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ORIGINAL PAPER

Executive Functioning in Adolescent Depressive Disorders

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Abstract Previous research on executive functioning within adolescent depression has provided somewhat inconsistent results, although the majority of research has identified at least partial evidence of executive functioning deficits in adolescent depression. The present study attempted to explore adolescent depression, specifically depressive disorder diagnoses and self-reported depressive/anxious symptoms, as well as executive functioning through the retrospective chart review of an inpatient/outpatient adolescent sample. The total sample (N = 155) was divided into four groups. The psychiatric inpatient sample was subdivided into a Major Depression Group (n = 22), Minor Depression Group (n = 28), Inpatient Control Group (n = 73) based on the discharge diagnoses. The Outpatient Control Group (n = 33) consisted of a group of adolescents who received evaluations at a neuropsychological evaluation clinic. Analyses of variance between the four clinical groups and follow-up pairwise comparisons revealed lowered executive functioning performance in major and minor depression groups compared to the outpatient control. Lowered working memory/simple attention was identified in minor and major depression, while lowered cognitive flexibility/set shifting was only identified in major depression, suggesting a continuum of executive dysfunction and depression severity. More generally, the inpatient groups displayed lower executive functioning than the outpatient control, with no identified executive functioning differences between inpatient groups. Additionally, no negative correlations were observed between self-reported depressive/anxious symptoms and executive functioning. These results are consistent with the majority of related research, and highlight the importance of executive functions in adolescent depression, and more broadly in adolescent psychopathology.

Keywords Adolescents · Depression · Executive functioning · Inpatient · Psychopathology

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Introduction

Within the adult literature, research has consistently identified executive dysfunction within depression (Castaneda et al. 2008; McDermott and Ebmeier 2009; Ottowitz et al. 2002; Porter et al. 2007). While depression can affect individuals across the lifespan, core symptom criteria can be different for children and adolescents (American Psychiatric Association (APA) 2000). According to the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV-TR; APA 2000), the presence of a depressed mood is a core symptom of adult depression. However, children and adolescents may be more likely to experience irritable mood, and therefore, irritable mood can serve as a substitute core criteria for children and adolescents (APA 2000). In addition, a portion of children and adolescents may not meet complete diagnostic criteria for depression, despite the presence of depressive symptoms (Mash and Barkley 2007). The differences associated with childhood

and adolescent depression suggests that research findings on adult depression should not be generalized to the child and adolescent population.

Depression in childhood and adolescence is associated with impairments across global domains of functioning, including impairments in developmental, social, and academic domains (Mash and Barkley 2007; National Institute of Mental Health (NIMH) 2001). In 2006, the incidence of hospitalizations due to depressive disorders was at 6.4 per 10,000 child and adolescent patients (Lasky et al. 2011). Despite the same DSM-IV-TR diagnostic criteria for depression in children and adolescents, research has also identified significant differences between childhood depression and adolescent depression (APA 2000; Crowe et al. 2006; Mash and Barkley 2007; NIMH 2001). Adolescent depression more frequently causes vegetative and affective symptoms, concerns about the future, interpersonal difficulties, and thought processing problems, while externalizing behaviors and cognitive symptoms are more frequently observed in childhood depression (Crowe et al. 2006; Mash and Barkley 2007). In addition, researchers have suggested that adolescence is a sensitive period for the development of depression (Forbes and Dahl 2012), especially considering the significant neurologic, cognitive, social, and emotional development that occurs during this developmental period (Mahone and Slomine 2007; Shaffer and Kipp 2007). For example, mood disorder-related hospitalizations show significant increases during the transition from childhood to adolescence (Lasky et al. 2011). More specifically, the 30-day prevalence rates of depression have been estimated between 9.6 and 10.4 % for individuals ages 15–18 years (Kessler and Walters 1998).

The majority of research that has examined the association between executive functioning and depression in adolescence has found at least partial evidence of executive functioning deficits in adolescent depression, specifically in sustained attention (Chantiluke et al. 2012; Han et al. 2012), response inhibition/impulsivity (Kavanaugh and Holler 2012; Kyte et al. 2005; Maalouf et al. 2011), attentional switching/set shifting (Wilkinson and Goodyer 2006), working memory (Klimkeit et al. 2011; Matthews et al. 2008), verbal fluency (Klimkeit et al. 2011), and problem solving/planning (Kavanaugh and Holler 2012; Maalouf et al. 2011). Maalouf et al. (2011) examined executive functioning in a group of 40 adolescents with a diagnosis of depression. Half of the adolescents had active depression and half had remitted depression, as indicated by self-report measures. Both depression groups were also characterized by elevated anxiety symptoms. Compared to controls, the adolescents with active depression displayed executive dysfunction, notably in problem solving/planning difficulties and impulsive responding. Kyte et al. (2005) assessed executive skills in 30 adolescents with major depression and other psychiatric co-morbid conditions. The depressed adolescents showed impulsive tendencies in decision-making when compared to healthy controls. Wilkinson and Goodyer (2006) assessed attention abilities, but not executive functioning, within a group of 39 adolescents with major depression and other co-morbid psychiatric conditions. The depressed adolescents displayed deficits in attentional switching when compared to healthy controls. Researchers also reported no significant effect of co-morbidity on attention performance. Kavanaugh and Holler (2012) examined self-reported depressive symptoms in a sample of adolescent inpatients diagnosed with a mood disorder. While group differences were not observed in executive functioning between high versus low self-reported depressive symptoms, negative correlations were identified between select executive functions (e.g., problem solving and response inhibition) and certain depressive symptoms (e.g., negative mood and interpersonal problems), providing evidence for the presence of executive dysfunction within adolescent depression.

Alternatively, a smaller group of studies have found no evidence of executive functioning deficits associated with adolescent depression (Frost et al. 1989; Halari et al. 2009; McClure et al. 1997). In addition, some adolescent research has found no executive/attention functioning differences between clinical diagnoses, such as between those young people with anxiety versus those with depression (Frost et al. 1989). These findings are in agreement with recent adult literature, which has suggested that the presence of individual psychiatric conditions may not result in neuropsychological deficits (Baune et al. 2009; Beblo et al. 2011). Rather, it may be clinical and demographic factors, such as the severity and co-morbidity of psychiatric conditions that causes subsequent neuropsychological deficits (Beblo et al. 2011).

In order to contribute to the research examining executive functioning in adolescent depression, the present study examined executive functioning in a combined adolescent inpatient/outpatient sample. The child and adolescent psychiatric inpatient setting is typically characterized by the presence of severe and co-morbid psychiatric conditions, in addition to general psychopathology (Fehon et al. 2001; Grilo et al. 1999; Kavanaugh and Holler 2012; Sukhodolsky et al. 2005). It was deemed important to examine the executive functioning in this setting, especially in relation to recent research findings identifying the importance of psychiatric severity and co-morbidity on neuropsychological functioning (Beblo et al. 2011). In addition, this research study is a continuation of the research done by Kavanaugh and Holler (2012). Select negative correlations between executive functioning and depressive symptoms were identified in this study, although specific depressive disorder diagnoses were not

examined. Researchers suggested that examining depressive disorder diagnoses, as opposed to self-reported symptoms, might shed further light on the association between executive functioning and adolescent depression. Therefore, the present study had three hypotheses: Those adolescent inpatients with depressive disorders would display lower performance on measures of executive functioning than the other inpatient and outpatient groups; regardless of depressive presentation, the inpatient groups would display lower performance on measures of executive functioning when compared to an outpatient control group; within those depressed inpatient adolescents, elevated self-reported depressive symptoms would be associated with worse performance on measures of executive functioning.

Method

Participants and Procedure

The present study received Institutional Review Board (IRB) approval from Butler Hospital/Alpert Medical School of Brown University and followed the ethical principles set forth by the American Psychological Association (APA). It is part of a research project at Butler Hospital, an inpatient psychiatric hospital. Specifically, the research project is examining the neuropsychological correlates of psychiatric conditions based on retrospective chart review of adolescents admitted to the hospital and who received a neuropsychological/psychological evaluation during the years of 2002–2012. During the hospital admission process, the clinicians in the admitting unit provide an initial or admitting diagnosis. These diagnoses were temporary diagnoses, largely influenced by previous diagnoses provided by the adolescent's outpatient providers. The discharge diagnoses were considered more comprehensive diagnoses, completed after the attending psychiatrist had ample opportunity to treat and assess the individual based on the DSM-IV-TR criteria (American Psychiatric Association 2000). Discharge diagnosis was used in the current study because of the clinical utility involved in the discharge diagnosis, as opposed to the less-stringently assessed admitting diagnoses. A clinical child neuropsychologist, a professional psychometrist, or a doctoral student in clinical psychology under direct supervision of a child neuropsychologist conducted the neuropsychological/psychological evaluations. This author (KH) conducted or supervised each evaluation, and each evaluation followed the protocol of a standard testing protocol. Reasons for evaluation were based on the parent/guardian concerns and/or a request for additional information by the attending psychiatrists. Evaluations were typically completed within a few days of the hospital admission. The diagnoses from the outpatient neuropsychology clinic evaluations were diagnosed by a child clinical neuropsychologist, based on the DSM-IV-TR criteria (American Psychiatric Association 2000).

Adolescents diagnosed with Bipolar Disorder, a pervasive developmental disorder [e.g., Autistic Disorder, Asperger's Disorder, Rett's Disorder, Childhood Disintegrative Disorder, and Pervasive Developmental Disorder—Not Otherwise Specified (NOS)], or a psychotic disorder were excluded from the current sample. Those adolescent inpatients with a Major Depressive Disorder diagnosis were included in the *Major Depression* Group, while those adolescent inpatients with a Depressive Disorder Not Otherwise Specified or Dysthymic Disorder diagnosis were included in the *Minor Depression* Group. Those adolescent inpatients that did not receive a depressive disorder diagnosis were included in the *Inpatient Control* Group. Additionally, any outpatient adolescents with a diagnosis of Major Depressive Disorder, Depressive Disorder Not Otherwise Specified, or Dysthymic Disorder were excluded from the *Outpatient Control* Group. A total of one hundred and fifty-five adolescents were included in the present study, with twenty-two participants included in the *Major Depression* group, twenty-eight participants included in the *Minor Depression* group, seventy-two participants included in the *Inpatient Control* group, and thirty-three participants included in the *Outpatient Control* group based on chart review. Demographic and co-morbidity were examined either using Chi squared or analyses of variance (ANOVA). Results are provided in Table 1.

Materials

Tasks of Executive Functioning

Based on a review of pediatric neuropsychological literature (Anderson 2002; Baron 2004; Henry and Bettenay 2010; Willcutt 2010), 5 executive functioning subdomains were constructed. These included 1. Problem Solving/Planning 2. Cognitive Flexibility/Set Shifting 3. Response Inhibition/Interference Control 4. Fluency 5. Working Memory/Simple Attention. *T*-Scores were reported for all measures of executive functioning.

Planning/Problem Solving

The Wisconsin Card Sorting Test (WCST) is a test of executive function that assesses skills in abstraction, shifting and maintaining focus, goal orientation, and impulse control (Baron 2004; Henry and Bettenay 2010; Strauss et al. 2006; Willcutt 2010). This study used the following WCST scores: Amount of categories achieved (WCST Categories), failures to maintain set (WCST FMS), and perseverative errors (WCST Perseverative Errors). The

Table 1 Clinical characteristics for the Major Depression (Group 1), the Minor Depression (Group 2), Inpatient Control (Group 3), and Outpatient Control (Group 4) Groups

Variable	Total (N = 155)	Major Dep. (1) (n = 22)	Minor Dep. (2) (n = 28)	Control Inpt. (3) (n = 72)	Control Outpt. (4) (n = 33)	Pearson X^2	F
% Female	41 %	36 %	46 %	39 %	42 %	.691	–
Age	15.21 (1.34)	15.70 (1.21)	15.46 (1.34)	15.12 (1.3)	14.85 (1.41)	–	2.29
# of diagnoses	1.93	2.05	1.86	2.06	1.64	–	2.54
Diagnosis							
Major dep.	14 %	100 %	0 %	0 %	0 %	155.00***	–
Minor dep.	18 %	0 %	100 %	0 %	0 %	155.00***	–
Mood NOS	41 %	0 %	0 %	76 %	24 %	76.049***	–
Anxiety	35 %	45 %	21 %	35 %	42 %	4.084	–
Behavior	33 %	23 %	14 %	47 %	24 %	13.236**	–
ADHD	52 %	36 %	50 %	47 %	73 %	8.524*	–

Major Dep. = Major Depressive Disorder; Minor Dep. = Depressive Disorder NOS and Dysthymic Disorder; Behavior = Disruptive Behavior Disorders (Conduct Disorder, Oppositional Defiant Disorder, Disruptive Behavior Disorder NOS)

* $p < .05$; ** $p < .01$; *** $p < .001$

WCST Categories score was used as a measure of planning/problem solving (Baron 2004; Strauss et al. 2006). The Rey Osterreith Complex Figure (ROCF) is a neuropsychological task designed to assess visual-spatial, perceptual, and planning, integration and organizational abilities (Strauss et al. 2006). The ROCF requires the participant to copy a picture of a complex geometric design as accurately as possible. The ROCF was used in the present study to assess planning.

Set Shifting/Cognitive Flexibility

The Trail Making Test (TMT) is a neuropsychological instrument that assesses attention, speed and cognitive flexibility (Baron 2004; Henry and Bettenay 2010; Strauss et al. 2006). It consists of two versions that are administered consecutively to the client. TMT A requires the client to use a pencil and connect encircled numbers in numerical order. TMT B requires the client to use a pencil and connect encircled numbers and letters in numerical and alphabetical order, alternating between numbers and letters until completed. The adult form is for ages 15–89 and the child form is for ages 9–14 years. The child form is very similar to the adult form, although it contains fewer numbers and letters. TMT B was used in the present study to assess set shifting/cognitive flexibility (Strauss et al. 2006). In addition, the WCST Perseverative Errors score was used to assess set shifting/cognitive flexibility (Baron 2004).

Response Inhibition/Interference Control

The Stroop Test is a verbal task of executive function that assesses processing speed, attention, cognitive flexibility, resistance to distraction, and response inhibition (Baron 2004; Henry and Bettenay 2010; Strauss et al. 2006; Willcutt 2010). It consists of three conditions, which require the client to read increasingly difficult patterns of words and colors. The third condition, called Color-Word (Stroop C–W), presents a word list of colors, with each color name printed in the ink of another color. For example, the word "RED" would be printed in blue ink, with the participant required to say the color of the ink, not the written word. The increasingly difficult conditions challenge the executive functions of the client. The Stroop C–W score was the only Stroop score used for this study and it was used to assess response inhibition/interference control. In addition, the WCST FMS score was used to assess response inhibition/interference control (Strauss et al. 2006).

Fluency

Controlled Oral Word Association Test (COWAT) is a verbal task that requires the individual to produce words based on clinician-delivered characteristics and is typically viewed as a task assessing executive functioning, specifically verbal fluency (Baron 2004, Henry and Bettenay 2010; Strauss et al. 2006). Two conditions were used in this administration, phonemic and semantic. The phonemic condition, FAS, asks the client to produce words starting with the letters F, A, S for 1 min per letter. The semantic condition, Animals, asks the client to say the names of various animals for 1 min. While the COWAT has been used as a language measure, for the present study, it was used to assess verbal fluency, identified as a subdomain of executive functioning.

Working Memory/Simple Attention

The Wide Range Assessment of Memory and Learning (WRAML) is a set of tasks that assesses the learning and memory abilities of children and adolescents (Sheslow and Adams 1990). One subtest, Sentence Repetition, involves the clinician verbally presenting increasingly difficult sentences to the client, asking the client to repeat the sentence. This subtest, similar to other verbally presented digit span and sentence repetition tasks, is believed to assess working memory and simple attention/concentration (Burton et al. 1996). Therefore, WRAML Sentence Repetition was used in this study to assess working memory. TMT A was also used in the present study to assess simple attention (Baron 2004; Strauss et al. 2006).

Self-Reported Anxiety/Depressive Symptoms

The Childhood Depression Inventory (CDI) is a self-report measure of depressive symptoms, specifically in the domains of negative mood, interpersonal problems, ineffectiveness, anhedonia, and negative self-esteem. The CDI contains 27-items and can be used for children and adolescents ages 7–17 (Kovacs 1992). The total score and subdomain scores on the CDI were used for the present study.

The Revised Children's Manifest Anxiety Scale—2nd Edition (RCMAS-2) is a self-report measure of symptoms of childhood anxiety, specifically physiological anxiety, worry, and social anxiety (Reynolds and Richmond 2008). It also contains scales that assess defensiveness and inconsistent reporting. The RCMAS-2 contains 49 items and can be used for children and adolescents ages 6–19. Of note, there was one change in the version of the RCMAS administered in the neuropsychological inpatient battery during these noted years (i.e., the first edition to the second edition of the instrument). Of note, a small portion of participants completed the first edition of the Revised Children's Manifest Anxiety Scale. Due to similar clinical subscale categorization, individuals who completed RCMAS-1 and RCMAS-2 were included in this sample.

Statistical Analyses

Composite scores were calculated for each executive functioning/language subdomain based on the mean performance of administered executive functioning and language measures: Cognitive Flexibility/Set Shifting (TMT B & WCST Perseverative Errors), Interference Control/Response Inhibition (Stroop C–W & WCST FMS), Planning/Problem Solving (ROCF & WCST Categories), Working Memory/Simple Attention (WRAML Sentence Repetition & TMT A), and Verbal Fluency (COWAT FAS & COWAT Animals). Initial ANOVA were conducted on all executive functioning and psychological domains/measures to examine differences between clinical groups. Follow-up pairwise comparisons using Tukey's Honestly Significant Difference (HSD) test were conducted on measures indicating significant group differences. Effect sizes (Cohen's *d*) were computed for these pairwise follow-up comparisons and were interpreted using Cohen's (1992) criteria. Pearson correlation coefficients were calculated to examine the relationship between executive functioning and psychological (anxiety and depression) variables in the two depression groups.

Results

Self-Reported Executive Functioning and Psychological Symptoms by Clinical Groups

An initial series of ANOVAs were conducted to explore the difference in self-reported psychological symptoms (CDI & RCMAS-2 scores) across three clinical groups. Statistically significant differences were identified between groups on the CDI $F(3, 141) = 5.6, p < .01$ and RCMAS-2 $F(3, 136) = 7.356, p < .001$. Higher scores on the CDI and RCMAS-2 indicate increased symptoms of depression and anxiety, respectively. Results are provided in Table 2. Pairwise comparisons identified that both the Major Depression and Minor Depression groups scored significantly higher than the Outpatient Control Group on the CDI (Cohen's *d* of 0.93 and 0.90 respectively, representing large effects). All three inpatient groups scored significantly higher than the Outpatient Control Group on the RCMAS-2. The effect sizes for the Major Depression ($d = 1.13$) and Minor Depression ($d = 0.99$) pairwise comparisons with the Outpatient Control Group were both large. The Inpatient Control Group effect size ($d = 0.55$) was medium.

ANOVAs were then conducted to explore the differences in executive functioning across the three clinical groups. There was a significant difference between groups on the Executive Functioning Composite $F(3, 150) = 5.759, p < .01$, Cognitive Flexibility/Set Shifting $F(3, 150) = 3.266, p < .05$, Working Memory/Simple Attention $F(3, 150) = 9.716, p < .001$, and Fluency $F(3, 141) = 3.256, p < .05$. Higher scores on executive functioning domains indicate better performance on respective domains. Results are provided in Table 2. Pairwise comparisons identified that the Major Depression and Inpatient Control groups scored significantly lower than the Outpatient Control Group on the Executive Functioning Composite (*d* of −0.77, medium effect, and −1.08, large effect, respectively). Similarly, the Major Depression and Inpatient Control groups scored significantly lower than the Outpatient Control Group

Table 2 Differences between clinical groups based on psychological and executive measures

Domains	n	Major Dep. (1) (n = 22)		Minor Dep. (2) (n = 28)		Inpt. Control (3) (n = 72)		Outpt. Control (4) (n = 33)		F	Pairwise	Controlling for ADHD and Behavior
		Mean	SD	Mean	SD	Mean	SD	Mean	SD			F
Psych.												
CDI	145	62.62	14.73	62.57	15.56	54.56	13.48	50.18	11.76	5.6**	1, 2 > 4	5.5**
RCMAS	140	59.19	11.39	57.44	11.52	51.97	11.21	45.16	13.29	7.356***	1, 2, 3, > 4	6.86***
Executive												
EF	154	44.05	9.26	45.41	9.38	43.47	6.62	49.70	4.75	5.759**	1, 3 < 4	4.99**
CF/SS	154	43.09	14.89	47.48	15.14	45.17	11.36	52.06	7.83	3.266*	1, 3 < 4	2.94*
WM/SA	154	41.82	11.86	44.93	11.70	42.31	10.42	53.76	9.10	9.716***	1, 2, 3 < 4	8.22***
RI/IC	144	50.74	8.31	48.15	8.55	46.51	8.60	46.76	4.87	1.578		1.17
PS/P	149	42.33	11.85	40.78	13.50	41.96	12.57	46.88	6.89	1.750		1.78
Fluency	145	47.70	9.94	46.43	11.83	44.13	9.02	50.42	8.96	3.256*	3 < 4	3.427*

CDI Childhood Depression Inventory Total Score, *RCMAS* Revised Children's Manifest Anxiety Scale Total Score, *EF Composite* Executive Functioning Composite Score, *CF/SS* Cognitive Flexibility/Set Shifting, *WM/SA* Working Memory/Simple Attention, *RI/IC* Response Inhibition/Interference Contro,*PS/P* Problem Solving/Planning, *Fluency* Fluency

* $p < .05$; ** $p < .01$; *** $p < .001$

on the Cognitive Flexibility/Set Shifting Composite (d of -0.75 and -0.71 respectively, both representing medium effect sizes). All three inpatient groups scored significantly lower than the Outpatient Control Group on the Working Memory/Simple Attention Composite. The effect sizes for these pairwise comparisons with the Outpatient Control Group (Major Depression $d = -1.13$, Minor Depression $d = -0.84$, and Inpatient Control Group $d = -1.17$) were all large. Finally, the Inpatient Control Group scored significantly lower than the Outpatient Control Group on the Fluency Composite ($d = -0.70$, medium effect).

Due to the significant group differences between Disruptive Behavior Disorder diagnoses and ADHD, supplemental ANCOVAs were conducted, entering Behavioral Disorder and ADHD diagnoses as covariates. When controlling for these potentially confounding variables, the results did not significantly differ from initial analyses. Notably, significance levels did not differ on any of the identified variables (i.e., moving from $p < .001$ to $p < .01$, etc.). Results are provided in Table 2.

Correlation Analysis

Pearson correlations were also conducted to examine the relationship between executive and psychological variables within the two depression groups (Group 1 and Group 2). Executive domains were not negatively correlated with any depressive or anxious domains. Alternatively, Fluency was *positively* correlated with CDI Ineffective. Additionally, the number of psychiatric diagnoses per individual was negatively correlated with Response Inhibition/Interference Control and Problem Solving/Planning. Results are provided in Table 3.

Discussion

The current study attempted to examine the link between adolescent depression and executive functioning based on the retrospective chart review from an adolescent psychiatric inpatient/outpatient setting. Within this retrospective chart review, adolescent inpatient charts were divided into Major Depression, Minor Depression, and Inpatient Control groups. An Outpatient Control group was added based on retrospective chart review from an outpatient neuropsychology clinic. Performance on measures of executive functioning was categorized into the following subdomains: Cognitive flexibility/set shifting, problem solving/planning, response inhibition/interference control, working memory/simple attention, and fluency. It was hypothesized that inpatients with depressive disorders would display lower performance on measures of executive functioning compared to inpatient and outpatient controls; regardless of depressive presentation, inpatients would display lower performance on measures of executive functioning; and within those inpatients with depression, self-reported depressive symptoms would be negatively correlated with performance on measures of executive functioning.

The first proposed hypothesis in this study was that adolescent inpatients with depressive disorders would

Table 3 Correlations between executive and psychological variables in the depression (major and minor depression) samples

	EF	CF/SS	WM/SA	RI/IC	PS/P	Fluency
# of diagnoses	−.240	−.239	−.037	−.285*	−.423**	.051
CDI total	.074	.050	.085	−.045	.085	.192
CDI mood	.090	.085	.131	−.082	.024	.190
CDI interpersonal	−.171	−.158	−.195	−.080	−.069	.051
CDI ineffective	.200	.140	.153	.126	.225	.313*
CDI anhedonia	.000	−.041	.032	.020	−.001	.130
CDI S-E	.121	.096	.133	−.137	.134	.142
RCMAS total	.020	−.059	.057	−.016	−.061	.212
RCMAS physio.	−.007	−.047	.069	−.140	−.115	.159
RCMAS worry	−.012	−.065	−.053	.102	−.079	.196
RCMAS social	.046	−.015	.070	−.029	.014	.163

* $p < .05$; ** $p < .01$

display worse performance on measures of executive functioning compared to the inpatient and outpatient control groups. This hypothesis was only partially supported, as there were no identified differences between the depressive disorder groups and the inpatient control group. Alternatively, both depressive disorder groups displayed significantly lower performance than the outpatient control on select executive functioning domains. Specifically, the major depression group displayed significantly lower performance than the outpatient control group on measures of cognitive flexibility/set shifting and working memory/simple attention, along with lower performance on the overall executive functioning domain. Additionally, the minor depression group displayed lower performance than the outpatient control group in working memory/simple attention. These results are generally consistent with the majority of the related literature, which has identified executive functioning deficits in adolescent depression (Chantiluke et al. 2012; Han et al. 2012; Kavanaugh and Holler 2012; Klimkeit et al. 2011; Kyte et al. 2005; Maalouf et al. 2011; Matthews et al. 2008; Wilkinson and Goodyer 2006), although it is inconsistent with studies that have not found such deficits (Frost et al. 1989; Halari et al. 2009; McClure et al. 1997). More specifically, the identified deficits in working memory/simple attention and cognitive flexibility/set shifting are consistent with previous studies that have found deficits in working memory (Klimkeit et al. 2011; Matthews et al. 2008) and attentional switching/set shifting (Wilkinson and Goodyer 2006). Notably, impairments in fluency, response inhibition, and problem solving were not identified, inconsistent with related research (Klimkeit et al. 2011; Kyte et al. 2005; Maalouf et al. 2011).

These results identify that working memory/simple attention may be initially implicated in lower as well as higher levels of depression, while domains such as cognitive flexibility/set shifting may be only implicated in the higher levels of depression. This finding suggests that the interplay between depression and executive functioning may be more appropriately conceptualized along a continuum of severity, rather than a categorical classification in that increased depressive symptomatology is associated with increased executive dysfunction. This conceptualization has been recently suggested researchers, after identifying different executive functioning performance between varying levels of adolescent depression compared to adolescent controls (Klimkeit et al. 2011; Maalouf et al. 2011). Current results, consistent with prior research, also suggest that executive dysfunction may not be globally impaired across subdomains in adolescent depression. Rather, it appears that select areas of executive functioning (i.e., working memory and cognitive flexibility) may be particularly vulnerable. This highlights the importance of conceptualizing executive functioning as a heterogeneous group of functions as well as the importance in identifying the particular subdomains of executive functioning that may be implicated in adolescent depression.

The second hypothesis was generally supported, which stated that inpatients would display lower performance on measures of executive functioning than the outpatient control. Two out of three inpatient groups displayed lower performance than the outpatient control group on the overall executive functioning composite. More specifically, lowered cognitive flexibility/set shifting was identified in the major depression and inpatient control groups, lowered working memory/simple attention was identified in all three inpatient groups, and lowered fluency was identified in the inpatient control group. Of note, there were no group differences on measures of response inhibition/interference control and problem solving/planning. This suggests that adolescent psychiatric inpatients may be at increased risk for impairments in executive functions, specifically in cognitive flexibility, working memory, and verbal fluency.

This further questions the role of these executive functions in the development of psychopathology. In his theoretical analysis of developmental psychopathology, Pennington

(2002) identified four levels of analysis in the development of psychopathology: Etiology, brain development, neuropsychology, and behavior. While the relationship between these levels is noted as bi-directional, it identifies brain development's contribution to neuropsychological functioning, with neuropsychological functioning subsequently contributing to behavioral presentation. Pennington (2002) also acknowledges that single factors (e.g., gene, neuropsychological domain, environmental event) most likely cannot directly account for the development of psychopathology, but it is more likely a combination of within level and between level risk factors that contribute to such psychopathology. Other researchers have further suggested that executive functioning deficits may contribute to or exacerbate psychiatric symptoms (Serper et al. 2008). Based on the conceptualization of executive functioning as a grouping of self-regulatory behaviors (Barkley 2012), along with Pennington's theory of psychopathology (Pennington 2002), it can be suggested that executive functions are responsible for the regulation of emotional functioning. Therefore, deficits in such executive functions (particularly cognitive flexibility and working memory, and to lesser degree verbal fluency) may result in emotional dysregulation, ultimately contributing to the development of psychopathology.

Finally, the third hypothesis was not supported, which stated that self-reported depressive symptoms would be negatively correlated with measures of executive functions in inpatients with depression. There were no noted correlations between depressive or anxious symptoms and executive functions. Alternatively, there was a positive correlation between verbal fluency and ineffectiveness. The lack of findings was somewhat surprising to researchers, especially given the previously noted executive functioning deficits in major and minor depression within the current study. This is in contrast to the findings of Maalouf et al. (2011), who found a relationship between self-reported depressive symptoms and executive functioning, further suggesting that executive functioning deficits may be state-dependent. A few other current findings may help to guide further research in this area. Within those inpatients with depression (major and minor), the number of psychiatric diagnoses was negatively correlated with response inhibition/interference control and problem solving/planning. This suggests that it may be the severity of the psychiatric presentation of the adolescent with depression that more accurately predicts executive functioning, consistent with recently proposed theories (Beblo et al. 2011). Additionally, self-reported depressive and anxious symptoms were significantly higher in the inpatient depression groups compared to the outpatient control. The inpatient control group also had significantly higher anxious symptoms than the outpatient control. These findings suggest a potential relationship between self-reported symptoms and executive functions, although this study was not able to identify the specific relationship between these noted areas, along with their potential relationship to unidentified clinical and demographic factors.

Despite these findings, there are several limitations to this study. The first limitation was the dependence on clinical protocol practices of the hospital psychiatrists in identifying psychiatric diagnoses. While these psychiatrists displayed consistent and standard approaches to their diagnostic decision-making, there was no structured interview or battery that was available to researchers. Future research should incorporate more standardized diagnostic protocols in order to most appropriately make diagnostic decisions. The second limitation is the high prevalence of psychiatric conditions across research groups. While attempts were made to control for co-morbidity (e.g., removing those with bipolar, psychotic disorders, or pervasive developmental disorders, as well as doing supplemental analyses while controlling for ADHD and behavioral disorders), the majority of these individuals presented with multiple psychiatric diagnoses. Unlike typically utilized control groups, our control group displayed comparable quantities of psychiatric conditions to the inpatient groups. This resulted in very important findings, but studies that use participants with one specific psychiatric condition and a control group with no psychiatric conditions may provide more specific information on the impact of various types of psychiatric conditions. More generally, this study was significantly limited due to the use of retrospective chart review. The field would benefit from future prospective research on the executive functioning-depression link, ideally examining executive skills prior to the development of depression in order to provide more clarity on the direction of the relationship between executive functioning and depression.

The present study attempted to explore the association between adolescent depression and executive functioning in a combined adolescent inpatient/outpatient sample. Results displayed evidence of lowered executive functioning in adolescent inpatients with depression compared to a control group, although similar executive functioning findings were identified in adolescent inpatients without depression. Lowered working memory/simple attention was identified in minor and major depression, while lowered cognitive flexibility/set shifting was only identified in major depression, suggesting a continuum of executive dysfunction and depression severity. Results also suggest that specific executive subdomains (e.g., working memory/simple attention, cognitive flexibility/set shifting, and verbal fluency) may be implicated in adolescent psychiatric inpatients, as opposed to more global executive dysfunction. Additionally, there were no negative correlations between self-reported depressive/anxious symptoms and

executive functioning. These results are consistent with the majority of related research, and highlight the importance of executive functions in adolescent depression, and more broadly in adolescent psychopathology.

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