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Predicting Impairment in College Students With ADHD: The Role of Executive Functions

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Abstract

Objective: This study longitudinally evaluated whether parent-ratings and self-ratings of executive function (EF) predicted the academic and overall functioning of college students with ADHD and whether EF deficits mediated the relationship between ADHD symptoms and functioning. **Method:** A prospective longitudinal study of 59 college students comprehensively diagnosed with ADHD and their parents who completed ratings at the beginning and end of the school year. **Results:** Student-rated motivation and parent-rated emotion regulation significantly predicted overall impairment above and beyond symptoms of ADHD. Student-rated EF motivation mediated the relationship between ADHD symptoms and overall impairment. Student-rated EF organization mediated the relationship between ADHD symptoms and end of the year grades. **Conclusion:** Motivation and organization aspects of EF appear particularly important for functioning. However, given the study's modest sample size, additional longitudinal research is needed to confirm these findings and to develop best-practice assessment and treatment recommendations for college students with ADHD. *(J. of Att. Dis. 2014; XX(X) XX-XX)*

Keywords

ADHD, college, executive function, academic functioning, impairment

The number of students with ADHD pursuing higher education has risen dramatically in the past 30 years, with current prevalence estimates for ADHD in college settings ranging from 2% to 8% (DuPaul, Weyandt, O'Dell, & Varejao, 2009; Janusis & Weyandt, 2010; Wolf, Simkowitz, & Carlson, 2009). For many emerging adults, with or without ADHD, the transition to college represents a critical development period in which individuals are faced with challenges such as a significant decline in external supports (e.g., parent supervision, teacher support) and an increase in environmental demands (e.g., academic independence, financial responsibility, maintaining personal health; Fleming & McMahon, 2012). These changes are particularly difficult for emerging adults with ADHD to navigate, and many experience significant impairment following the transition to college (Weyandt & DuPaul, 2008, 2013). Relative to their non-ADHD peers, college students with ADHD have significantly lower grade point averages (GPAs), are more likely to be placed on academic probation, and are less likely to graduate (e.g., Advokat, Lane, & Luo, 2011; Blase et al., 2009; Norvilitis, Sun, & Zhang, 2010; Weyandt et al., 2013).

Potential Predictors of Impairment in College Students With ADHD

Little is known about factors that may predict the functioning of college students with ADHD (Weyandt & DuPaul, 2006). This research is important because significant heterogeneity in functioning has been documented, with some college students with ADHD performing well academically (e.g., Gregg, Coleman, Stennett, & Davis, 2002; Wilmhurst, Peele, & Wilmhurst, 2011). In addition, the underlying mechanisms that contribute to the academic success and failure of college students with ADHD are poorly understood. There has been some research exploring the role that ADHD symptoms play in predicting the functioning of college students diagnosed with ADHD (see

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DuPaul et al., 2009 for a review). For example, Rabiner, Anastopoulos, Costello, Hoyle, and Swartzwelder (2008) reported that among students with self-reported ADHD, inattentive symptoms predicted academic concerns after controlling for sex, race, and personality traits. To date, however, the range of predictors examined has been limited, and there has been no research on factors that might mediate the relation between ADHD symptoms and functional impairment.

The Role of Executive Functions in ADHD

Researchers have hypothesized that the impairments of individuals with ADHD may be associated with underlying deficits in Executive Function (EF). EFs broadly refer to a set of neurocognitive processes mediated by the prefrontal cortex that are responsible for goal-directed problem-solving behaviors and attention control (Barkley, 1997, 2011b). Research conducted with children and adolescents with ADHD demonstrates that EFs are related to multiple domains of impairment after controlling for ADHD symptoms (Biederman et al., 2004; Langberg, Dvorsky, & Evans, 2013; Miller, Nevado-Montenegro, & Hinshaw, 2012; Miller & Hinshaw, 2010). To date, evidence suggests that behavioral aspects of EF (e.g., emotional control, inhibition) are most salient for functioning of preschool and elementary aged youth, whereas the more complex, meta-cognitive aspects of EF (e.g., planning, organization) are most relevant for functioning in adolescence (e.g., Jacobson, Williford, & Pianta, 2011; Langberg et al., 2013).

College represents a unique environment where the effective use of complex EF skills such as planning and organization and self-regulation of behavior is frequently required (Weyandt & DuPaul, 2013). For example, students are expected to independently manage extracurricular schedules and activities, long-term assignments, projects, and exam preparation (Eccles, 2004). Accordingly, to be successful academically, college students must be able to organize materials and time, plan ahead, engage in goal-directed activities, and inhibit inappropriate or ineffective behaviors (Fleming & McMahon, 2012). However, there is almost no research on EF deficits in college students with ADHD. Weyandt and colleagues (2013) recently published the only study examining the neuropsychological, academic, and psychological functioning in a sample of college students with ADHD. This study compared college students with ADHD (n = 24) to controls (n = 26) and found those with ADHD rated significantly more EF difficulties compared with non-diagnosed peers across all specific and global aspects of EF on the *Behavior Rating Inventory of Executive Function* (BRIEF-A; Roth, Isquith, & Gioia, 2005).

To date, there has been no study of the relation between ratings of EF and impairment in college students with ADHD. In addition, methodological limitations associated with almost all prior predictor research with college students with ADHD prohibit any firm conclusions from being drawn, including (a) lack of comprehensive diagnostic evaluation procedures and specifically, the reliance on self-report for diagnosis; and (b) the lack of longitudinal study designs. Accordingly, the purpose of the present study was to examine the role of ratings of EF in predicting the academic and overall functional impairment of college students comprehensively diagnosed with ADHD. This study utilized both student and parent interviews and ratings to diagnose ADHD and ratings to assess EF. Academic and functional impairment outcomes included grades, ratings of academic adjustment, and functional impairment.

The present study included the following aims: (a) provide a longitudinal evaluation of the relation between EF, ADHD symptom severity, and relevant student characteristics in predicting impairment in college students with ADHD; (b) examine an integrative model to explore whether deficits in ratings of EF mediate the association between ADHD symptoms and impairment; and (c) evaluate whether differences in impairment exist between participants with ADHD with and without clinically significant EF deficits. Based upon prior work in children and adolescents with ADHD (e.g., Miller et al., 2012; Miller & Hinshaw, 2010), we hypothesized the ratings of EF would be a significant predictor of functioning and would mediate the relation between ADHD symptoms and functional outcomes.

Method

Participants

Participants were undergraduate students enrolled in a large public university in Virginia. For the current study, 139 students or parents/guardians called, initially expressed interest in the study, and completed a phone screen. In all, 101 families were eligible based upon the phone screen, 94 completed the inclusion/exclusion evaluation, and 68 met full study criteria and were enrolled. Given the focus on academics and school maladjustment, we limited the sample for the current study to those students taking > 9 credit hours (N = 62), and 59 of these participants completed the primary study measures examined in this study. In comparing the demographic characteristics of those participants for whom full data were available with those without complete data, no differences were found for age, gender, ethnicity, year in school, parent education level, family income, and ADHD medication status (ps > .05). Similarly, no differences were found for ADHD subtype, symptoms of ADHD,

EF deficits, anxiety, depression, GPA, or functional impairment ratings (*p*s > .05).

The final sample of 59 participants included in this study ranged in age from 17 to 30 years (M = 19.90, SD = 2.75), and 32 (54.2%) were male. Forty-two participants (71.2%) self-identified as Caucasian; the remaining were 6 (10.2%) African American, 6 Hispanic (10.2%), or 5 Multiracial (8.5%). Twenty-seven participants (45.8%) were in their first year of college, with remaining participants in their second (n = 13; 22.0%), third (n = 11; 18.6%), or fourth (n = 8; 13.6%) year. Based on procedures described below, 30 participants (50.8%) were diagnosed with *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*; American Psychiatric Association, 1994) ADHD-I, and 29 (49.2%) were diagnosed with ADHD-C. Thirty-five participants (59.3%) were taking medication for ADHD and 4 (6.8%) were taking medications for other psychological disorders. Fifty participants (84.7%) had received an ADHD diagnosis prior to the study. In addition, 35 participants (59.3%) reported taking medication for ADHD as a child, 40 (67.8%) reported receiving services from a mental health provider in the past (e.g., psychologist, psychiatrist, counselor, social worker), and 15 (25.4%) reported receiving educational accommodations through a 504 Plan or Individualized Education Plan (IEP) prior to college.

Procedure

The study was approved by the university Institutional Review Board and student participants signed informed consent and their parents/guardians provided verbal consent. The inclusionary criteria included attendance at the university where the research was being conducted and meeting full diagnostic criteria for ADHD-I or ADHD-C. Diagnosis was determined through separate administration of Part I and Part II of the *Conners' Adult ADHD Diagnostic Interview for the DSM-IV* (CAADID; Epstein, Johnson, & Conners, 2000; Epstein & Kollins, 2006) to students and their parent/guardian. The CAADID interview assesses both current and childhood symptoms and impairment as well as age of onset and pervasiveness of symptoms across time. Part I of the interview provides a detailed history, and Part II is the ADHD diagnostic interview.

Strict diagnostic inclusion criteria were adhered to in this study. Specifically, parents/guardians had to endorse at least six symptoms in an ADHD domain on the CAADID as present and impairing during childhood for a student to be included. In addition, the student and their parents/guardians had to endorse a total of six symptoms in a domain as currently present and impairing on the CAADID. For documentation of current ADHD symptoms, we did allow parent interview data to be supplemented with student self-report and vice versa. However, both the parent and student had to endorse a minimum of four symptoms in a domain as currently present and impairing for supplementation to occur. Flyers describing the study were included in the orientation packets of all incoming freshman, e-mailed to all students currently receiving ADHD accommodations, and posted in the Disability Services Office, at Student Health, and in all university dorms. The flyers stated that students with difficulties with attention and concentration and/or students with a diagnosis of ADHD were eligible to receive a free diagnostic evaluation. Students and their parents/guardians completed baseline measures at the beginning of the school year (T1) and follow-up measures at the end of the school year (T2; 9 months post-baseline).

Baseline Predictor Measures

Demographic/student characteristics. At baseline, students completed a demographics questionnaire, which provided information about their age, gender, ethnicity, employment status, ADHD medication status, and current living status (i.e., whether they lived with their parents or on campus). In addition, parents/guardians completed a demographics questionnaire, which provided information about household income and parents' education level.

ADHD symptoms. ADHD symptoms at baseline were assessed using the self-report version of the *Barkley Adult ADHD Rating Scale–IV* (BAARS-IV; Barkley, 2011a). The BAARS-IV includes the 18 *DSM* symptoms of ADHD. Each item was rated using a four-point scale (1 = *never or rarely*, 4 = *very often*). The BAARS-IV scales demonstrate satisfactory internal consistency and test–retest reliability (Barkley, 2011a). The ADHD symptom total score was used in the current study, with self- and parent-reported ADHD symptoms considered separately (αs = .84 and .85 for self- and parent-report, respectively).

Executive functioning. The *Barkley Deficits in Executive Functioning Scale* (BDEFS; Barkley, 2011b) is an 89-item rating scale for adults aged 18 to 81 years and used to generate a global composite EF score. The items can also be divided into five scales: Self-Management of Time, Self-Organization and Problem Solving, Self-Restraint (inhibition), Self-Motivation, and Self-Regulation of Emotion. Items are rated using a four-point scale identical to the one described for the BAARS-IV. A nationally representative sample of 1,249 adults demonstrated that the BDEFS exhibited adequate internal consistency across each of the five scales (Cronbach's α ranges from .91 to .96). Adequate test–retest of the subscales scores has also been reported with ranges from r = .62 to .90 across the five scales (Barkley, 2011b). Internal consistencies in the present study for self-report are as follows: Self-Management of Time, α = .93; Self-Organization, α = .93; Self-Restraint, α = .93; Self-Motivation, α = .90; Self-Regulation of Emotion, α = .92.

Further, internal consistencies for parent report are as follows: Self-Management of Time, α = .96; Self-Organization, α = .94; Self-Restraint, α = .96; Self-Motivation, α = .95; Self-Regulation of Emotion, α = .97.

Follow-Up Measures

Overall functional impairment. Participants completed the *Barkley Functional Impairment Scale* (BFIS; Barkley, 2011c), which assesses psychosocial impairment in 15 domains of major life activities. The BFIS is a norm-referenced measure ($N > 1,200$) with high internal consistency (.97) and test–retest reliability (.72). Participants rated impairment in each major life activity on a 10-point Likert-type scale ranging from 0 (*not impaired*) to 9 (*severely impaired*). A total impairment score (sum of all 15 domains of functioning) was examined in the present study (α = .96).

GPA. Participants' GPA was used as a measure of academic functioning and was coded based upon a system developed and refined in past work with adolescents and young adults (Molina et al., 2009). Importantly, for a college sample, students' GPA was calculated such that is took into account the number of credits attempted and also when students withdrew from courses or earned incomplete grades. For all students, A = 4.0, B = 3.0, C = 2.0, D = 1.0, and F = 0. Spring semester grades were examined as an outcome measure in the current study.

School maladjustment. Participants completed the *Behavior Assessment System for Children–Second Edition, Self-Report of Personality–College Version* (BASC-2: SRP-College Version; Reynolds & Kamphaus, 2004). The BASC-2 College Version has demonstrated high internal consistency for a normative sample of 706 college students (18-25 years old). The measure consists of 185 items, which are rated on either a 4-point rating scale (1 = *never*, 2 = *sometimes*, 3 = *often*, 4 = *almost always*) or as true/false. In the present study, the School Maladjustment scale was examined (α = .79), with *T* scores of 65 or higher indicating significant levels of distress or impairment. The School Maladjustment subscale provides an indication of how one is responding to the academic demands of college.

Data Analytic Plan

First, bivariate correlation analyses were conducted to examine whether any baseline (T1) participant demographics/characteristics were significantly associated with each of the three follow-up (T2) outcomes (i.e., grades, school maladjustment, and overall impairment). Variables correlated with a specific outcome variable at $p < .05$ were retained for subsequent regression analyses. Second, correlation analyses were conducted to examine the interrelations of T1 (baseline) functional impairment, T1 ADHD symptom severity, T1 deficits in EF, and the T2 functional impairment outcomes. Next, hierarchical regression analyses were conducted to examine whether T1 Deficits in EF significantly predicted T2 impairment after controlling for T1 ADHD symptom severity, T1 impairment, and significant covariates. Parent and student ratings of EF were examined in separate regression models.

Finally, exploratory mediation models were conducted, guided by the process modeling strategies described by Hayes and colleagues (Hayes, 2013; Hayes & Preacher, 2013). The MEDIATE macro for SPSS (Hayes & Preacher, 2013) was used to test whether the associations between T1 ADHD symptom severity and T2 impairment (i.e., overall impairment, GPA) were mediated by any of the T1 EF dimensions separately. Potential mediator variables were selected from those significantly correlated with the outcome at the bivariate level and were entered simultaneously into a multiple mediation model to determine the magnitudes of their relative indirect effects. The MEDIATE macro also tested the interaction effect between EF deficits to confirm the independent effects of each mediator. Bootstrapping tests of mediation (10,000 replications in the current study) are preferred over earlier recommendations for tests of mediation (Baron & Kenny, 1986), particularly in smaller samples, since bias-corrected bootstrapped estimates of the confidence intervals (CIs) for indirect effects (denoted as *ab* below) do not assume normality of the distribution of sampled indirect effects like the Sobel test does (Preacher, Cai, & MacCallum, 2007). For these analyses, 95% CIs are considered significant if they do not encapsulate zero.

In addition to examining the relation between baseline ADHD symptom severity and impairment dimensionally, grouping analyses were also conducted to examine differences between participants with and without clinically significant EF deficits. Participants were grouped based upon their EF deficits subscale scores at the beginning of the school year, T1. Using the normative standardized sample data for males and females between the ages of 18 to 34 (Barkley, 2011b), participants at or above the 93rd percentile were classified as exhibiting a clinically significant EF deficit in that area. Using this threshold, two groups were created for each EF deficit subscale: (a) ADHD present but not EF deficits and (b) ADHD and EF deficit present. Next, *t* tests were run to compare the two groups on the outcomes. Cohen's *d* effect sizes were calculated to determine the magnitude of the difference between the groups on the functional impairment outcomes.

Results

Correlation Analyses

Participant age, race, employment status, living status, current and childhood treatments including medication, therapy, and educational accommodations, and prior ADHD

diagnostic status were not significantly correlated with any of the academic outcome variables and are not considered further. Gender was significantly correlated with GPA ($r = -.36$, $p = .008$) such that females had higher GPAs than males. Participants who had previously attended college (e.g., transferred to current university) had higher overall impairment at follow-up ($r = .27$, $p = .04$). Gender and previous college schooling were included as covariates in the regression and mediation models predicting GPA and overall impairment, respectively.

Correlations between predictor and outcome variables and within-measure correlations are displayed in Table 1. As hypothesized, T1 student-rated and parent-rated ADHD symptoms were significantly associated with T2 overall impairment. In addition, T1 student-rated deficits in EF were all significantly associated with T2 overall impairment. Parent-rated deficits on Self-Management of Time, Self-Restraint, and Self-Regulation of Emotion were significantly positively associated with overall impairment. Only parent-rated Self-Motivation and student-rated Self-Organization subscales were significantly negatively associated with GPA. Student-rated Self-Motivation was the only predictor significantly associated with school maladjustment.

Regression Analysis

Next, hierarchical regression analyses were conducted to examine whether T1 deficits in EF remained significantly associated with T2 impairment outcomes (i.e., overall impairment, GPA, school maladjustment) after controlling for both T1 ADHD symptom severity, T1 impairment scores, and significantly correlated covariates (see Table 2). Across all regression analyses, no variance inflator factor (VIF) values were above 10 (values > 10 are typically considered problematic) and no tolerance values were below .10 (values < .10 are typically considered problematic; Cohen, Cohen, West, & Aiken, 2003), indicating that multicollinearity was not an issue.

Functional impairment. As displayed in Table 2, when significantly correlated student ratings of deficits in EF from the BDEFS were entered on Step 2, these predictors explained an incremental 15% of the variance in overall impairment at follow-up, ΔF (5, 49) = 2.43, $p = .04$, above and beyond the variance accounted for by ADHD symptoms, baseline levels of impairment, and previous college schooling in the model. The student-rated Self-Motivation, $\beta = .48$, $p = .009$, subscale and baseline impairment were the only significant predictors of overall impairment in Step 2. Alternatively, when significantly correlated parent ratings of EF from BDEFS (i.e., Self-Management of Time, Self-Restraint, and Self-Regulation of Emotion) were entered on Step 2, these predictors explained an incremental 9% of the variance in overall impairment at follow-up, ΔF (3, 48) = 1.91, $p = .09$, above and beyond the variance accounted for by ADHD symptoms, baseline levels of impairment, and previous college schooling. The parent-rated Self-Regulation of emotion, $\beta = .36$, $p = .03$, subscale was the only significant predictor of overall impairment in Step 2.

GPA. As displayed in Table 2, student-rated Self-Organization from the BDEF was significantly associated with GPA at follow-up, ΔF (1, 54) = 5.69, $p = .02$, above and beyond the variance accounted for by ADHD symptoms, gender, and baseline levels of impairment. When parent-rated Self-Motivation was entered on Step 2, it did not explain incremental variance in school maladjustment at follow-up, ΔF (1, 53) = 1.06, $p = .31$, above and beyond the variance accounted for by ADHD, gender, and baseline levels of impairment.

School maladjustment. When significantly correlated student ratings of EF from the BDEFS (i.e., Self-Motivation) were entered on Step 2, an incremental 0.04% of the variance was explained, ΔF (1, 55) = .34, $p = .56$, above and beyond the variance accounted for by ADHD symptom severity and baseline levels of school maladjustment.

Mediation Analyses

Analyses using the MEDIATE macro for predicting overall impairment and GPA are summarized below and displayed in Figures 1 and 2. Although student-rated Self-Motivation was correlated with school maladjustment ($r = .28$), the mediation model for predicting school maladjustment is not presented given that neither the direct or indirect paths were significant in the model.

Overall impairment. Although together, parent- and student-rated ADHD symptom severity demonstrated an effect to T2 overall impairment, $F(3, 50) = 4.08$, $p = .01$, a total effect from student-rated ADHD symptom severity to T2 overall impairment was not present ($c = .21$, $SE = .14$, $p = .13$), nor was a total effect from parent-rated ADHD symptom severity to overall impairment ($c = .25$, $SE = .15$, $p = .08$). However, current mediation guidelines are clear that an indirect effect may exist in the absence of a direct effect (see Hayes, 2013; Preacher et al., 2007). In line with this possibility, and as shown in Figure 1, as a set, the total indirect effects of the mediators were significant ($p < .01$). Examination of the specific indirect effects shows that there was a significant indirect effect from T1 student-rated ADHD symptom severity to T2 overall impairment via T1 student-rated Self-Motivation (T1 ADHD symptom

Table 1. Means, Standard Deviations, and Intercorrelations of Predictor, Mediator, and Outcome Variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Predictor variables																		
1. T1 SR ADHD total symptoms	—	.42**	.51***	.50***	.54***	.35**	.37**	.08	.28*	.14	−.09	.05	.46***	.03	.13	.37**	.02	.03
2. T1 PR ADHD total symptoms		—	.30*	.08	.26*	.09	.29*	.56***	.43**	.56***	.40**	.32*	.30*	−.15	.08	.36**	−.07	−.10
Potential mediator variables																		
3. T1 SR Time Management			—	.59***	.38**	.66***	.24	.36**	.36**	.21	.19	.16	.59***	−.17	.36**	.33*	.16	.09
4. T1 SR Organization				—	.47***	.39**	.41**	.02	.35**	.04	−.21	.06	.62***	−.18	.28*	.32*	.29*	.12
5. T1 SR Self-Restraint					—	.56***	.67***	.13	.11	.43**	.09	.30*	.56***	−.09	.31*	.35**	.00	.13
6. T1 SR Motivation						—	.41**	.21	.04	.24	.26*	.25	.55***	−.21	.57***	.47**	−.11	.28*
7. T1 SR Emotion Regulation							—	.08	.02	.25	.02	.28*	.48***	−.13	.32*	.47**	.01	.23
8. T1 PR Time Management								—	.52***	.47***	.67***	.30*	.30*	−.22	.24	.28*	−.13	.13
9. T1 PR Organization									—	.40**	.34**	.21	.14	−.21	.14	.06	.00	.05
10. T1 PR Self-Restraint										—	.56***	.69***	.31*	−.27*	.16	.28*	−.16	.16
11. T1 PR Motivation											—	.41**	.09	−.19	.22	.10	−.24*	.20
12. T1 PR Emotion Regulation												—	.26*	−.14	.13	.39**	.00	.19
Baseline assessment of outcomes																		
13. T1 BFIS total													—	−.19	.29*	.56***	.07	.26*
14. T1 baseline GPA														—	−.31*	−.32*	.20	−.43**
15. T1 school maladjustment															—	.40**	−.06	.63***
Follow-up outcomes variables																		
16. T2 BFIS total																—	.01	.41**
17. T2 spring semester GPA																	—	−.20
18. T2 school maladjustment																		—
M	46.84	42.32	62.78	59.86	42.36	28.84	27.02	60.30	50.49	41.06	27.52	26.28	50.08	2.97	50.50	47.58	2.30	51.93
SD	8.53	8.76	12.28	14.61	12.14	8.45	8.95	14.71	14.78	13.87	9.72	11.00	23.25	0.67	9.03	24.58	1.09	9.35

Note. Sample size varies between 59 and 62 across measures/time points (see "Method" section for specific *N*s). BFIS = Barkley Functional Impairment Scale; GPA = grade point average; SR = Student Self-report; PR = Parent-report.
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 2. Hierarchical Regression Model of T1 Executive Functioning Predicting T2 Outcomes.

DV: T2 overall impairment	Step 1 model summary: $F(4,55) = 4.37$, $r^2 = .32$**				Step 2 model summary: $F(9,50) = 4.27$, $r^2 = .46$***, $\Delta F(5,49) = 2.43$*			
Student-rated EF deficits	*B*	*SE*	β	*t*	*B*	*SE*	β	*t*
T1 overall functional impairment	**.43**	**.15**	**.39**	**2.84****	**.38**	**.17**	**.34**	**2.20***
Previous college schooling	8.08	7.08	.14	1.14	12.19	7.68	.21	1.59
T1 SR ADHD total	.14	.39	.05	.35	.38	.45	.14	.80
T1 PR ADHD total	.53	.38	.18	1.39	.66	.40	.23	1.60
T1 SR Self-Management of Time	—	—	—	—	.68	.39	.34	1.74
T1 SR Self-Organization	—	—	—	—	−.09	.30	−.05	−.29
T1 SR Self-Restraint	—	—	—	—	.48	.39	.24	1.23
T1 SR Self-Motivation	—	—	—	—	**1.42**	**.52**	**.48**	**2.74****
T1 SR Self-Regulation of Emotion	—	—	—	—	.53	.44	.19	1.21
DV: T2 overall impairment	Step 1 model summary: $F(4,54) = 5.21$, $r^2 = .31$*				Step 2 model summary: $F(7,51) = 4.15$, $r^2 = .40$***, $\Delta F(3,48) = 1.91$			
Parent-rated EF deficits	*B*	*SE*	β	*t*	*B*	*SE*	β	*t*
T1 overall functional impairment	.44	.15	.40	2.85**	.39	.15	.32	2.18
Previous college schooling	7.28	7.36	.12	.99	4.75	7.39	.08	.64
T1 SR ADHD total	.14	.39	.05	.34	.31	.40	.11	.77
T1 PR ADHD total	.50	.39	.17	1.28	.11	.53	.04	.22
T1 PR Self-Management of Time	—	—	—	—	.19	.27	.12	.71
T1 PR Self-Restraint	—	—	—	—	.27	.33	.15	.79
T1 PR Self-Regulation of Emotion	—	—	—	—	**.81**	**.15**	**.36**	**2.56***
DV: Spring GPA	Step 1 model summary: $F(3,56) = 4.63$, $r^2 = .23$**				Step 2 model summary: $F(5,54) = 4.54$, $r^2 = .30$**, $\Delta F(1,54) = 5.69$*			
Student-rated EF deficits	*B*	*SE*	β	*t*	*B*	*SE*	β	*t*
T1 GPA	.27	.21	.16	1.26	.37	.21	.22	1.76
Gender	**−.95**	**.29**	**−.43**	**−3.33***	**−.81**	**.28**	**−.37**	**−2.92****
T1 SR ADHD total	.01	.02	.06	.48	−.02	.02	−.14	−.92
T1 PR ADHD total	−.03	.02	−.20	−1.41	−.02	.02	−.12	−.82
T1 SR Self-Organization	—	—	—	—	**−.03**	**.01**	**−.33**	**−2.39***
DV: Spring GPA	Step 1 model summary: $F(4,54) = 3.60$, $r^2 = .21$*				Step 2 model summary: $F(5,53) = 3.10$, $r^2 = .23$*, $\Delta F(1,53) = 1.06$			
Parent-rated EF deficits	*B*	*SE*	β	*t*	*B*	*SE*	β	*t*
T1 GPA	.23	.22	.14	1.07	.22	.22	.13	1.01
Gender	**−.93**	**.29**	**−.42**	**−3.25****	**−.87**	**.29**	**−.40**	**−2.98****
T1 SR ADHD total	.01	.02	.07	.50	.00	.02	.02	.14
T1 PR ADHD total	−0.03	.02	−.23	−1.54	−.02	.02	−.14	−.82
T1 PR Self-Motivation	—	—	—	—	−.02	.02	−.15	−1.03

Note. Significant effects are in boldface (*p*s < .05). *N* = 59 were examined for student ratings on ADHD symptoms and EF deficits. *N* = 58 were examined for parent ratings on ADHD symptoms and EF deficits. No significant interaction effects of ADHD symptoms and EF deficits were found and therefore not reported above. EF = executive function; GPA = grade point average; DV = Dependent Variable; SR = Student Self-report; PR = Parent-report.

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

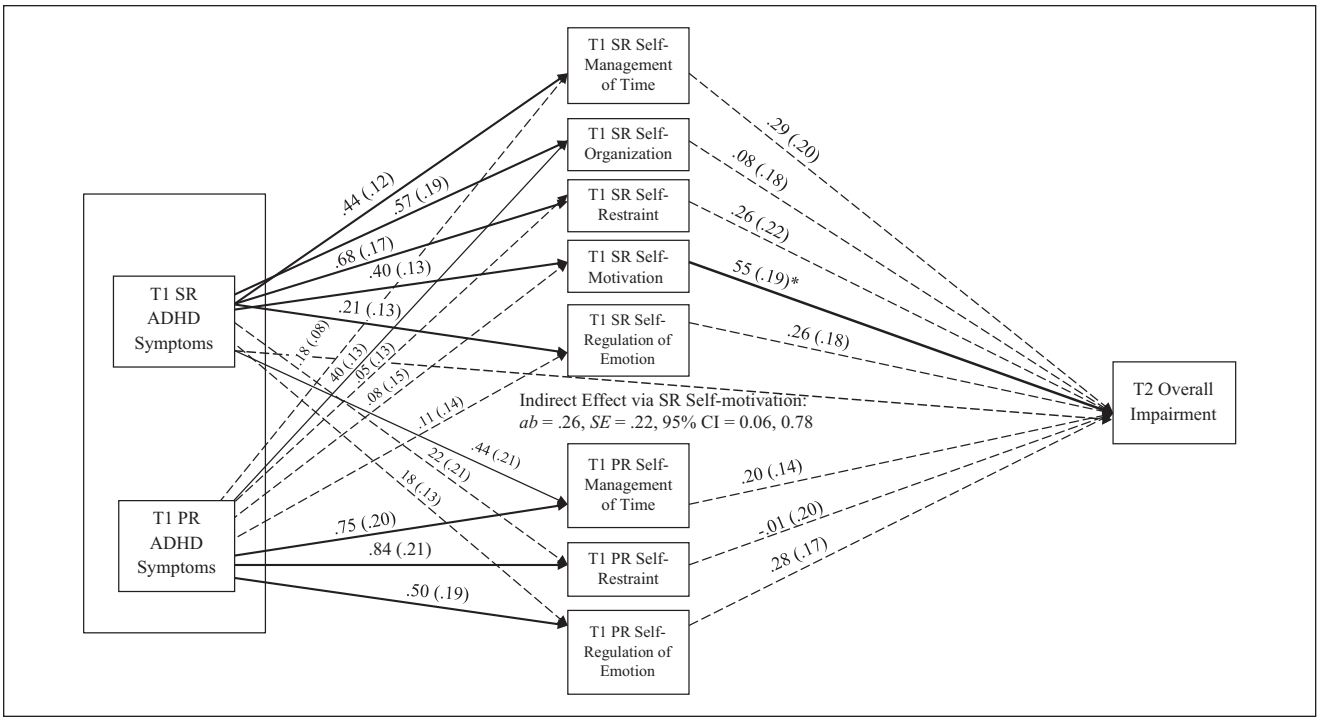

Figure 1. Indirect effects model of T1 ADHD symptoms predicting T2 Overall Impairment via T1 deficits in EF domains ($N = 58$).
Note. Unstandardized coefficients shown outside parentheses; standard errors are shown inside parentheses. Dashed paths are nonsignficant ($ps > .05$). Analyses controlled for T1 overall functional impairment and previous college, which in the final model were not significantly associated with any of the mediator or outcome variables with the exception of T1 functional impairment being significantly positively associated with T2 functional impairment ($b = .34$, $SE = .17$, $t = 2.02$, $p = .05$). SR = Student Self-report; PR = Parent-report.
*$p < .05$.

severity → T1 Self-Motivation → T2 Overall impairment, $ab = .26$, $SE = .22$, 95% CI = [0.06, 0.78]) over and above previous college schooling and T1 overall impairment. In addition, the paths from T1 student-rated ADHD symptoms to each of the student-rated EF scales were also significant, but none of the other EF deficit subscales in turn predicted T2 overall impairment.

GPA. Although together, parent- and student-rated ADHD symptom severity demonstrated an effect to T2 overall impairment, $F(3, 54) = 4.41$, $p = .007$, only a marginally significant total effect from parent-rated ADHD symptom severity to T2 GPA was present ($c = -.27$, $SE = .14$, $p = .06$), and no total effect from student-rated ADHD symptom severity to GPA ($c = -.09$, $SE = .13$, $p = .49$). However, as shown in Figure 2, as a set, the total indirect effects of the mediators were significant ($p < .01$) after controlling for gender and baseline grades. Examination of the specific indirect effects shows that there was a significant indirect effect from T1 student-rated ADHD symptom severity to T2 GPA via T1 student-rated Self-Organization (T1 ADHD symptom severity → T1 Self-Organization → T2 GPA, $ab = -.21$, $SE = .09$, 95% CI = [−0.03, −0.42]).

Group Differences in Academic Outcomes

As hypothesized, the groups with ADHD and clinically significant EF deficits had significantly higher levels of overall impairment in comparison with the ADHD and low EF deficit group ($ps < .05$, ds ranging from .54 to .85). In particular, those with clinically significant deficits in Self-Organization ($M = 53.79$, $SD = 25.03$) had significantly higher levels of overall impairment in comparison with the ADHD and low EF deficits group ($M = 36.33$, $SD = 19.67$) and the magnitude of this effect was large ($d = .78$). Similarly, those with clinically significant deficits in Self-Motivation ($M = 55.29$, $SD = 24.82$) had significantly higher levels of overall impairment in comparison with those with low EF deficits ($M = 36.33$, $SD = 19.76$) and the magnitude of this effect was large ($d = .85$). Although effect sizes differences were moderate (e.g., $d = .38$ for GPA), there were no significant group differences in those with or without high levels of EF deficits in GPA or School Maladjustment.

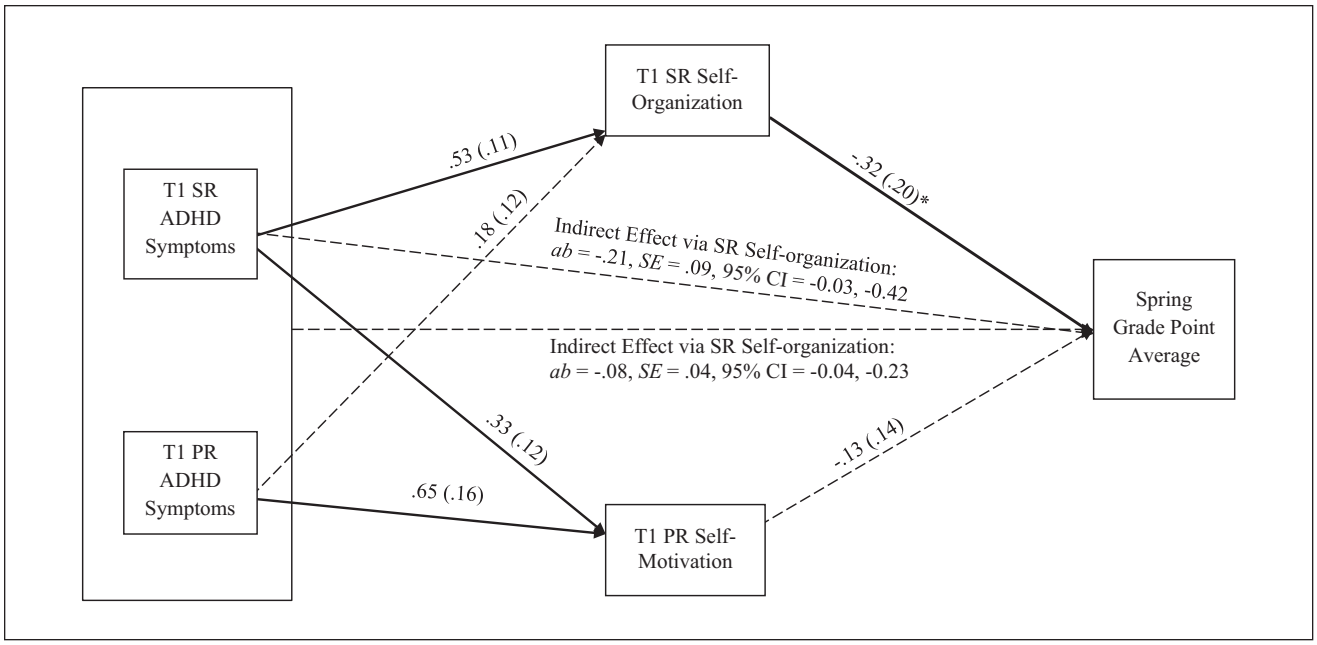

Figure 2. Indirect effects model of T1 ADHD symptoms predicting T2 grade point average via T1 deficits in EF domains (*N = 58*).
Note. Standardized coefficients shown outside parentheses; standard errors are shown inside parentheses. Dashed paths are nonsignficant (ps > .05). Analyses controlled for T1 grades and gender, which in the final model were not significantly associated with any of the mediator or outcome variables with the exception of gender being significantly positively associated with T2 grades (b = −.75, SE = .28, t = −2.63, p = .05). SR = Student Self-report; PR = Parent-report.
*p < .05.

Discussion

This is the first prospective longitudinal study to evaluate the effect of EFs on the academic functioning and overall impairment of college students comprehensively diagnosed with ADHD. College students in this sample were experiencing significant academic difficulties as evidenced by an overall spring semester GPA of 2.30. Parent and student ratings of EF at the beginning of the school year were significantly associated with overall impairment at the end of the school year, with stronger associations present for student ratings in comparison with parent ratings. The bivariate association between ratings of EF and the academic specific outcomes (school maladjustment and grades) was less robust and present only for a few specific aspects of EF (see Table 1). The regression, mediation, and grouping analyses revealed that the organization and motivation aspects of EF appear to be particularly important in predicting the academic and overall impairment of college students with ADHD. These findings are discussed in more detail below in terms of their relation to prior work in the area.

As expected, academic performance in this sample was relatively poor, and many students had low and failing grades and frequently withdrew from classes. Specifically, we found that on the spring academic semester report card, 25% of students had at least one D and 24% had at least one F with 44% of the sample having at least one D or F. In addition, 21% of the sample was placed on either "academic warning" or "academic probation," and 29% of the sample withdrew from at least one course during the second semester. In terms of service utilization and history of services, 24% (n = 15) reported having an IEP and receiving accommodations in high school, and about half (n = 31) reported currently receiving university accommodations. About one quarter of the participants in this sample had previously attended vocational or junior colleges, rates consistent with previous studies of college students with ADHD (Kuriyan et al., 2012; Mannuzza, Klein, Bessler, Malloy, & Hynes, 1997). The most commonly received services in this sample were accommodations, for which there is very little evidence-base supporting efficacy for students with ADHD (Harrison, Bunford, Evans, & Owens, 2013), and ADHD medication use. Interestingly, ADHD medication use was not significantly associated with any of the academic outcomes in this study. These findings are consistent with Advokat et al. (2011) who reported that although 90% of the college students with ADHD in their sample endorsed that medication helped them academically, there was no effect of medication on GPA. The poor academic functioning found in this sample along with the lack of available evidence-based services highlights the need for the development of interventions for college students with ADHD.

Ratings of EF deficits were strongest in predicting overall impairment with significant correlations for all five domains on self-reported EF and three of five domains on parent-reported EF. In contrast, only self-reported organization and parent-reported regulation of emotion were significant in predicting grades in the bivariate correlation analyses. In the regression models predicting overall impairment, self-reported motivation and parent-reported regulation of emotions were found to be the most important predictors, along with parent-rated ADHD symptoms. In the regression predicting GPA, self-rated organization was the only significant predictor, and ADHD symptoms were not significant in the model.

The pattern of mediation results found in this study further support the importance of motivation and organization in predicting the impairment of college students with ADHD. As noted in the introduction, there is an established relationship between ADHD symptoms and functional impairment in college students with ADHD. Findings from this study build upon this work and suggest that in college students with ADHD, the relation between ADHD symptoms and functional impairment may go through motivation aspects of EF. The Self-Motivation subscale included in this study contains items related to resisting immediate rewards to work toward longer-term or delayed rewards. Increasing evidence suggests that dysfunction in motivation and reward processing plays a significant role in the functional impairments of individuals with ADHD (e.g., Reaser, Prevatt, Petscher, & Proctor, 2007; Volkow et al., 2011). Specifically, individuals with ADHD appear to be particularly sensitive to immediate rewards and to have a difficult time getting motivated to work toward rewards available in the future, even if those rewards are larger than those that are immediately available (Sonuga-Barke, 2003). These motivational deficits have significant implications for the college setting where tasks are often long term (e.g., papers, projects, and exams) and where there are plenty of immediately available rewards and distractions. The results of this study suggest that strategies for increasing motivation to pursue long-term goals will be an important component of interventions for high school students with ADHD preparing to make the transition to college.

The mediation model examining GPA revealed that self-report of organization abilities mediated the relationship between ADHD symptoms and GPA. These findings are consistent with previous research with younger adolescents with ADHD suggesting that organizational skills are important predictors of academic functioning. For example, Langberg et al. (2011) found that organization of homework materials rated by parents in elementary school predicted GPA in high school above and beyond symptoms of ADHD and service utilization history. As noted in the introduction, Weyandt and colleagues (2013) demonstrated that college students with ADHD experience significant impairment in EF relative to non-ADHD controls, with large effect sizes exceeding one standard deviation for organization of time (i.e., planning), organization of materials, and task management. This study builds upon that work by showing that self-rated EF organizational skills longitudinally predict GPA. College students with ADHD and significant disorganization problems likely struggle with materials management, failure to plan ahead for assignments or exams, and poor task management, leading to late, incomplete or lower-quality work, as well as lateness or absences from class. Accordingly, these data suggest that college students with ADHD are likely to require support and intervention surrounding organizational skills to be successful.

Limitations

The primary limitation of this study is the modest sample size, which may have limited our ability to detect effects and the generalizability of the findings. These findings will need to be confirmed in larger longitudinal samples of college students with ADHD. In addition, all of the students in this sample came from a single public university, and as such, until these findings are replicated, it cannot be assumed that these results will generalize to college students with ADHD attending other universities. It is worth noting that the university where this study was conducted predominately serves in-state students (87%), is diverse (45% minority), and has average admissions standards (Class of 2017 high school GPA, $M = 3.27$; SAT, $M = 1{,}111$). Research is needed that includes multi-site college data on students diagnosed with ADHD collected from several universities across the United States including state colleges, private colleges, and community colleges. This would increase the external validity of the findings as well as provide evidence of the generalizability of these characteristics among college students with ADHD across different regions in the United States. This would also open the door for multi-level between and within group comparisons or controlling for university location or type (e.g., private, public, community college) as potential covariates in the model.

Relatedly, this study did not include measures of some potentially important covariates that should be considered in future research. For example, it is possible that cognitive factors not measured in this study such as intelligence or learning disabilities are important predictors of academic functioning in college students with ADHD. Future research is also needed to determine how college students with ADHD may differ from the overall population of young adults with ADHD. For example, it may be that certain factors (e.g., above average intelligence) are unique to college students with ADHD and explain why they are able to attend and potentially succeed in college, despite the presence of ADHD symptoms and EF deficits. In addition,

comorbid internalizing mood, anxiety, or substance use disorders were not captured in the diagnostic evaluation, and it would be important to explore the role of comorbities on the academic functioning of college students with ADHD in future research.

Finally, as noted in the introduction, there is currently no consensus definition for EF and this study relied upon self and parent ratings of EF using the BDEF ratings scale. Our findings would be strengthened had we used a multi-method approach for assessing EF. An important direction for future research would be to include both neuropsychological tasks of EF and ratings of EF in a single study predicting academic outcomes for college students with ADHD.

Future Directions

Longitudinal studies are crucial for increasing our understanding of the developmental course and consequences of EF deficits in individuals with ADHD. Our study contributes to the literature by examining ratings of EF in an emerging adult sample over the course of one academic year. However, longitudinal data collection using repeated measures over a longer period of time is important for understanding how EFs unfold across development and the degree to which EFs predict adjustment over the entire college experience. For example, it will be important to establish a temporal relation between ratings of EFs and other markers of academic functioning in college such as grade retention and school dropout. Future longitudinal studies could also follow students with ADHD before, during, and after the transition to college to identify important risk and protective factors present in high school students with ADHD. This type of research could lead to the development of high-school-based interventions that would facilitate a smooth transition to college for students with ADHD.

As noted above, approximately 60% of the sample reported taking medication for ADHD. Given that medication use was not associated with any of the academic outcomes in the present study, future research is needed to further explore the effect of medication on the EFs and functioning of college students with ADHD. One possibility is that college students with ADHD do not consistently take their medications, as parents can no longer consistently monitor adherence. Another possibility is that ADHD medication dose is not being monitored and titrated frequently enough to be maintaining efficacy because college students are separated geographically from their prescribing doctors. These factors were not evaluated in the present study, and future research is warranted. In addition, given the present study's findings related to the importance of EF for academic success in college, future research could also explore the effect medications may or may not have on the EFs of college students with ADHD.

These findings also have important clinical implications for the development of interventions to enhance motivation and organizational skills for college students with ADHD. The data from this study suggests that it is likely that many college students with ADHD will need intervention targeting goal setting, organization of materials and actions, working toward long-term goals, and managing emotional stress to be successful. Teaching students with ADHD to effectively self-regulate organization behaviors and organization of materials in the college context may be beneficial. This may include strategies for recording assignments, planning out activities, tasks or responsibilities and structuring contingencies to support follow-through (e.g., working with a study group). In addition, as discussed above, college students with ADHD are more likely to choose immediately rewarding behavior (e.g., talking with friends, playing computer games) over larger, long-term reward (e.g., starting a paper that s due in a week, going to sleep to be well rested for class the next day). Strategies for addressing deficits in motivation toward long-term rewards may include problem solving contextual factors that impact decision-making processes, immediate and contingent self-enforcement for completing tasks and sustaining effort, establishing external reinforcement contingencies toward long-term rewards, breaking tasks into small chunks, and using time reminds and planning ahead. Given what is known about college students with ADHD, it may be helpful to promote continued motivation by structuring treatment to provide relatively immediate rewards for participating and leveraging social support and engagement (Fleming & McMahon, 2012).

Conclusion

Findings from this study suggest that EFs are highly relevant for college students with ADHD and have important clinical implications for assessment and treatment. Assessment of students with ADHD preparing to transition to college should not only focus on symptoms but should also include measures of EF to best evaluate student readiness for the transition. The present study demonstrates that motivation and organization appear to be particularly important aspects of EF for the functioning of college students with ADHD. It appears likely that many college-age emerging adults with ADHD will need intervention targeting goal setting, organization of materials and actions, working toward long-term goals, and managing emotional stress to be successful in college. Importantly, if the mediational relationships found in this study are confirmed in future research, this would suggest that medication alone as a treatment, which primarily impacts symptoms (Epstein et al., 2010), would likely not be sufficient as the underlying causes of the impairment (e.g., lack of motivation) would not have been addressed.

Declaration of Conflicting Interests

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References

Advokat, C., Lane, S. M., & Luo, C. (2011). College students with and without ADHD: Comparison of self-report of medication usage, study habits, and academic achievement. *Journal of Attention Disorders*, *15*, 656-666.

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.

Barkley, R. A. (1997). Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. *Psychological Bulletin*, *121*, 65-94.

Barkley, R. A. (2011a). *The Barkley Adult ADHD Rating Scale–IV*. New York, NY: Guilford Press.

Barkley, R. A. (2011b). *The Barkley Deficits in Executive Functioning Scale*. New York, NY: Guilford Press.

Barkley, R. A. (2011c). *The Barkley Functional Impairment Scale*. New York, NY: Guilford Press.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, *51*, 1173-1182.

Biederman, J., Monuteaux, M., Doyle, A., Seidman, L., Wilens, T., Ferrero, F., . . .Faraone, S. (2004). Impact of executive function deficits and ADHD on academic outcomes in children. *Journal of Consulting and Clinical Psychology*, *72*, 757-766.

Blase, S. L., Gilbert, A. N., Anastopoulos, A. D., Costello, E. J., Hoyle, R. H., Swartzwelder, H. S., & Rabiner, D. L. (2009). Self-reported ADHD and adjustment in college: Cross-sectional and longitudinal findings. *Journal of Attention Disorders*, *13*, 297-309.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences* (3rd ed.). London, England: Routledge.

DuPaul, G. J., Weyandt, L. L., O'Dell, S. M., & Varejao, M. (2009). College students with ADHD: Current status and future directions. *Journal of Attention Disorders*, *13*, 234-250.

Eccles, J. S. (2004). Schools, academic motivation, and stage-environment fit. In R. M. Learner & L. Steinberg (Eds.), *Handbook of adolescent psychology* (pp. 125-154). Hoboken, NJ: John Wiley.

Epstein, J. N., Johnson, D., & Conners, C. K. (2000). *Conners' Adult ADHD Diagnostic Interview for DSM-IV*. North Tonawanda, NY: Multi-Health Systems.

Epstein, J. N., & Kollins, S. H. (2006). Psychometric properties of an adult ADHD diagnostic interview. *Journal of Attention Disorders*, *9*, 504-514.

Epstein, J. N., Langberg, J. M., Lichtenstein, P. K., Altaye, M., Brinkman, W. B., House, K., & Stark, L. J. (2010). Attention-deficit/hyperactivity disorder outcomes for children treated in community-based pediatric settings. *Archives of Pediatrics & Adolescent Medicine*, *164*, 160-165.

Fleming, A. P., & McMahon, R. J. (2012). Developmental context and treatment principles for ADHD among college students. *Clinical Child and Family Psychological Review*, *15*, 303-329.

Gregg, N., Coleman, C., Stennett, R. B., & Davis, M. (2002). Discourse complexity of college writers with and without disabilities: A multidimensional analysis. *Journal of Learning Disabilities*, *35*, 23-38.

Harrison, J., Bunford, N., Evans, S. W., & Owens, J. S. (2013). Educational accommodations for students with behavioral challenges: A systematic review of the literature. *Review of Educational Research*, *83*, 551-597.

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis*. New York, NY: Guilford Press.

Hayes, A. F., & Preacher, K. J. (2013). Statistical mediation analysis with a multicategorical independent variable. *British Journal of Mathematical and Statistical Psychology*. Advance online publication. doi:10.1111/bmsp.12028

Jacobson, L. A., Williford, A. P., & Pianta, R. C. (2011). The role of executive function in children's competent adjustment to middle school. *Child Neuropsychology*, *17*, 255-280.

Janusis, G. M., & Weyandt, L. L. (2010). An exploratory study of substance use and misuse among college students with and without ADHD and other disabilities. *Journal of Attention Disorders*, *14*, 205-215.

Kuriyan, A. B., Pelham, W. E., Molina, B. S. G., Waschbusch, D. A., Gnagy, E. M., Sibley, M. H., . . .Kent, K. M. (2012). Young adult educational and vocational outcomes of children diagnosed with ADHD. *Journal of Abnormal Child Psychology*, *37*, 739-747.

Langberg, J. M., Dvorsky, M. R., & Evans, S. W. (2013). What specific facets of executive function are associated with academic functioning in youth with attention-deficit/hyperactivity disorder? *Journal of Abnormal Child Psychology*, *41*, 1145-1159.

Langberg, J. M., Molina, B. S. G., Arnold, L. E., Epstein, J. N., Altaye, M., Hinshaw, S. P., . . .Hechtman, L. (2011). Patterns and predictors of adolescent academic achievement and performance in a sample of children with attention-deficit/hyperactivity disorder. *Journal of Clinical Child & Adolescent Psychology*, *40*, 519-531.

Mannuzza, S., Klein, R. G., Bessler, A., Malloy, P., & Hynes, M. E. (1997). Educational and occupational outcome of hyperactive boys grown up. *Journal of the American Academy of Child & Adolescent Psychiatry*, *36*, 1222-1227.

Miller, M., & Hinshaw, S. P. (2010). Does childhood executive function predict adolescent functional outcomes in girls with ADHD? *Journal of Abnormal Child Psychology*, *38*, 315-326.

Miller, M., Nevado-Montenegro, A. J., & Hinshaw, S. P. (2012). Childhood executive function continues to predict outcomes in young adult females with and without childhood-diagnosed ADHD. *Journal of Abnormal Child Psychology*, *40*, 657-668.

Molina, B. S. G., Hinshaw, S., Swanson, J., Arnold, L., Vitiello, B., Jensen, P., . . . MTA Cooperative Group. (2009). The MTA at 8 years: Prospective follow-up of children treated for combined type ADHD in a multisite study. *Journal of the American Academy of Child & Adolescent Psychiatry*, *48*, 484-500.

Norvilitis, J. M., Sun, L., & Zhang, J. (2010). ADHD symptomatology and adjustment to college in China and the United States. *Journal of Learning Disabilities*, *43*, 86-94.

Preacher, K. J., Cai, L., & MacCallum, R. C. (2007). Alternatives to traditional model comparison strategies for covariance structure models. In T. D. Little, J. A. Bovaird, & N. A. Card (Eds.), *Modeling contextual effects in longitudinal studies* (pp. 33-62). Mahwah, NJ: Lawrence Erlbaum.

Rabiner, D., Anastopoulos, A., Costello, J., Hoyle, R., & Swartzwelder, H. (2008). Adjustment to college in students with ADHD. *Journal of Attention Disorders*, *11*, 689-699.

Reaser, A., Prevatt, F., Petscher, Y., & Proctor, B. (2007). The learning and study strategies of college students with ADHD. *Psychology in the Schools*, *44*, 627–638.

Reynolds, C. R., & Kamphaus, R. W. (2004). *Behavior Assessment System for Children–Second Edition (BASC-2)*. Circle Pines, MN: AGS Publishing.

Roth, R. M., Isquith, P. K., & Gioia, G. A. (2005). *Brief Rating Inventory of Executive Function–Adult Version (BRIEF-A)*. Lutz, FL: Psychological Assessment Resources.

Sonuga-Barke, E. J. (2003). The dual pathway model of AD/HD: An elaboration of neuro-developmental characteristics. *Neuroscience & Biobehavioral Reviews*, *27*, 593-604.

Volkow, N. D., Wang, G.-J., Newcorn, J. H., Kollins, S. H., Wigal, T. L., Telang, F., . . .Swanson, J. M. (2011). Motivation deficit in ADHD is associated with dysfunction of the dopamine reward pathway. *Molecular Psychiatry*, *16*, 1147-1154.

Weyandt, L. L., & DuPaul, G. J. (2006). ADHD in college students. *Journal of Attention Disorders*, *10*, 9-19.

Weyandt, L. L., & DuPaul, G. J. (2008). ADHD in college students: Developmental findings. *Developmental Disabilities*, *14*, 311-319. doi:10.1002.ddrr.38

Weyandt, L. L., & DuPaul, G. J. (2013). *College students with ADHD: Current issues and future directions*. New York, NY: Springer.

Weyandt, L. L., DuPaul, G. J., Verdi, G., Rossi, J. S., Swentosky, A. J., Vilardo, B. S., . . .Carson, K. S. (2013). The performance of college students with and without ADHD: Neuropsychological, academic, and psychological functioning. *Journal of Psychopathology and Behavioral Assessment*, *35*, 421-435. doi:10.1007/s10862-013-9351-8

Wilmhurst, L., Peele, M., & Wilmhurst, L. (2011). Resilience and well-being in college students with and without a diagnosis of ADHD. *Journal of Attention Disorders*, *15*, 11-17.

Wolf, L. E., Simkowitz, P., & Carlson, H. (2009). College students with attention-deficit hyperactivity disorder. *Current Psychiatry Reports*, *11*, 415-421.

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