2008; Kessler et al., 2006; Miller et al., 2007; Secnik et al., 2005). EF deficits are one plausible explanation for this elevated risk. ADHD is a valid developmental disorder that often persists into adulthood (Barkley et al., 2008) and comprises two dimensions of age-inappropriate behavior: inattention and poor inhibition (American Psychiatric Association, 2000). It is also associated with deficits in EF (Barkley and Murphy, 2011), particularly on measures of response inhibition and working memory (Boonstra et al., 2005; Hervey et al., 2004) similar to the considerably larger literature on child ADHD (Frazier et al., 2004; Willcutt et al., 2005). However, when measuring EF using laboratory tests at the individual level just a minority (35 - 50%) of those with ADHD show clinically significant deficits (Biederman et al., 2006; Willcutt et al., 2005), leading some investigators to conclude that ADHD is *not* a disorder of EF (Boonstra et al., 2005; Jonsdottir et al., 2006; Marchetta et al., 2008).

Others, however, have challenged EF tests as the gold standard for assessing EF deficits (Barkley, 2011, 2012; Barkley and Fischer, 2011; Barkley and Murphy, 2011; Barkley and Murphy, 2010). Laboratory tests primarily tap “cold” cognitive processes across small ascertainment periods and thus do not assess emotionally contextualized difficulties or the cross-temporal organization of actions toward socially important goals that may be more

relevant to challenges encountered in everyday life (Barkley, 2012; Castellanos et al., 2006). Indeed, EF tests have very low or no ecological validity in adult patients with frontal lobe injuries, correlating poorly with ratings of EF in daily life activities, direct observations of EF performance, and adaptive functioning in natural settings (Burgess et al., 1998; Chaytor et al., 2006; Wood and Liossi, 2006). In contrast, moderate relationships are found between EF ratings and adaptive functioning in children with traumatic brain injuries (Gilotty et al., 2002; Mangeot et al., 2002) and with overall impairment rating and occupational functioning in adults with ADHD (Barkley and Murphy, 2011; Barkley and Murphy, 2010). In the current study, we employed both a rating scale of EF deficits in daily life and a battery of laboratory tests evaluating most of the major constructs believed to represent EF.

Given the evidence for executive dysfunction as a key component of ADHD and the heightened risk for depression linked to the disorder, adults referred for an evaluation of ADHD are an ideal subgroup in which to investigate connections between EF and depression. This is, to our knowledge, the first study to assess the relationship of both an EF rating scale and laboratory tests to depressive diagnoses and symptomatology. The aims of the project were to: (1) evaluate the association of EF deficits with current or past depressive disorders and current symptoms in patients referred for an evaluation of ADHD; (2) examine these relationships after removing variance associated with possible confounds (anxiety and impairment); and (3) compare the utility of EF ratings versus tests in evaluating an EF-depression link.

Method

Participants

Detailed description study methods appears in Barkley et al. (2008). The current study is an analysis of those data not previously published. Data from two groups of adults referred to an ADHD outpatient clinic were analyzed: 146 adults diagnosed with ADHD and 97 Clinical controls who did not receive an ADHD diagnosis. ADHD group participants had to meet DSM-IV criteria, excepting the age of onset criterion, as judged by an experienced clinical psychologist using a structured interview for ADHD. All had symptom onset prior to age 21. Nearly 45% of the Clinical control group initially reported enough symptoms to meet DSM-IV criteria but these were not convincingly corroborated via the diagnostic interview. Primary clinical diagnoses assigned to the Clinical control group were: 43% any anxiety disorders, 15% any drug use disorders, 12% any mood disorders, 4% any learning disorders, 4% any partner relationship problems, 4% adjustment disorders, 1% personality disorders, 1% ODD, and 17% no diagnosis.

These groups were collapsed together for the analyses. The mean age of the entire sample was 34.43 years (SD = 12.11) and mean education was 15.05 years (SD = 2.68). The group had a mean Hollingshead job index of 44.38 (SD = 29.63). The mean IQ was in the average range (107.81; SD = 8.96). 63% of the group was male and 94% of the group self-identified as White.

Measures

Structured Clinical Interview for ADHD (Barkley and Murphy, 2006)—This structured interview was created for research investigating ADHD in adults (Barkley et al., 2002; Barkley et al., 2001; Murphy and Barkley, 1996). Inter-judge agreement on DSM-IV ADHD criterai for 11% of audiotaped interviews was 85.3% (Kappa=.712, Approx. T^b=4.76, p<.001).

Adult ADHD Symptoms Scale (Barkley and Murphy, 2006)—Participants completed a rating scale containing the ADHD items from DSM-IV. Each item was answered on a 4-point scale (0-3; Not At All, Sometimes, Often, and Very Often). The scale also asked respondents used the same scale to rate the degree to which endorsed ADHD symptoms produced impairment in 10 domains: home life, work, social interactions, community activities, educational activities, dating or marriage, money management, driving, leisure activities, and handling daily responsibilities. A sum across domains served as the impairment index.

Deficits in Executive Functioning Scale (Barkley and Murphy, 2010)—This 91-item scale evaluates five dimensions of EF deficits in daily life: Self-Management to Time, Self-Organization and Problem-Solving, Self-Discipline or restraint, Self-Motivation, and Self-Activation/Concentration. The response scale is identical to the ADHD Symptoms Scale. Internal consistency was $\alpha = .99$ with similarly high internal consistency reported by others (Biederman et al., 2008; Fedele et al., 2010). Subscales are significantly inter-correlated (.74 to .88), which may indicate a single underlying meta-construct. A recent study (Barkley, 2011) using a slightly revised version of this scale obtained test-retest reliability of .84.

Structured Clinical Interview for DSM-IV Disorders (SCID; (Spitzer et al., 1995)—The SCID covers the diagnostic criteria for several DSM-IV disorders. Current and lifetime major depression and dysthymia diagnoses were examined in this study. Administration procedures followed those set forth in the manual associated with these interviews (Spitzer et al., 1995).

Symptom Checklist 90 - Revised (Derogatis, 1986)—This self-report rating scale assesses symptom severity across nine dimensions of psychopathology. T-scores for depression served as a criterion and T-scores for anxiety were examined as a possible confound.

Shipley Institute of Living Scale (Shipley, 1946)—This short paper-and-pencil test with 40 vocabulary items and 20 abstract thinking items served as a measure of IQ. The composite IQ score correlates well with other measures of intelligence (Zachary, 1988).

Executive Function Test Battery. Five—EF tests were chosen to represent major EF components frequently cited in the literature. Each test is described in more detail in Barkley et al. (2008) and in the reference accompanying each test. Response inhibition was indexed via commission errors and reaction time from the **Conners' Continuous Performance Test** (Conners, 1995), while sustained attention was represented by omission errors and the reaction time variability index (Egeland and Kovalik-Gran, 2010; Murphy et al., 2002). Response inhibition and interference control was measured using percentile scores from the interference condition of the **Stroop Color Word Test** (Stroop, 1935) using the version and norms published by Trenerry et al. (1989). The **Wisconsin Card Sort Test** (WCST; Heaton (1981)) was used to measure problem-solving and set shifting via percent errors, percent perseverative errors, percent concepts, and categories achieved. Non-verbal working memory and fluency was measured using the number of unique designs generated on the **Five-Points Test of Design Fluency**(Lee et al., 1997; Regard et al., 1982). Verbal working memory was indexed using the total forward and backward score on the **Digit Span Task** from the **Learning and Memory Battery** (LAMB; (Schmidt and Tombaugh, 1995).

Results

Plan of Analysis

SCID major depression and dysthymia diagnoses were analyzed together as a single category. This resulted in 31% of the ADHD group and 26% of the Clinical group having current depressive disorder and 47% of the ADHD group and 42% of the Clinical group having a lifetime diagnosis. The two groups did not differ significantly in these occurrences (current $X^2 = 0.72$, p = NS; lifetime $X^2 = 0.59$, p = NS). The ADHD group (M = 69.5, SD = 9.1) had higher ratings of current depressive symptoms on the SCL-90 than the Clinical group (M = 65.5, SD = 10.3), $F(1, 233) = 9.57$, $p = .002$. For all subsequent analyses, ADHD and Clinical control groups were collapsed together.

We examined the extent to which EF ratings on the DEFS subscales predicted current and lifetime depression on the SCID using binary logistic regression (Table 1) and examined relationships with SCL-90-R symptom severity using multiple regression (Table 2). EF predictors were entered using forward conditional stepwise entry (criterion = .05). For analyses yielding significant predictors, we then examined whether anxiety and functional impairment could account for observed EF-depression relationships. Anxiety was highly correlated with both ratings of depression and EF in these samples and EF may serve as a proxy for degree of impairment. Analyses were repeated separately with current SCL-90-R anxiety symptoms and then current ADHD-related impairment (ADHD symptoms scale impairment index) forced in at Step 1, producing a rigorous test of the EF-depression relationship.

Relationship of EF Measures to Current Diagnosis of Depression

In Table 1, when all DEFS subscales were used to predict current depressive diagnosis, only Self-Management to Time was significant. Anxiety entered at Step 1 was significantly related to current depression (*Beta* = .042, *SE* = .016, *Wald* = 6.95, $p = .008$, *OR* = 1.04, *95% CI* = 1.01-1.08); however, it was no longer significant when the Self-Management to Time subscale entered as a significant predictor. Current impairment entered at Step 1 was initially significant (*Beta* = .085, *SE* = .031, *Wald* = 7.47, $p = .006$, *OR* = 1.09, *95% CI* = 1.02-1.16); however, it was no longer significant when the Self-Motivation scale entered and made a significant contribution. None of the EF tests were significant predictors of current depression.

Relationship of EF Measures to Lifetime Diagnosis of Depression

In the lower half of Table 1, two DEFS subscales were significant predictors of lifetime depression—Self-Management to Time and Self-Organization and Problem-Solving. Anxiety entered at Step 1 was significantly related to lifetime depression (*Beta* = .045, *SE* = .015, *Wald* = 9.28, $p = .002$, *OR* = 1.05, *95% CI* = 1.02-1.08) and remained significant when Self-Management to Time entered as a significant predictor. Current impairment entered at Step 1 was initially significant (*Beta* = .107, *SE* = .030, *Wald* = 13.23, $p < .001$, *OR* = 1.11, *95% CI* = 1.05-1.18); however it was no longer significant when Self-Organization and Problem-Solving entered and made a significant contribution. None of the EF tests were significant predictors of lifetime depression.

Relationship of EF Measures to Current Depressive Symptoms

In Table 2, All DEFS scales were positively correlated with SCL-90-R depressive symptoms (all $p < .001$): Self-Management to Time $r = .37$, Self-Organization = .46, Self-Restraint = .47, Self-Motivation = .40, and Self-Activation = .41. Using multiple linear regression, both Self-Organization and Problem-Solving and Self-Restraint significantly predicted current depressive symptoms. Anxiety entered at Step 1 significantly predicted depressive

symptoms as did two DEFS subscales—Self-Management to Time and Self-Organization and Problem-Solving. Current impairment entered at Step 1 significantly predicted depressive symptoms as did two DEFS subscales—Self-Motivation and Self-Organization and Problem-Solving.

Only one EF test significantly predicted depressive symptoms—percent errors on the WCST. However, the direction of the effect was opposite to the expected result, with more errors predicting lower less severe symptoms. Anxiety entered at Step 1 significantly predicted depressive symptoms and the WCST score was no longer significant. Instead, total score from the Digit Span test in this analysis made a small but significant contribution to risk in the expected direction. Current impairment entered at Step 1 predicted depressive symptoms but no EF test reached significance.

Discussion

EF was significantly associated with risk for current and lifetime depression and with severity of current depressive symptoms in this group of clinic-referred adults, depending on the EF assessment method. EF ratings consistently predicted depression while EF tests did so weakly and inconsistently. Although one EF test was significantly associated with severity of current depressive symptoms—the WCST percent errors score—the relationship was in the opposite direction of that predicted (i.e., more errors predicting less severe depression) and did not survive analyses that included possible confounds. EF ratings, however, predicted all depression measures. These two approaches to measuring EF may not be assessing the same construct and EF ratings may have far greater ecological validity than do EF tests (Barkley and Murphy, 2011; Burgess et al., 1998).

Examining subscales of the DEFS, deficits in Self-Management to Time—including difficulty planning ahead and preparing in advance—were specifically associated with risk for current and lifetime depression. Deficits in Self-Organization and Problem-Solving—including difficulty holding information in mind and using it to efficiently arrive at solutions—increased the risk for lifetime depression and current symptoms. Self-Management to Time was related to all measures of depression over and above anxiety, while Self-Motivation and Self-Organization and Problem-Solving were the most consistently related to depressive risk above and beyond current impairment. Problems in managing goal-directed behavior across time may increase risk for depression via its negative impact on functioning but does so independently from anxiety symptoms, while problem-solving and information-processing difficulties produce greater subjective distress.

Limitations of this study must be noted. First, the test battery for assessing EF was limited in scope. The battery does not provide comprehensive coverage of all constructs that have been attributed to EF, numbering up to 33 in some surveys (Eslinger, 1996). Yet it does provide coverage of most of the constructs identified in past research on adults with ADHD. Importantly, the cross-sectional nature of the current study does not allow us to determine the direction of the EF-depression relationship or to fully test the hypothesis that EF deficits in ADHD represent a true risk factor for depression. Previous cross-sectional studies using neuropsychological tests have yielded different conclusions as to whether depression confers additional risk for EF deficits above and beyond ADHD alone (Larochette et al., 2011; Riordan et al., 1999) and rating scale studies may yield different conclusions. Prospective studies using both types of EF assessment are clearly needed to clarify whether EF deficits are a true risk factor for depression, both in people with and without ADHD.

An important research implication of this study is that researchers conducting neuroimaging and neuropsychological studies of depression should assess for possible ADHD comorbidity

in study participants, given the overlap of EF deficits in the disorders and the elevated risk for depression in adults with ADHD. McClintock et al. (2010) recently called for better characterization of comorbidity when studying neurocognitive functioning in depressed samples, but did not list ADHD as a comorbidity to consider. Clearly, studies of the EF-depression link that do not assess for ADHD may be missing a critically important piece of the puzzle.

Clinically, this study highlights the potential impact of comorbid EF deficits or ADHD in clients with depression and the importance of assessing deficits in an ecologically valid manner. Clinicians working primarily with either patient population should be vigilant for the other disorder during assessment and treatment planning. Little empirical research guides treatment selection for this comorbidity, although it is beginning to receive greater attention in the literature (Wilens et al., 2008). We hypothesize that depression treatments targeting increases in planned, goal-oriented activities (behavioral activation, Dimidjian et al. (2006)) or integration of depression treatment with approaches that help patients develop compensatory skills for EF deficits (e.g., Safren et al., 2010) may be particularly useful for patients with both depression and significant EF impairment or ADHD, but further research is needed.

The current study demonstrated a link between EF deficits and depressive symptoms and diagnoses in a sample of adults at high risk for both outcomes—those referred for assessment of ADHD. Time management, organization, and problems-solving deficits appeared to be especially important predictors of depressive diagnoses and symptoms. Our findings highlight the importance of considering ADHD comorbidity in research on EF and depression. Findings also introduce the potential utility of assessing EF via rating scales in adults at-risk for depression and support consideration of EF in the assessment and treatment of depressive disorders.

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Table 1

Prediction of SCID Current and Lifetime Depression/Dysthymia using the Deficits in Executive Functioning Scale (DEFS) or EF Tests

SCID Depression Categories	Beta	S.E.	Wald	*p*	Odds Ratio	95% CI
Predicting Current Depression:						
From DEFS Ratings Alone:						
Self-Management to Time	.046	.013	1.69	.001	1.05	1.02-1.07
From Anxiety and DEFS Ratings:						
Anxiety (SCL-90-R)(entered at Step 1)	.032	.017	3.63	NS	1.03	1.00-1.07
Self-Management to Time	.041	.014	9.12	.003	1.04	1.01-1.07
From Impairment and DEFS Ratings:						
Current Impairment (entered at Step 1)	.043	.036	1.47	NS	1.04	0.97-1.12
Self-Motivation	.062	.027	5.26	.022	1.06	1.01-1.12
From EF Tests Alone:						
No tests significant						
Lifetime Depression:						
Self-Management to Time	.036	.013	7.45	.006	1.04	1.01-1.06
Self-Organization & Problem-Solving	.031	.013	5.76	.016	1.03	1.01-1.06
From Anxiety and DEFS Ratings:						
Anxiety (SCL-90-R) (entered at Step 1)	.034	.015	4.90	.027	1.03	1.00-1.07
Self-Management to Time	.044	.012	12.61	<.001	1.04	1.02-1.07
From Impairment and DEFS Ratings:						
Current Impairment (entered at Step 1)	.066	.035	3.65	NS	1.07	1.00-1.14
Self-Organization & Problem-Solving	.032	.015	4.74	.029	1.03	1.00-1.06
From EF Tests:						
No tests significant						

Only significant DEFS or EF test predictors shown. SCID = Structured Clinical Interview for DSM Disorders. EF = executive functioning. S.E. = standard error for Beta. Odds Ratio = Exp(B). 95% CI = 95% confidence interval for the Odds Ratio. Statistical Analysis: Binary Logistic Regression using forward conditional entry method (constant included in equation)

Table 2

Prediction of SCL-90-R Depression Ratings Using the Deficits in Executive Functioning Scale (DEFS) Ratings or EF Tests

Symptom Predictors	Beta	R	R^2	$R^2\Delta$	*F*	*p*
From DEFS Ratings Alone:						
Self-Organization & Problem-Solving	.302	.469	.220	.220	50.32	<.001
Self-Restraint	.291	.526	.277	.057	13.88	<.001
From Anxiety and DEFS Ratings:						
Anxiety (entered at Step 1)	.623	.715	.512	.512	186.69	<.001
Self-Management to Time	.151	.741	.550	.038	14.83	<.001
Self-Organization & Problem-Solving	.124	.748	.560	.010	4.06	.045
From Impairment and DEFS Ratings:						
Current Impairment (entered at Step 1)	.243	.474	.225	.225	45.81	<.001
Self-Motivation	.210	.528	.278	.054	11.65	.001
Self-Organization & Problem-Solving	.214	.307	.293	.028	6.34	.013
From EF Tests Alone:						
WCST - Percent Errors	−.163	.163	.027	.027	4.47	.036
From Anxiety and EF Tests:						
Anxiety (SCL-90-R)(entered at Step 1)	.713	.715	.511	.511	171.26	<.001
Digit Span Total	−.122	.725	.526	.015	5.12	.025
From Impairment and EF Tests:						
Current Impairment (entered at Step 1)	.503	.503	.253	.253	47.03	<.001
No EF tests were significant						

Only significant DEFS or EF test predictors shown. SCL-90-R = Symptom Checklist 90 – Revised. DEFS = Deficits in Executive Functioning Scale. EF = executive functioning. WCST = Wisconsin Card Sort Test. Analyses are for linear multiple regression with stepwise entry. Beta = Standardized Beta Coefficient from the final model, R = Regression coefficient, R^2 = Percent of explained variance accounted for by all variables at this step, $R^2\ \Delta$ (Change) = Percent of explained variance accounted for by this variable added at this step, *F* = F to Change results, *p* = probability value for the *F*-test.