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PREDICTING THE ACADEMIC FUNCTIONING OF COLLEGE STUDENTS WITH
ATTENTION-DEFICIT/HYPERACTIVITY DISORDER: THE IMPORTANCE OF
EXECUTIVE FUNCTIONS AND PARENT REPORT

A thesis submitted in partial fulfillment of the requirements for the degree of Master of
Science at Virginia Commonwealth University

By: MELISSA RENEE DVORSKY

Bachelor of Arts, Ohio University, 2010

Director: Joshua M. Langberg, Ph.D.

Assistant Professor, Department of Psychology

Virginia Commonwealth University

Richmond, Virginia

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Abstract

PREDICTING THE ACADEMIC FUNCTIONING OF COLLEGE STUDENTS WITH ATTENTION-DEFICIT/HYPERACTIVITY DISORDER: THE IMPORTANCE OF EXECUTIVE FUNCTIONS AND PARENT REPORT

By Melissa R. Dvorsky, B.A.

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science at Virginia Commonwealth University.

Virginia Commonwealth University, 2014

Major Director: Joshua M. Langberg
Associate Professor, Department of Psychology

This study examined the impact of several dimensions of executive functioning (EF), as well as Attention-Deficit/Hyperactivity Disorder (ADHD) symptoms, in relation to college students' academic and overall functional impairment. Participants were 62 college students comprehensively diagnosed with ADHD and their parents/guardians who completed measures of symptoms of ADHD, EF, school maladjustment and functional impairment. The primary goal of the study was to evaluate whether parent- and self-ratings of EFs completed at the beginning of the school year longitudinally predict end of the school year academic and overall functioning above and beyond symptoms of ADHD. Mediation analyses controlling for covariates, including gender and transfer student status, were used to determine whether EF deficits mediate the relationship between ADHD symptoms and functioning. Additionally, parent- and student-rated deficits in EFs were examined for agreement as well as the incremental validity of each rater in predicting impairment. Deficits in student-rated self-motivation and parent-rated self-regulation of emotion significantly predicted overall impairment at the end of the year above and beyond symptoms of ADHD. Further, self-report of

self-motivation mediated the relationship between ADHD symptoms and overall impairment. In a separate model, student-rated self-organization at the beginning of the year mediated the relationship between ADHD symptoms and end of the year grades. Students with ADHD experience significant difficulties with the transition to college which may lead to the development of increased academic or functional impairment, particularly for students with EF deficits. The present study demonstrates that motivation and organization appear to be particularly important components of academic functioning for college students with ADHD. Overall, findings suggest that EF skills are highly relevant for college students with ADHD with important clinical implications for assessment and treatment. Further studies are needed to confirm the mediational mechanisms of EFs contributing to functional impairments in college students with ADHD.

Predicting the Academic Functioning of College Students with Attention-Deficit/Hyperactivity Disorder: The Importance of Executive Functions and Parent Report

Attention-deficit/hyperactivity disorder (ADHD) is characterized by developmentally atypical levels of inattention and/or hyperactivity-impulsivity (American Psychiatric Association, 2000, *Diagnostic and Statistical Manual of Mental Disorders*, 4th ed., text revision; American Psychiatric Association, 2013, *Diagnostic and Statistical Manual of Mental Disorders*, 5th ed.). While often first diagnosed during childhood, multiple longitudinal studies have demonstrated that ADHD symptoms, and symptoms of inattention in particular, persist into adulthood (Barkley, Fischer, Smallish, & Fletcher, 2002; Barkley, Fischer, Smallish, & Fletcher, 2006; Barkley, Murphy, & Fischer, 2008; Kuriyan, Pelham, Molina, Waschbusch, Gnagy, Sibley et al., 2012; Mannuzza, Gittelman-Klein, Bessler, Malloy, & LaPadula, 1993; Turnock, Rosen, & Kaminski, 1998), with prevalence rates estimated to be between 4 and 5% for adults with ADHD (Kessler, Adler, Barkley, Biederman, Conners, Demler et al., 2006; DuPaul, Weyandt, O'Dell, & Varegao, 2009; Glutting, Youngstrom, & Watkins, 2005). Importantly, even when youth diagnosed with ADHD no longer meet full diagnostic criteria as adults, they frequently continue to exhibit clinically significant impairment across a range of functional domains (Barkley, 2012; Molina, Hinshaw, Swanson, Arnold, Vitiello, & MTA Cooperative Group, 2009; Sibley, Pelham, Molina, Gnagy, Waxmonsky, Waschbusch et al., 2012; Weyandt, Rice, Linterman, Mitzlaff, & Emert, 1998)

ADHD is related to significant impairment across the developmental lifespan and adolescents with ADHD are at particular risk for academic difficulties. As a group, adolescents with ADHD experience significantly lower standardized achievement scores and school grades, and higher rates of grade retention and school dropout in comparison to their same-aged peers

(DuPaul & Stoner, 2003). Longitudinal research demonstrates that the educational impairments of youth with ADHD are best attributed to core characteristics of the disorder, such as deficits in executive function (EF) and symptoms of inattention, rather than to comorbid conditions such as oppositional defiant disorder (ODD) or conduct disorder (CD) (Masseti, Lahey, Pelham, Loney, Ehrhardt, Lee et al., 2008; Miller, Nevado-Montenegro, & Hinshaw, 2012; Langberg, Molina, Arnold, Epstein, Altaye, Hinshaw et al, 2011). Further, the long-term connection between ADHD symptoms and delinquency is largely mediated by low academic achievement (Defoe, Farrington, & Loeber, 2013), thus highlighting the critical importance of educational impairment as an assessment and intervention target for this population.

ADHD in the College Setting

Prevalence of ADHD in college. With improved diagnosis and treatment services as well as special education laws (e.g., Individuals with Disabilities Education Act, Section 504 of the Rehabilitation Act) mandating services for students with disabilities, the number of graduating high school students with ADHD pursuing higher education has risen dramatically in the past 30 years (DuPaul, Scheughency, Weyandt, Tripp, Kiesner, Ota et al., 2001; DuPaul et al., 2009; Wolf, 2001; Wolf, Simkowitz, & Carlson, 2009; Weyandt & DuPaul, 2006). It is estimated that between 2 and 8% of college students in the United States (U.S.) meet criteria for ADHD (DuPaul et al., 2001; DuPaul et al., 2009; Pryor, Hurtado, DeAngelo, Blake, & Tran, 2010; Janusis & Weyandt, 2010; Pope, Whiteley, Smith, Lever, Wakelin, Dudiak, et al., 2007). Further, 25% of all college students receiving disability support services obtain such services for ADHD (Wolf, 2001). However compared to their non-ADHD peers, fewer college students with ADHD successfully complete their degree and graduate from college or professional school programs (Dunn, 1995; Weiss & Hechtman, 1993; Wolf, 2001). Given more young adults with

ADHD pursuing college yet failing to successfully graduate, there is a significant need for research on the academic functioning of college students with ADHD and predictors of impairment.

The context of the college transition. For many individuals, with or without ADHD, the transition to college is the primary developmental context in which the shift into “emerging adulthood” occurs. “Emerging adulthood” and the transition to college, in particular, represent a developmental period in which individuals are faced with new challenges, such as a 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). Further, relative to high school environments, most college settings have larger class sizes, less frequent direct contact with professors or evaluative feedback, and more long-term assignments (Janiga & Costenbaderm, 2002). These developmental and academic changes may be particularly difficult for students with ADHD to navigate (Weyandt & DuPaul, 2008; Wolf, 2001), especially if they previously received significant supports or structure at school or home. Accordingly, the resulting student by environment interaction produces unique challenges that are particularly difficult for those with ADHD who may already struggle with distractibility, disorganization, and self-management.

Academic Impairment among College Students with ADHD

Given the increasing prevalence of students with ADHD entering college, researchers have begun to explore the nature and impact of ADHD for young adults in this setting. In 2007, Frazier and colleagues conducted a comprehensive meta-analysis of published literature since 1990 focused on the academic achievement problems associated with ADHD. The authors found only four manuscripts that examined academic outcomes and functioning of college students

with ADHD (Frazier, Youngstrom, Glutting, & Watkins, 2007). Since 2007, there has been a surge of research examining the relationship between ADHD and academic functioning in college (e.g., Blasé, Gilbert, Anastopoulos, Costello, Hoyle, Swartzwelder, et al., 2009; Kuriyan et al., 2012; Lewandoski, Lovett, Coddington, & Gordon, 2008; Nelson & Gregg, 2012; Rabiner, Anastopoulos, Costello, Hoyle, & Swartzwelder, 2008; Weyandt, DuPaul, Verdi, Rossi, Swentosky, Vilaro, et al., 2013; Norvilitis, Ingersoll, Zhang, & Jia, 2008; Weyandt, 2009); however, a number of important questions remain unanswered.

Many students with ADHD experience significant academic impairment following the transition to college (Heiligenstein, Guenther, Levy, Savino, & Fulwiler, 1999; Meaux, Green, & Broussard, 2009). Relative to their peers, college students with ADHD have lower grade point averages (GPAs), are more likely to be placed on academic probation, and tend to self-report more academic problems (e.g., Advokat, Lane, & Lou, 2011; Blasé et al., 2009; Dupaul et al., 2009; Frazer et al., 2007; Glutting et al., 2002; Heilgenstein et al., 1999; Lewandowski, Lovett, Gathje, Lovett, & Gordon, 2012; Murphy, Barkley, & Bush, 2002; Norvilitis, Sun, & Zhang, 2010; Rabiner et al., 2008; Pope, 2010; Schwanz, Palm, & Brallier, 2007; Weyandt et al., 2013; Wolf, 2001; Wolf et al., 2009). Further, given these academic difficulties, young adults with ADHD are less likely to graduate from college compared to their non-ADHD peers (Barkley et al., 2006; Kuriyan, et al., 2012; Wolf, 2001; Murphy et al., 2002; Weyandt & DuPaul, 2006).

Grades. One of the first studies in this area found that students with ADHD presenting at the university counseling center for services ($n = 26$) had GPAs a full standard deviation lower than non-ADHD students ($n = 28$) presenting for counseling (Heilgenstein et al., 1999). However, the extent that these findings would generalize to students with ADHD not seeking services through a university counseling center is unclear. Blasé and colleagues (2009) found

that students with self-reported ADHD ($n = 153$) had GPAs that were approximately 0.5 standard deviations below a comparison non-ADHD group ($n = 3,153$). In a separate longitudinal sample, the authors also found that freshman with self-reported ADHD ($n = 27$) had significantly lower GPAs during their sophomore year compared to those who did not self-report ADHD ($n = 813$).

In another study focused on grades, Lewandowski et al. (2012) found that students with ADHD ($n = 35$; diagnostic status based on self-report of prior diagnosis, receiving accommodations at the postsecondary level and/or meeting criteria for ADHD on a self-report checklist) had significantly lower GPAs ($M = 3.18$, $SD = 0.43$) than a non-ADHD control group ($M = 3.34$, $SD = 0.40$, $p < .05$). Weyandt and colleagues (2013) examined group differences on grades at the level of weekly performance on assignments and tests/exams. Students with self-reported ADHD ($n = 24$) had significantly lower grades than non-ADHD controls ($n = 26$), with weekly assignment and test grades differing by 10 percentage points on average. The Weyandt et al. (2013) data suggests that college students with ADHD may perform a full letter grade (C+ vs. B+) below their non-ADHD peers.

Finally, there is also some evidence to suggest that college students with ADHD perform worse than their peers academically irrespective of medication status. Specifically, Advokat et al. (2011) examined the school grades of students who self-reported an ADHD diagnosis and a current prescription for ADHD medication ($n = 92$) in comparison to a non-ADHD control group ($n = 143$). Students with ADHD currently taking medication reported significantly lower GPAs ($M = 2.94$, $SD = 0.44$) in comparison to the non-ADHD control group ($M = 3.12$, $SD = 0.49$). Those with ADHD currently taking medication also withdrew from significantly more classes ($M = 2.3$, $SD = 2.4$) compared to the non-ADHD control group ($M = 1.6$, $SD = 1.7$). Both groups were undergraduate college students surveyed through the psychology department extra credit

system and ADHD diagnosis, medication status, and GPA was all self-reported (Advokat et al., 2011).

Academic standing and education attainment. Studies have also reported that students with ADHD are more likely to be placed on academic probation (Heiligenstein et al., 1999) and are less likely to graduate from college than their non-ADHD peers (Murphy, Barkley, & Bush, 2002; Wolf, 2001). Significant group differences in the level of post-secondary education attainment have also been documented (i.e., including junior college, four-year college, trade school, business school) with young adults with childhood ADHD having completed few years of college compared to non-ADHD groups (Kuriyan et al., 2012; Mannuzza, Klein, Bessler, Malloy, & Hynes, 1997; Barkley, Murphy, & Fischer, 2008). In a longitudinal study of adults with ADHD, Mannuzza and colleagues (1997) found that individuals with ADHD ($n = 176$) completed less schooling than controls ($n = 178$) by approximately 2.5 years, (Mannuzza et al., 1997). More recently, Kuriyan et al. (2012) examined the educational attainment of young adults (aged 19-22) with history of childhood ADHD diagnosis, followed as part of the Pittsburgh ADHD Longitudinal Study (PALS Study). The authors found those with childhood ADHD ($n = 264$) had significantly less years of total education compared to those without ADHD ($n = 185$), $\chi^2(9) = 194.22, p < .001$, after controlling for parent education and IQ. Further, only 29.5% of the young adults with ADHD were enrolled in a four-year degree compared to 76.8% of the non-ADHD control adults.

Ratings of academic functioning. College students diagnosed with ADHD frequently self-report greater problems on ratings of academic behaviors important for successful academic functioning, such as time-management and study skills (Heiligenstein et al., 1999; Lewandowski et al., 2012; Kaminski, Turnock, Rosen, & Laster, 2006; Reaser, Prevatt, Petscher, & Proctor,

2007; Norwalk, Norvilitis, & MacLean, 2009; Kane, Walker, & Schmidt, 2011; Weyandt et al., 2013; Turnock, Rosen, & Kaminiski, 1998; Weyandt & DuPaul, 2006; 2013). College students with ADHD demonstrate clinically significant difficulties with time management, concentration, use of appropriate test strategies, selecting main ideas, and failing to reach academic goals (Kane, Walker, Schmidt, 2011; Blasé et al., 2009; Lewandowski et al., 2008; Reaser et al., 2007). Lewandowski and colleagues (2008) found that a sample of college students with self-reported ADHD ($n = 38$) reported greater difficulties with timed tests, completing assignments on time, taking more time to complete assignments, and feeling that they work harder to achieve good grades compared to those without ADHD ($n = 496$). A later study by Lewandowski et al. (2012) also found that students with ADHD ($n = 35$) perceived themselves as inferior test takers compared to their non-ADHD peers ($n = 185$). Specifically, those with ADHD reported higher scores on the Self-Evaluation of Performance on Timed Academic Reading (SEPTAR; Kleinmann & Lewandowski, 2005) indicating that they perceived themselves as having more problems in reading and testing under timed conditions, $t(218) = 5.66, p < .001, d = 1.05$. Further, the ADHD group reported significantly higher ratings of anxiety on timed tests compared to their non-ADHD peers, $t(218) = 5.93, p < .001, d = 0.85$.

Additional studies have found that college students with ADHD reported greater levels of difficulty than peers in note taking, studying ahead of time for exams, and completing homework assignments (Reaser et al., 2007; Norwalk et al., 2009; Kane, et al., 2011; Blasé et al., 2009; Weyandt et al., 2013). Reaser et al (2007) also found that students' with ADHD tended to display negative attribution styles, resulting in low motivation related to their testing and academic performance. For example, college students with ADHD often reported procrastination for long-term assignments and tests, less persistence, and preference for easier work. College

students with ADHD also appear to have significant difficulties with organizational skills. For example, Weyandt and colleagues (2013) reported that students with self-reported ADHD ($n = 24$) endorsed having significantly impaired study and organizational skills ($d = -2.058$), over 2 standard deviations below their non-ADHD peers ($n = 26$).

College students with ADHD also rate themselves as having more difficulties with academic adjustment to college relative to their non-ADHD peers (Norwalk, Norvilitis, & MacLean, 2009; Shaw-Zirt, Popali-Lehane, Chaplin, & Bergman, 2005; Rabiner et al., 2008). For example, Rabiner and colleagues (2008) examined the adjustment to the transition of college among a sample of 1,648 incoming freshman across two separate universities. Students were classified as ADHD or non-ADHD based on their self-report. Those with ADHD ($n = 68$) reported more academic adjustment concerns ($d = .58$) and depressive symptoms ($d = .37$) when compared with a randomly selected subgroup of control students without ADHD ($n = 200$). Similarly, Shaw-Zirt et al. (2005) compared college students with ADHD ($n = 21$) to controls ($n = 20$) matched on age, gender, and GPA, and found those in the ADHD group self-reported more difficulties related to academic adjustment, $F(1, 37) = 34.88, p = .001$, partial $\eta^2 = .49$.

Little is known about factors that may predict the academic 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 et al., 2002; Wilmhurst, Peele, & Wilmhurst, 2011). Further, the underlying mechanisms that contribute to academic success and failure of college students with ADHD are poorly understood. There has been some research exploring the role that ADHD symptoms and academic enablers (e.g. organizational skills) play in predicting the

academic functioning of college students with ADHD and findings from these studies are summarized below.

ADHD symptoms and academics in ADHD samples. Recent investigations in college settings have examined the relationship between ADHD symptoms (i.e., inattention and hyperactivity-impulsivity behaviors) and school performance, academic adjustment, academic skills, and educational attainments (see DuPaul et al., 2009 for a review). Most of these studies reported small but significant relationships between symptoms of inattention and measures of academic functioning such as GPA. Rabiner et al. (2008) reported that among students with self-reported ADHD, inattentive symptoms uniquely predicted both academic concerns ($\beta = .49, p < .001$) and depressive symptoms ($\beta = .42, p < .001$) even after controlling for gender, race, and personality traits (i.e., extraversion, agreeableness, conscientiousness, emotional stability, openness). However, the significance of hyperactive and impulsive symptoms in predicting academic performance in college remains unclear.

ADHD symptoms and academics in general samples. Among normative representative samples of college students, greater self-reported inattentive symptoms have also been associated with lower self-reported academic adjustment, lower achievement test scores, poor career decision-making self-efficacy, and lower GPAs (Glutting et al., 2002; Frazier et al., 2007; Norwalk et al., 2009; Schwanz et al., 2007; McKee, 2012). In a general sample of 380 freshman college students, Frazier and colleagues (2007) examined the predictive validity of parent and student reported ADHD symptoms in predicting end of year grades, dichotomized as GPA above or below 2.0. Evidence from this sample found that parent and student ratings of ADHD were equally predictive of first year GPA. Specifically, they found small but significant correlations between inattentive symptoms rated both students ($r = .17$) and parents ($r = .17$) in relation to

first year grades. Subsequent logistic regression analyses tested a complete model with five predictors (i.e., student-rated inattention, hyperactivity, impulsivity, and parent-rated inattention and hyperactivity) and indicated that together, parent and student ratings of ADHD distinguished students on academic probation (i.e., GPA below 2.0) from those with average to above average academic status (i.e., GPA above 2.0). Further, only student-rated inattention ($\beta = .040, p = .02$) and parent-rated inattention ($\beta = .036, p = .05$) significantly contributed to the prediction of GPA after controlling for the other predictors of ADHD in the model. In a separate model examining the same variables for predicting standardized admission tests such as the Scholastic Assessment Test (SAT) scores, student-rated inattention was the sole significant predictor. These findings contradict previous research that suggested that parent-ratings are more accurate and predictive of functioning as compared to student self-report ratings (Glutting et al., 2002; Achenbach, McConaughy, & Howe, 1987; Bird, Gould, & Staghezza, 1992; Loeber, Green, Lahey, & Stouthamer-Loeber, 1989).

Norwalk and colleagues (2009) examined the influence of inattentive and hyperactive symptoms for predicting GPA, academic adjustment to college, and use of study skills among college students ($n = 321, Mage = 20.04, SD = 4.33$). This study found that inattention was significantly related to lower levels of study skills ($\beta = -.45, p < .001$) and academic adjustment to college ($\beta = -.24, p < .001$). However, the authors failed to demonstrate a significant relationship between either inattentive or hyperactive symptoms and GPA ($p > .05$). The authors speculated that the lack of a relationship between ADHD symptoms and GPA might be due to the use of a general college population sample in which only a small portion self-reported a previous ADHD diagnosis ($n=9$). Glutting, Monaghan, Adams, and Sheslow (2002) examined the predictive validity of student and parent ADHD symptom ratings in a sample of incoming

freshmen ($n = 680$) and found that parent-rated inattention was a significant predictor of end of year GPA, while student self-report was not related to GPA.

More recently, McKee (2012) compared the utility of three-factor and two-factor solutions of self-reported ADHD symptom ratings from 1,096 college students for predicting academic adjustment, GPA, and achievement test scores (i.e., math and verbal scholastic achievement test scores; SAT). Self-reported inattention, hyperactivity, impulsivity, and hyperactivity/impulsivity (i.e., as one construct) were each significantly correlated (r s from $-.32$ to $-.61$) with academic adjustment during the first semester of college as measured by the Student Adaptation to College Questionnaire (SACQ; Baker & Siryk, 1999). However subsequent regression analyses supported inattention as a unique predictor of academic adjustment ($\beta = -.38$, $p < .001$) and hyperactivity, impulsivity, and hyperactivity/impulsivity were not significant predictors in the final model. Further, while inattention and hyperactivity were both significantly correlated with grades (r s from $-.14$ to $-.27$), only inattention uniquely predicted students' first year cumulative GPA ($\beta = -.24$, $p < .001$).

These findings support the clinical utility and predictive validity of both parent and student ratings of ADHD, in predicting the academic functioning of college students with ADHD. Further, these studies suggest that inattention problems are the most robust predictor of college GPA relative to symptoms of hyperactivity or impulsivity (e.g., Schwanz et al., 2007; Frazier et al., 2007; Glutting et al., 2002). However, small regression coefficients suggest that although symptoms of ADHD are significant predictors of academic functioning in college, other factors may account for a greater proportion of the variance. Therefore, it would be beneficial to explore the extent to which other malleable factors such as academic skills deficits,

organizational skills, or executive functioning predict the academic performance of college students with ADHD.

Academic enabler deficits predicting functioning. The term *academic enabler* encompasses a range of behaviors that facilitate the process of learning and performance, such as managing and organizing homework assignments and studying effectively (DiPerna & Elliott, 2000). Reaser and colleagues (2007) compared students with ADHD ($n = 50$) to students with learning disorders (LD; $n = 50$) and to a control group ($n = 50$) and found that students with ADHD self-reported more problems with motivation, time management, test-taking strategies, and use of study aids in comparison to students with LD and the control group. Multiple regression analyses examining the predictive strength of these academic enablers revealed a positive association between motivation and GPA for both the control ($\beta = .40, p < .05$) and ADHD ($\beta = .54, p < .05$) groups. However, the overall regression model examining the relation between all of the academic enablers in a single model in predicting GPA for the ADHD group was nonsignificant, $F(10,50) = 1.31, p > .05, R^2 = .06$.

Advokat and colleagues (2011) examined college students with and without self-reported ADHD and found that those with ADHD reported worse difficulties with planning ahead and completing assignments, taking notes during lectures, studying in advance for tests, and avoiding distractions. Further, within the ADHD group, GPA significantly differed as a function of their report of these academic skills $ps < .05$. Interestingly, no differences were found in amount of time spend studying per week, suggesting that college students with ADHD may display similar overall effort to their peers (Advokat, Lane, & Luo, 2011). Kaminski and colleagues (2006) reported that among 68 students recruited from student disability services and previously diagnosed with ADHD, students' report of coping resources and behaviors differentiated those

with high versus low academic success (defined as those with cumulative GPA below 2.61) and suggested that time management was a key determinant of academic success or failure among college students with ADHD. Together, these findings suggest that deficits in academic enabling behaviors such as organization, motivation, and study skills may place students with ADHD at high risk for academic failure.

Limitations of Current Literature

Despite the surge of research on ADHD in college samples since 2009, the current body of research remains extremely limited compared to the vast body of literature concerning ADHD in children. The small number of studies conducted in college samples as well as the significant methodological limitations of these investigations prohibits drawing firm conclusions about the impact of ADHD in college. Below, we review a number of important limitations associated with the work completed to date, including: (a) lack of comprehensive diagnostic evaluation procedures for identifying college students with ADHD; (b) the lack of longitudinal study designs; (c) the reliance on small samples that are not generalizable; and (d) the lack of research on the role that EFs play in the academic performance of college students with ADHD.

Comprehensive diagnosis and the importance of multiple informants. Almost all studies with college students with ADHD completed to date have relied upon either (a) students' self-report of prior ADHD diagnosis or (b) students' self-report on a standardized ADHD rating scale. Evidence-based assessment recommendations for evaluating ADHD in college students include the use of clinical interviews, emotional and behavioral questionnaires, and review of school records (Barkley, 2006). Further, McGough and Barkley (2004) recommend collecting third party (e.g., parent, teacher, relative) corroboration of symptoms and impairment in order to confirm diagnosis. In particular, obtaining parents' perspective of symptom presentation and

history through clinical interviews and behavioral questionnaires is particularly important (Barkley, 2006). Unfortunately, such thorough diagnostic procedures have rarely been followed in studies of ADHD in college samples.

Clinical interviews are important as several studies have found that students' self-report on ADHD symptom ratings scales do not accurately differentiate diagnostic group status (e.g., Lewandowski et al., 2008; Sollman, Ranseen, Berry, 2010; Burlison & Dwyer, 2013). For example, one study examined the utility of ADHD symptom checklists, neurocognitive tests, and symptom validity tests (i.e., Word Memory Tests used to detect feigned neurocognitive and psychological functioning), and found that neither measure including ADHD self-report scales, was effective for determining ADHD diagnostic status (Sollman, Ranseen, Berry, 2010). Burlison and Dwyer (2013) also investigated the predictive utility of a brief self-report six-item screener, the Adult Self-Report Scale-Version 1.1 (ASRS-V1.1; Kessler, Chiu, Demler, & Walters, 2005) in predicting the relation between ADHD symptoms and measures of academic performance and scholastic aptitude among 523 college students. The ASRS-V1.1 reliably discriminated between those "ADHD likely" and "non ADHD likely", however this did not result in differences in predicting academic performance. The authors concluded that self-report screeners of ADHD alone are likely not useful for evaluating the relation between academic performance in the college context.

In addition, self-report should not be relied upon to diagnose ADHD among college students given the risk for malingering. Multiple studies have documented students malingering (i.e., feigning or exaggerating symptoms) of ADHD to obtain eligibility for academic accommodations or to receive stimulant medication (Sullivan, May, & Galbally, 2007; Green & Rabiner, 2012; Nelson, 2013; Rabiner et al., 2008). For example, Sullivan and colleagues (2007)

found that 25-48% of college students who self-referred for ADHD evaluations feigned symptoms. Multiple studies have evaluated the utility of neuropsychological tasks or symptom validity tests for detecting cases of malingering, but have had limited success (e.g., Sollman, Ranseen, Berry, 2010). This underscores the importance of taking a multi-informant approach including the collection of parent ratings to protect against malingering. Additional research is needed that evaluates the academic functioning of college students comprehensively diagnosed with ADHD using a multi-informant approach.

Reliance on small samples. Most studies completed to date have reported findings for sample sizes that are limited to approximately 20 participants or less (DuPaul et al., 2009). As a result, these findings may not generalize to the overall population of college students with ADHD. Additional studies with larger samples are needed to further explore the impact of ADHD and other factors related to the disorder (e.g., executive functioning).

Lack of longitudinal study designs. Given that prior investigations have been primarily cross-sectional in nature, little is known about the long-term outcomes of individuals diagnosed with ADHD. In fact, no longitudinal study has been published looking at what factors predict negative academic outcomes for college students with ADHD. Future studies should incorporate longitudinal designs in order to identify patterns of changes in functioning over time.

Lack of research on the role of executive functions. Multiple cross-sectional and longitudinal studies have found that EF is an important predictor of academic functioning in samples of children and adolescents with ADHD (e.g., Miller & Hinshaw, 2010; Miller, Nevado-Montenegro, & Hinshaw, 2012). However, to date, the impact of EF on the academic outcomes of college students with ADHD has not been examined. Below, the role and theory of EF in

individuals with ADHD is briefly reviewed, followed by a review of studies showing that EF is a significant predictor of academic functioning in children and adolescents with ADHD.

The Role of Executive Functioning with ADHD

Researchers have hypothesized that the impairments of youth with ADHD may be associated with underlying deficits in EFs. Although there is no clear consensus for an operationalized definition of EF (Barkley & Fischer, 2011; Jurado & Rossellie, 2007; Wilcutt, Doyle, Nigg, Faraone, & Pennington, 2005), EF broadly refers to a set of neurocognitive processes mediated by the prefrontal cortex (Tranel, Anderson, & Benton, 1994) that are responsible for goal-directed problem solving behaviors and attention control (Nadeau, 1995; Nigg, 2005; Nigg et al., 2002; Welsh & Pennington, 1988; Barkley, 2011b; Barkley, 1997; Osmon, 1996). This collection of processes is typically recognized as entailing: response inhibition, working memory, emotional and motivational self-regulation, and planning and problem solving (Barkley, 1997; Frazier et al., 2004; Hervey et al., 2004; Pennington & Ozonoff, 1996; Welsh & Pennington, 1988).

One of the most widely recognized theories of EF in ADHD published to date is Barkley's (1997, 2001) unified theory of EF, in which EF is conceptualized as a hierarchal *meta-construct* that relies on multiple interacting neuropsychological processes. According to Barkley (1997, 2011), EF is a multidimensional construct founded on behavioral inhibition, and delays or deficits in inhibition are interrelated with more complex processes essential for self-regulation. Barkley (1997) presents a schematic configuration that links behavioral inhibition to (1) self-management to time, (2) self-organization or problem solving, (3) self-restraint or inhibition, (4) self-motivation (i.e., executing goal-directed responses and persistence to goal-directed behavior), and (5) self-activation or concentration (i.e., ability re-engage in tasks after

disruption). EF is thus a self-directed set of actions over time intended to change a future outcome or attain a goal (Barkley, 2011b). That is, EF represents a set of self-directed actions intended to achieve, alter, or delay future outcomes (Barkley, 2011b). Overall, it has been acknowledged that EFs reflect to the ability to engage in sequences of planned, goal-directed, behaviors over prolonged periods of time, by resisting distractions and inhibiting inappropriate responses (Baron, 2003; Friedman et al., 2006; Naglieri & Das, 2005). EFs are considered critical for complex human behavior, and their deficiencies are thought to result in significant psychological, behavioral and functional impairment (Goldberg & Seidman, 1991).

More recently, researchers have highlighted the importance of considering the variability in the presentation of EF. Specifically, though deficits in EF are common in individuals with ADHD, not all individuals with ADHD demonstrate EF deficits (Doyle, Seidman, Weber, & Faraone, 2000; Hinshaw, Carte, Sarni, Treuting, & Zupan, 2002; Nigg, 2005; Tripp & Wickens, 2008), and EF deficits are not necessarily unique to individuals with ADHD (e.g., Banaschewski, Hollis, Oosterlaan, Roeyers, Rubia, Willcutt, & Taylor, 2005; Willcutt et al, 2005). Further, there is considerable variability in the specific types of EF deficits individuals with ADHD exhibit. For example, some individuals with ADHD exhibit deficits in working memory, while others display working memory in the average range but have deficits in planning, or self-regulation of emotion. (Boonstra, Oosterlaan, Sergeant, & Buitelaar, 2005; Willcutt et al., 2005). Thus, it's likely that multiple mechanisms (e.g., ADHD symptoms, EF deficits) conspire to produce impairment (Biederman, Mouteaux, Doyle, Seidman, Wilens, Ferrero et al., 2004; Castellanos, Sonuga-Barke, Milham, & Tannock, 2006; Sergeant, Geurts, & Oosterlaan, 2002). This multiple-deficit hypothesis for explaining the complexity of ADHD and related impairment aligns with the theory of developmental psychopathology in that most disorders are likely to be

multifactorial (Sergeant, 2003). As a result, several theoretical models have emerged to attempt to explain the neuropsychological heterogeneity of ADHD and EFs (e.g., Willcutt et al., 2005; Alderson, Kasper, Hudec, & Patros, 2013; Barkley, 1997; Rogers et al., 2011; Semrud-Clikeman & Harder, 2011; Thorell, 2007; Tillman et al., 2013).

Persistence of EF over time. Longitudinal research has demonstrated that EF deficits associated with ADHD are fairly stable and persist throughout the developmental lifespan from childhood to adulthood (Biederman et al., 2006; Murphy et al., 2002; Tillman, Eninger, Forssman, & Bohlin, 2011; Tillman et al., in press). Moreover, some evidence supports that EF deficits are greater among adults compared to those experienced by children (Lijffijt et al., 2005). These findings support the notion that EF deficits are not solely the result of delayed development, but are a fundamental deficit that is persistent over time in most individuals. However, the relation between ADHD symptom trajectories and EF over time is not well understood. Some studies have found that EF deficits only persist into adolescence for those with persistent ADHD (Halperin, Trampush, Miller, Marks, & Newcorn, 2008), while others have found no differences in EF performance between those whose ADHD persists or remits (Biederman et al., 2009; Miller, Ho & Hinshaw, 2012). Miller and colleagues (2012) conducted a longitudinal investigation of females and found that those with childhood ADHD ($n = 140$) continued to show impairments in inhibition, working memory, and global EF relative to comparisons ($n = 88$) in young adulthood regardless of persistence of diagnosis.

Weyandt and colleagues (2013) recently conducted the only study to date to examine ratings of EF in a sample of college students with ADHD. This study compared college students with ADHD ($n = 24$) to control students ($n = 26$) and found that students with ADHD rated significantly more difficulties compared to non-diagnosed peers across all specific and global

areas of EF on the Behavior Rating Inventory of Executive Function, Adult Version (BRIEF-A; Roth, Isquith, & Gioia, 2005). Overall, these findings suggest that deficits in EF persist over time and may be a significant risk-factor for poor academic performance in college students with ADHD.

Executive functioning predicting academic impairment in youth. A significant association between EF and academic functioning has been demonstrated across samples of youth with ADHD and general education youth (Best, Miller, & Naglieri, 2011; Biederman et al., 2006; Biederman et al., 2004; Diamantopoulou, Rydell, Thorell, & Bohlin, 2007; Langberg, Dvorsky, & Evans, 2013; Loo et al., 2007). In a cross-sectional study, of youth with ($n = 259$) and without ($n = 222$) ADHD, Biederman et al. (2004) examined the interaction between EF deficits and ADHD on academic outcomes. The authors reported that children and adolescents with both ADHD and EF deficits ($Mage = 12.3$, $SD = 3.7$) had significantly lower academic achievement and were more likely to repeat a grade in comparison to children with ADHD alone ($Mage = 13.1$, $SD = 3.5$). In this study, EF was defined as impairment on at least two measures of EF from a battery of eight neuropsychological tests, including measures of sustained attention, planning and organization, response inhibition, set shifting, selective attention and visual scanning, verbal and visual learning, and memory. Biederman et al. (2004) also found that EF deficits in students without an ADHD diagnosis were not linked with achievement, suggesting that the relationship between ADHD symptoms and EF deficits may work together to create academic impairment. Importantly, these analyses also controlled for group differences in socioeconomic status, learning disorders, and intelligence.

A significant relationship between EF and academic functioning has also been found longitudinally among a sample of girls rigorously diagnosed with ADHD ($n = 140$) followed

from middle childhood through young adulthood (Miller & Hinshaw, 2010; Miller, Nevado-Montenegro, & Hinshaw, 2012). In the first paper, Miller and Hinshaw (2010) reported that EF in childhood predicted academic achievement and global functioning in adolescence, independent of intelligence. That is, after controlling for IQ, baseline performance on the error proportion score (EPS) from the Rey-Osterrieth Complex Figure (ROCF; Osterrieth, 1944) significantly predicted follow-up math achievement scores ($\beta=0.11$, $p = 0.038$), measured by performance on the Wechsler Individual Achievement Test (WIAT; Wechsler, 1991) and global functioning, ($\beta=0.20$, $p = 0.004$), as rated by parents on the Columbia Impairment Scale (Bird et al., 1993). These findings are in line with prior research showing that youth with ADHD and EF deficits have lower academic performance compared to those without EF deficits or without and ADHD diagnosis (Biederman et al., 2004). However, Miller and Hinshaw (2010) failed to find significant moderations for group status (ADHD diagnosis vs. non-ADHD comparison group), suggesting that EF was predictive of future academic functioning for the entire sample and suggesting non-specificity of EF deficits.

Rogers and colleagues (2011) examined the role of inattention and working memory in predicting academic achievement among adolescents ($N = 145$) aged 13 to 18 clinically referred for ADHD. Specifically, the authors conducted a path analysis to examine whether auditory-verbal and visual-spatial working memory mediated the relationship of teacher-rated inattention to math and reading achievement. Auditory-verbal and visual-spatial working memory constructs were both measured by the Digit Span and Letter-Number Sequencing subtests of the Wechsler Intelligence Scale for Children-Fourth Edition (WISC-IV; Wechsler, 2003), inattention was measured from the teacher form of the Strengths and Weaknesses of ADHD-symptoms and Normal Behavior Scale (SWAN; Swanson, Schuck, Mann, Carlson, Hartman, & Sergeant,

2005), and academic achievement in math and reading was measured using the Woodcock-Johnson-III Test of Achievement (WJ-III; Woodcock, McGrew, & Mather, 2001). The path from inattention to reading achievement was partially mediated by auditory-verbal and visual-spatial working memory. However, the path from inattention to math achievement was not mediated by working memory. Together, the ADHD symptoms and working memory variables accounted for approximately 35% of the variance in adolescents' reading achievement and 40% of the variance in math achievement with acceptable model fit, $\chi^2(1) = 10.37, p < .05$. These findings provide preliminary support for the potential role of working memory for predicting academic achievement among adolescents with attention problems. However, this study was limited to single indicators (for predictors and outcomes), which limits our ability to draw conclusions about the impact of multiple components of EF on various academic outcomes in comparison to different ADHD symptoms.

In a sample of 145 Swedish children in kindergarten ($M_{age} = 6.33, SD = 0.41$), Thorell (2007) studied the role of delay aversion and EF deficits in contributing to impact of ADHD symptoms for predicting early academic skill deficits. Ratings of ADHD symptoms were collected from the child's preschool teachers using a rating scale containing the 18 criteria for ADHD as presented in the *DSM-IV* (DuPaul, Power, Anastopoulos, & Reid, 1998), delay aversion was measured using a computerized task modified from the Choice Delay Task (C-DT; Sonuga-Barke, Taylor, Sembi & Smith, 1992), EF was defined using an aggregate score from two inhibition tasks (inhibition control and response inhibition) and two working memory tasks (verbal and spatial working memory), math and language skills were measured with a standardized achievement test battery used in Sweden. Both delay version and EF deficits were independently related to ADHD symptoms ($ps < .05$). However, only EF deficits, not delay

aversion, mediated the relationship between inattentive symptoms to mathematics and language skills.

Finally, Langberg, Dvorsky, and Evans (2013) examined the unique contributions between ratings of specific factors of EF and academic functioning in a sample of 94 middle-school-aged youth with ADHD ($M_{age} = 11.9$). This study builds on prior work by separately evaluating associations between multiple specific facets of EF (e.g., working memory, inhibition, and planning and organization) as rated by both parents and teachers on the Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000), with school grades and homework problems. Authors examined the relationship between EF ratings and academic outcomes above and beyond ADHD symptoms after controlling for potentially important covariates, including intelligence and achievement scores. The authors reported that EF predicted academic functioning above and beyond symptoms of ADHD. Importantly, not all aspects of EF were found equal in their ability to predict the academic outcomes. Specifically, when examined as a set, the metacognitive EF mechanisms including initiating tasks, working memory, planning and organizing, monitoring and organization of materials, but not the behavioral regulation aspects of EF, were significant in predicting grades ($\Delta F(5,84) = 5.09^{**}$, $R^2 = .34$) and homework problems ($\Delta F(5,84) = 3.02^*$, $R^2 = .72$). Parent and teacher ratings of the Planning and Organization aspects of EF were consistently the strongest predictors of academic functioning above and beyond ADHD symptoms and other aspects of EF.

Summary of EF and academics literature. Together, the results of these studies document the broad utility of specific aspects EF in predicting the academic functioning of individuals with and without ADHD. The abilities to self-manage time, organization, problem solving, and motivation are essential for positive academic performance. In fact, evidence has shown that

youth with ADHD who also exhibit EF deficits are likely to require academic intervention in order to prevent school failure or dropout (Barry et al., 2002; Biederman et al., 2004; Massetti et al., 2008). Further, it appears that while behavioral aspects of EF (e.g., emotional control, inhibition) are most salient for academic functioning in preschool and elementary school, meta-cognitive aspects of EF (e.g., planning, organization) are most relevant for older students (e.g., Fleming & McMahon, 2012; Langberg et al., 2013). However, to date, there has been no study of the relation between EF and academic outcomes in college students with ADHD.

Summary of Significance

In summary, there has been increasing research on college students with ADHD but very little research on predictors of functioning. Further, the studies completed to date have significant limitations including reliance on self-reported ADHD diagnoses and academic outcomes and use of cross-sectional designs. Clearly more research is needed to identify predictors of academic functioning in college students with ADHD as this could lead to the development of targeted intervention.

The hypothesis that EF deficits could underlie the academic impairments of college students with ADHD has excellent face validity when considering the contextual demands of college. As mentioned above, EFs allow individuals to set goals and to execute specific behaviors towards achieving those goals (i.e. planning and organization), to suppress behaviors that are inconsistent with the goal (i.e. response inhibition and emotion regulation), and to self-evaluate behavior and change course if the plan is not leading to the desired outcome (i.e. self-monitoring; Barkley, 1997; Best, Miller, & Naglieri, 2011; Blair & Diamond, 2008). The college setting represents a unique environment where the effective use of complex EF skills such as planning and organization and self-regulation is frequently required (Anderson, 2002; Best,

Miller, & Naglieri, 2011). While these skills and processes are still maturing during emerging adulthood, they are increasingly important for academic success as students are expected to independently manage assignment and exam preparation (Bowers, 2011; Eccles, 2004; Jacobson, Williford, & Pianta, 2011; Randall & Englehard, 2009). In order to succeed academically in college, students must be able to organize materials and time, plan in advance, engage in goal-directed activities, inhibit inappropriate or ineffective behaviors, and shift fluidly from one task to another (Fleming & McMahon, 2012). The college setting represents a unique environment where the effective use of complex EF skills such as self-regulation and organization is frequently required (Anderson, 2002; Best, Miller, & Naglieri, 2011).

However, research is lacking for understanding the degree to which the EF deficits associated with ADHD in college students might contribute to students' academic impairment. It is not known whether the effects of EF deficits and ADHD symptoms on academic impairment are unique and additive or whether these two mechanisms combine synergistically, meaning that the combination of EF deficits and ADHD symptoms results in a collective effect that is greater than the sum of each component. Given that EF deficits have been associated with both ADHD symptoms (Willcut et al., 2005) and with academic impairment (Biederman et al., 2004), it is worth considering whether EF deficits are merely proxy measures of ADHD or do they add unique contributions to predicting impairment above and beyond ADHD symptom severity. For samples of children with ADHD, it has been hypothesized that the two processes (i.e., EF and ADHD symptoms) can be differentiated in terms of their effect on academic impairment, such that EF deficits act as a mediator in the relation between ADHD symptoms and impairment (e.g., Thorell, 2007). However, prior studies have not explored the nature of specific EF deficits as

mechanisms responsible for the path between ADHD symptoms and reduced academic functioning in college students with ADHD.

Study Aims

Accordingly, the purpose of the present study was to fill a gap in the existing literature by examining the role of EF in predicting the academic and overall functional impairment of college students comprehensively diagnosed with ADHD. This study collected both student and parent ratings in view of the evidence discussed above that ratings from each informant may capture unique aspects of EF and ADHD symptoms as well as may contribute differently to the prediction of functional impairment. Based on Barkley's (1997; 2001) unified theory of EF as a hierarchally organized meta-construct, this study will examine the unique contribution of ratings of specific EF deficits relative to ADHD symptom severity. As recommended by prior investigators, this study utilized a multi-method approach for assessing academic impairment by collecting multiple measures of academic functioning (i.e., objective and subjective methods) at the end of the school year. Academic and functional impairment outcomes included grades, ratings of academic adjustment and functional impairment. The sample included in this study was rigorously diagnosed with ADHD using both parent- and self-report diagnostic interviews and standardized rating scales. This is important, as most prior research with college students with ADHD has relied solely on self-report to establish diagnoses. Specifically, the present study was guided by the following primary aims:

Aim 1: Given that the empirical study of ADHD in the college student population is in its infancy compared to the vast body of literature concerning children and adolescents with ADHD (DuPaul et al., 2009; Green & Rabiner, 2008), the first goal of the present study is

to evaluate and present data on the demographic characteristics and academic functioning profiles of a sample college students comprehensively diagnosed with ADHD.

- *Hypothesis 1:* It is hypothesized that consistent with studies of younger adolescents with ADHD (Langberg et al., 2011) and college ADHD samples relying on self-report (e.g., Blase et al., 2009; Frazier et al., 2007; Norwalk et al., 2009) students with ADHD in this sample will exhibit considerable academic impairment as evidenced by a low (below B average) GPAs and high rates of course withdrawals and D's and Fs' in classes.

Aim 2: Examine the correspondence between participant self and parent informant ratings of ADHD symptoms and EF deficits.

- *Hypothesis 1:* Consistent with prior research investigating agreement between self- and parent-report of ADHD symptoms in general college student samples (Nelson, 2013; Glutting et al., 2002; Zucker et al., 2002), ratings of EF deficits and ADHD symptom severity are expected to demonstrate cross-informant correlations that are low to moderate in magnitude (r s and ICCs ranging from .20 to .50; see Cohen, 1988, for benchmarks).
- *Hypothesis 2:* Given that studies using nonclinical samples have shown that adult participants self-report more symptoms than other-informants (Glutting, Youngstrom, & Watkins, 2005; Murphy & Schacar, 2000), it is hypothesized that the mean self-reported ADHD symptom and EF subscale scores will be significantly higher than the mean parent-reported ADHD symptom and EF subscale scores.

Aim 3: Longitudinally examine the relation between EF, ADHD symptom severity, and student demographic characteristics in predicting the functional impairment of college students with ADHD.

- *Hypothesis 1:* It is predicted that ADHD symptoms and EF deficits (at the beginning of the school year) will negatively predict academic performance and positively predict overall impairment at the end of the school year.
- *Hypothesis 2:* It is hypothesized that EF deficits will predict impairment above and beyond parent- and self-report of ADHD symptoms and relevant covariates.
- *Hypothesis 3:* Extending the prior literature with adolescents with ADHD (Langberg, Dvorsky, Evans, 2013; Langberg et al., 2011), it is hypothesized that the organization and time management aspects of EF will be associated with grades whereas the emotion regulation aspect of EF will be associated with school adjustment and overall functional impairment (Miller, Nevado-Montenegro, & Hinshaw, 2012).

Aim 4: Compare the incremental validity of each rater in predicting the academic functioning of college students with ADHD.

- *Hypothesis 1:* In view of the problems with the validity of self-report of symptoms and behaviors among young adults with ADHD (Barkley et al., 2002; Nelson, 2013), and evidence supporting the increased predictive validity of models including multiple informants (e.g., Sibley et al., 2012), it is hypothesized that including parent-ratings will significantly improve predictive models.

Aim 5: Explore the means by which ADHD symptoms may influence academic and functional outcomes by examining an integrative model to explore whether deficits in EF mediate the relationship between ADHD symptoms and academic impairment.

- *Hypothesis 1:* Based on the theory that college students with ADHD are more likely to have increased problems with EF, which in turn may be associated with poor academic and functional impairment, it is hypothesized that EF deficits will mediate the relationship between ADHD symptoms and functional impairment.

Aim 6: Conduct exploratory analyses to examine whether significant differences in functional impairment exist between participants with ADHD with and without clinically significant EF deficits.

- *Hypothesis 1:* It is hypothesized that participants with ADHD and clinically elevated EF deficits will demonstrate significantly higher levels of functional impairment, more problems adjusting to school, and lower grades compared to those with EF deficits that fall below the clinical range.

Method

Participants

The study was conducted at a large, urban public university. To gain admission at this university, students must have a minimum ACT score of 13 and a high school GPA of 2.18 or higher. As such, a wide range of academic aptitude and an average six-year graduation rate of 56% characterize the university student body. The university enrolls a total of approximately 23,951 undergraduate students, of which 2,021 (8.4%) are transfer students from community colleges. Of the undergraduate VCU population, 36% self-identify as a racial and/or ethnic minority (i.e., 16% African American, 11% Asian American, 6% Hispanic, 3% multi-racial) and 38% receive need-based scholarships (Virginia Commonwealth University, 2013; The National Task Force on Civic Learning and Democratic Engagement, 2012)

Participants in the present study were 68 undergraduate students. Given the focus on

academic functioning, we limited the sample to those students taking at least 3 courses (≥ 9 credit hours), resulting in a final sample of 62. These 62 participants ranged in age from 17 to 30 years of age ($M = 19.50$, $SD = 2.46$) and slightly over half were male ($n = 35$). Forty-four participants (71%) self-identified as Caucasian; the remaining participants (29%) self-identified as a racial and/or ethnic minority (i.e., 9.7% African American, 9.7% Hispanic, or 9.7% Multiracial). Approximately half of the participants ($n = 32$) were in their first year of college, with remaining participants in their second ($n = 14$), third ($n = 10$), or fourth ($n = 6$) year. Based on procedures described below, 35 participants were diagnosed with *DSM-IV* ADHD Predominately Inattentive Type (ADHD-I) and 27 participants were diagnosed with ADHD Combined Type (ADHD-C). See Table 1 for descriptive participant information.

Table 1.

Participant Demographic Characteristics

Variable	Frequency (Percent)	Mean \pm SD
Age	--	19.5 \pm 2.46
Sex		
Male	N=35 (56.5%)	--
Female	N=27 (43.5)	--
Race/Ethnicity		
Black	N = 6 (9.7%)	--
Hispanic	N = 6 (9.7%)	--
Caucasian	N= 44 (71.0%)	--
Multiracial	N = 6 (9.7%)	--
Year in School		
Freshman	N=32 (51.6%)	--
Sophomore	N=14 (22.6%)	--
Junior	N=10 (16.1%)	--
Senior	N = 6 (9.7%)	--
Parent Education Level		--
High school/GED	N = 9 (14.52%)	
Some college	N = 7 (11.29%)	
Bachelors degree	N = 25 (40.37%)	
Graduate degree	N = 21 (33.87%)	
Student employment Status	N=32 (51.6%)	
Student employment Hours		14.32 \pm 4.65
Previous College Schooling	N=14 (22.6%)	
High school GPA	--	3.09 \pm 0.52

College Achievement Test	--	1115.79 ± 137.52
Family Income		
Below \$25,000	N=5 (9.8%)	--
\$25,000 to \$74,999	N=5 (9.8%)	--
\$75,000 to \$99,999	N=10 (19.6%)	--
\$100,000 to 149,999	N=13 (21.0%)	--
\$150,000 and above	N=18 (29.0%)	--
ADHD Medication Status	N=36 (58.1%)	--
Other Psychotropic Medication	N=4 (6.5%)	
Housing Status		
Live at home with parents	N=14 (22.6%)	--
ADHD Inattentive Presentation Diagnosis	N=35 (56.5%)	--
ADHD Combined Presentation Diagnosis	N=27 (43.5%)	--

Note. $N = 62$. Age is calculated in years. For employment status, 0 = participant not employed, 1 = participant employed. For employment hours, participants estimated the average number of hours worked per week. For previous college schooling, 1 = participant indicated having transferred to current university after attending another university or community college, 0 = participant indicated they did not previously attending any other college. ADHD medication status, 0 = not taking medication for Attention-Deficit/Hyperactivity Disorder (ADHD), 1 = taking medication for ADHD. For other psychotropic medication, 0 = not taking other psychotropic medication, 1 = taking psychotropic medication for reasons other than ADHD. For housing status, 0 = participant not living at home, 1 = participant living at home.

Procedure

The present study was approved by the university IRB. The inclusionary criteria were: (a) attendance at the university where the research was being conducted, (b) consent for research staff to contact participants' parent/guardian for a diagnostic interview, (c) meeting full diagnostic criteria for ADHD-I or ADHD-C, and (d) not meeting criteria for a pervasive developmental disorder, bipolar disorder, or psychosis (based upon interview about medical history). Diagnosis was determined through administration of both Part I and Part II of the *Conners' Adult ADHD Diagnostic Interview for the DSM-IV* (CAADID; Epstein, Johnson, & Conners, 2000; Epstein & Kollins, 2006) separately to both the student and their parent/guardian. The CAADID interview assessed both current (past 6 months) and childhood symptoms and impairment as well as age of onset and pervasiveness of symptoms across time. Part I of the interview provided a detailed patient history designed to obtain information about past mental

health diagnoses, medication usage, psychiatric comorbidity, educational and work history, and other potential risk factors. Part II of the interview consisted of the DSM-IV criteria for ADHD.

Strict diagnostic inclusion criteria were adhered to in this study because of questions/debates in the field regarding the validity of self-report in college students with ADHD and concerns about malingering (e.g., Sollman, Ranseen, & Berry, 2010). Specifically, parents/guardians had to endorse at least 6 symptoms in an ADHD domain on the CAADID as present and impairing during childhood for a student to be included. Further, the student and their parents/guardians had to endorse a total of 6 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 4 symptoms in a domain as currently present and impairing for supplementing to occur. Once an ADHD diagnosis was confirmed, student self-report on the CAADID interview was prioritized in making ADHD subtype determinations.

Students were referred to the study in one of three ways. First, flyers describing the study were included in the orientation packets of all incoming freshman. 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 families were informed that if an ADHD diagnosis was confirmed, the evaluation report could be used as documentation at the University Disability Services Office and at Student Health Services. In addition, students and their families were told they would be compensated \$75 for their time and effort in coming to the University to complete the evaluation procedures. Parents were paid \$20 each for the forms that they completed. Second, the University Disability Services Office e-mailed the flyer to all students in their database currently receiving accommodations for ADHD. The e-mail

stated that students who were interested in the study should call the study research coordinator to complete a phone screen. Third, the flyer was posted in the Disability Services Office, at Student Health, and in all university dorms. Students who called research staff to express interest in the study were read a phone script describing the study in detail and administered a phone screen. On the phone screen, the student had to endorse either a current diagnosis of ADHD *or* at least 4 of 9 *DSM-IV* symptoms of inattention in order to be scheduled for an inclusion/exclusion evaluation. Parents and students completed baseline measures at the beginning of the school year (August) and follow-up measures at the end of the school year (May; 9 months post-baseline).

Baseline Predictor Measures

Demographic/Student Characteristics. 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. Descriptive statistics for these demographic and student characteristic variables are presented in Table 1.

Adult ADHD Rating Scale-IV (Barkley, 2011a). ADHD symptoms were assessed using the *Barkley Adult ADHD Rating Scale-IV* (BAARS-IV; Barkley, 2011a). The BAARS-IV is a self-report measure that includes the 18 *DSM-IV* symptoms of ADHD (APA, 2000) and nine symptoms of sluggish cognitive tempo (SCT) (e.g., easily confused; slow moving). Barkley established scale norms for the Adult ADHD Rating Scale-IV, the Deficits in Executive Functioning Scale, and the Functional Impairment Scale on a nationally representative sample of 1,249 adults comprising of males (49.9%) and females ages 18 to 89 years. Further, Barkley provided specific normative information based on three age groupings (i.e., 18-39 years, 40-59

years, 60-89 years), and the scoring for the scales used in this study were score based on the information from the youngest normative age grouping, 18-39 years ($n= 412$), in the Barkley manuals. The 18 *DSM-IV* symptoms of ADHD include nine symptoms of inattention, six symptoms of hyperactivity, and three symptoms of impulsivity. Each item was rated using a four-point scale (1 = *never or rarely*, 4 = *very often*). The four-factor structure of the BAARS-IV has demonstrated satisfactory internal consistency (α s from .80 to .90) and test-retest reliability (r s from .66 to .88) over a two- to three-week period (Barkley, 2011a). Internal consistencies in the present study are: SCT $\alpha = .86$, ADHD Inattention $\alpha = .81$, ADHD Hyperactivity $\alpha = .77$, and ADHD Impulsivity $\alpha = .78$. This study utilized both the Self-Report and Other-Report (i.e., completed by parent or guardian) of current symptoms forms. Validity of the BAARS-IV has been demonstrated by high inter-observer agreement between adult Self-Report and Other-Report (i.e., for someone who is well familiar with the individual), with symptom rating scores ranging from $r = .59$ to $.76$ (Barkley, 2011a). The BAARS-IV was used as a dimensional measure of ADHD symptomatology, whereas ADHD subtype will be derived from the CAADID interview (i.e., ADHD Inattentive Presentation or ADHD Combined Presentation) and included in the analyses to represent participants' diagnostic status. In order to reduce the number of predictor variables included in the analyses (given sample size constraints), a total score of current ADHD symptoms was used in this study, with self- and parent-reported Total ADHD symptom scores considered separately (α s = .84 and .85 for self-report and parent-report, respectively). The Total ADHD score was used as a continuous predictor variable in this study and was calculated by summing the subscale scores from ADHD Inattention, ADHD Hyperactivity, and ADHD Impulsivity with possible scores ranging from 0 to 72 for Total ADHD Symptom Score.

The Deficits in Executive Functioning Scale (Barkley, 2011b). The Deficits in Executive Functioning Scale (BDEFS; Barkley, 2011b) is an 89-item rating scale used to measure five key domains of deficits in executive function (EF). Three forms of this scale exist: the Self-Report, the Other-Report, and the Clinical Interview. This study used the Self-Report and Other-Report (i.e., completed by parent or guardian) forms. Participants rated each item according on 4- point scale, identical to the previously described BAARS-IV scale. Items on the BDEFS are specifically intended to measure commonly identified constructs under the broader term of EF: inhibition, nonverbal working memory, verbal working memory, organization, problem solving, time management, self-motivation, and self-regulation of emotion (Barkley, 2011b). The five factor based scales include self-management to time, self-organization and problem solving, self-restraint (inhibition), self-motivation, and self-regulation of emotion. These variables were used as continuous predictor variables in correlation, regression, and group analyses in the current study (see Tables 4 through 9). For group analyses, clinically significant groups of high EF deficits based on self-report ratings on the five subscales were examined in comparison to each of the outcome variables (see Table 10). The BDEF has been established in a nationally representative sample of 1,249 adults demonstrated adequate internal consistency across each of the five scales (Cronbach's alpha 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 $\alpha = .93$, Self-organization $\alpha = .93$, Self-restraint $\alpha = .93$, Self-motivation $\alpha = .90$, Self-regulation of emotion $\alpha = .92$. Further, internal consistencies in the present study for parent-report are as follows: Self-management of time $\alpha = .96$, Self-organization $\alpha = .94$, Self-restraint $\alpha = .96$, Self-motivation $\alpha = .95$, Self-regulation of emotion $\alpha = .97$.

Follow-up Outcome Measures

Overall Functioning. 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 ($N=1,249$ adults) with high internal consistency ($\alpha = .97$) and test-retest reliability over a one- to two-week period ($r = .72$) reported in the normative sample. Participants rated impairment in each major life activity on a 10-point Likert scale ranging from 0 (*not impaired*) to 9 (*severely impaired*). The activities include home life with your immediate family; finishing chores at home and managing your household, work or occupation; social interactions with friends; activities in the community; any educational activities; marital, co-living, or dating relationships; management of your money, bills, and debts; driving a motor vehicle and your history of citations and accidents; sexual activities and sex relations with others; organization and management of your daily responsibilities; caring for yourself daily; maintaining your health; and taking care of and raising your children. A “not applicable” option is also available for each item (e.g., most of our college participants indicated “n/a” for the item assessing impairment “in taking care of and raising your children”).

Cumulative scores from these categories result in two outcome scores: (a) the mean functional impairment score, and (b) total overall functional impairment score across all 15 domains of functioning. The total overall impairment score variable was used in this study ($\alpha = .96$ for the current sample) as continuous outcome variable in correlation, regression, and group analyses.

Grade Point Average (GPA). Participants’ GPA was used as an objective 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 it took into account the number of credits attempted and

also when students withdrew from courses or earned incomplete grades. Specifically, for each student, the sum of their course grades was multiplied by the number of credit hours earned and then divided by the total attempted credit hours. For all students, A = 4.0, B = 3.0, C = 2.0, D = 1.0, and F = 0. GPA, total number of D's or F's, total number of course withdrawals, and academic probation status for the spring semester was used in the analyses. A GPA of 2.0 was selected as this represents a "D" average and has been used in prior studies (e.g. Frazier et al., 2007) because students below 2.0 are typically placed on academic probation.

School Maladjustment. Participants completed the *Behavior Assessment System for Children, Second Edition, Self-Report of Personality College Version* (aged 18-25 years; BASC-2: SRP-College Version; Reynolds & Kamphaus, 2004). The BASC-SRP-COL consists of 185 items and employs two response formats. For the first 68 items, the rating scale utilizes a true/false response format and the remaining items are rated on a 4-point scale (1 = *never*; 2 = *sometimes*; 3 = *often*; 4 = *almost always*). All of the items are brief statements that are written on a third-grade reading level. Items are worded both positively and negatively to prevent patterned responding. There are 12 clinical subscales (Alcohol Abuse, Anxiety, Attention Problems, Atypicality, Depression, Hyperactivity, Locus of Control, School Maladjustment, Sensation Seeking, Sense of Inadequacy, Social Stress, and Somatization) and four adaptive scales (Interpersonal Relations, Relations with Parents, Self-Esteem, and Self-Reliance) on the BASC-2-COL, with higher scores representing increased levels of maladaptive functioning. On the clinical subscales, *T* scores greater than 65 are considered indicators of clinically significant levels of distress. The BASC-2-COL has demonstrated high internal consistency for a normative sample of 706 college students (18 to 25 years old). Alpha measures of internal consistencies ranged from .71 to .96. Test-retest reliability over two to eight weeks after the first

administration has been demonstrated with a small subscale of college students ($n = 59$), and suggests moderate temporal stability with correlations ranging from .74 to .99 (Reynolds & Kamphaus, 2004; Nowinski, Furlong, Rahban, & Smith, 2008). This measure has also demonstrated initial evidence of by comparing BASC-2-COL scores with conceptually similar scales from the Personality Assessment Inventory (PAI; Morey, 1991) and the Adult Self-Report (ASR; Achenbach & Rescorla, 2003; Nowinski et al., 2008). The School Maladjustment subscale from the BASC-2: SRP-College was examined in the present study and internal consistency is $\alpha = .79$. The School Maladjustment subscale provides an indication of how one is responding to the academic demands of college. Elevated scores may indicate the tendency to feel frustrated, bored, dispassionate, or indifferent.

Analytic Plan

Sample size was calculated a priori based on the primary aim of the study. A power analysis using G Power 3.1.1 (Buchner, Faul, & Erdfelder, 1997; Faul, Erdfelder, Lang, & Buchner, 2007) was conducted to determine if the sample size would be sufficient to assess the relationships of predictors to the three outcomes to detect a moderate effect size. Namely, sample size of at least 49 is estimated to achieve 80% power to detect the estimated effect size, $f^2 = 0.15$, and assuming an alpha of .05 for the linear multiple regressions (Cohen, 1988; Cohen, Cohen, West & Aiken, 2003). Thus, the sample size of the present study is sufficient.

Data preparation

Prior to analysis, means, standard deviations and 95% confidence intervals (or medians and inter-quartile ranges) were estimated for each continuous variable, while frequencies, proportions and 95% confidence intervals were computed for each categorical variable. Data was checked for univariate and multivariate outliers, violations of assumptions of normality and

homogeneity of variance was also evaluated to guide modification of analyses (i.e., using transformations of variables). Homogeneity of variance was assessed using the Levene's test. Outlier data points were examined further for errors in data coding. Linearity was assessed by generating a matrix of scatterplots between variables. Additionally, multicollinearity was assessed by examining the correlations between variables. As suggested by Tabachnick and Fidell (2007), $r = .80$ was used as a cutoff to assess for multicollinearity.

For the linear regression analyses, the assumption of normality was evaluated by examining skewness and kurtosis. Data were considered normal if skewness was found to be within the range of +1 to -1. However, the resampling methods used in the mediation analyses described below do not require the same assumptions of normal distribution of the independent variables, mediator variables and dependent variables. Instead, a bootstrap confidence interval for the indirect effect in the mediation model is calculated using bootstrapping resampling methods used to generate an empirically derived representation of the sampling distribution of the indirect effect. Bootstrapping distributions yields inferences for the mediated effect estimated in each bootstrap sample, which is used to form a distribution of the bootstrap mediated effect estimates and confidence intervals for the bootstrap distribution. Further in bias-corrected bootstrap sampling methods described in more detail below, the difference between the observed sample mediated effect and the average mediated effect in the bootstrap distribution are used to correct the percentiles in the bootstrapped distribution. This forms a distribution that more likely to be accurate and result in a test with higher power. However, this method assumes that the sample in this study represents the population from which the sample was derived.

Statistical Analyses

Aim 1: Descriptive sample characteristics. To address the first study aim, frequency and descriptive statistics were calculated for all study variables including participant characteristics, ADHD symptom severity, EF deficits, and academic outcomes. The demographic variables examined included: sex, race/ethnicity, age, year in school, living status (home or campus), employment status, prior college, parent education, family income, and ADHD medication status.

Aim 2: Correspondence between student and parent ratings. The second research question examined the extent of agreement across parent- and student-ratings EF deficits and ADHD symptoms. To assess cross-informant correspondence, Pearson correlations, intraclass correlations (Shrout & Fleiss, 1979) and mean differences using *t*-tests were run to compare informant ratings on ADHD symptoms and EF deficits (see Table 2). Prior to making any comparisons of scores within raters (e.g., student ratings on the BDEFS scales) or between raters (e.g., student ratings on the BDEFS vs. parent ratings on the BDEFS), it is important to consider the distinction between cross-informant correlations and inter-rater reliability (Achenbach et al., 2005; LeBreton & Senter, 2008; Tinsley & Weiss, 2000). Cross-informant correlations are correlations between ratings obtained from different informants who have different perspectives on the behavior being assessed (e.g., self and parent). Interrater reliability can be measured in terms of absolute agreement (i.e., captures the absolute difference between ratings and is sensitive to mean differences between raters; Tinsley & Weiss, 2000). Interrater reliability can also be measured in terms of agreement between the ordering of ratings (i.e., the extent that different informants rate in a similar or consistent trend). High agreement would suggest that student and parent scores are very similar. Alternatively, high cross-informant correlations

between students and parents would indicate that both informants are rating deficits in a similar fashion or trend, which is assessed using correlational coefficients. It is crucial to understand that two informants can reach high correlations, but have virtually no agreement. For this study intraclass correlations (ICCs) were estimated because they account for both absolute agreement and rater consistency.

Cross-informant correlations. Cross-informant correlations were conducted using Pearson correlation analyses to explore the total impact of informants' rating similarity across the scales and displayed in Table 2.

Intraclass correlations. ICCs in this study will represent the proportion of observed variance in parent and student ratings that is due to between-student differences compared to the overall variance in the ratings (LeBreton & Senter, 2008). High ICC estimates will correspond to high agreement and relative consistency among parent and student ratings, whereas low ICC estimates may be a product of low agreement, low consistency, or both (LeBreton, Burgess, Kaiser, Atchley, & James, 2003). Differences in parent-student correlational coefficients between ADHD symptoms and EF deficits were assessed using Fisher r -to- z transformations (De Los Reyes & Kazdin, 2004).

Interrater agreement. Mean differences between the average student and parent rating were evaluated in order to determine the level of agreement and compare the scores from the separate subscales. Independent sample t tests were computed to determine if there were significant differences between student and parent ratings. Cohen's d effect sizes were calculated to determine the magnitude of the difference between informants (Group 1 Mean – Group 2 Mean / pooled SD). Cohen's d effect sizes compliment p values as a measure of student and parent rating differences, providing a metric for identifying substantive, versus simply statistical,

significance. Effect sizes (d) at or above .20 are small, at or above .50 are medium, and above .80 are typically considered large (Cohen, 1988). Consequently, subscales scores with significant independent sample t values and large effect sizes represent student and parent disagreement, whereas nonsignificant independent sample t scores and small effect sizes suggest higher agreement.

Further, small correlations between student and parent informants do not necessarily mean that the informants' ratings are inaccurate (Achenbach et al., 2005), but rather may indicate that the problems are relatively specific to certain situations or recognized by others. Evidence of low or moderate correlations between student and parent ratings indicate increased potential for each informant adding incremental validity and the benefit of augmenting self-ratings with parent informant ratings (Achenbach et al., 2005; Kraemer et al., 2003).

Aim 3: Relation of EF, ADHD symptoms, and student characteristics to impairment. To address the third aim, this study assessed the relationship between the BDEF subscale total scores and each of the outcome variables (i.e., grades, school maladjustment, and overall impairment).

Bivariate correlations of predictors to impairment. Demographic variables that were significantly correlated ($p < .05$) with a specific academic outcome variable were included as covariates in subsequent analyses (see Table 3). Additionally, bivariate correlation analyses examined whether parent- and student-ratings of ADHD symptom severity and EF deficits were significantly related to each of the outcome domains (see Table 4). Any EF variables significantly correlated with the academic outcome of interest were included in subsequent regression analyses. Further, correlations between and within ADHD symptom ratings to deficits in EF scale dimensional scores were examined to consider the extent of potential shared variance

between ADHD and EF constructs if not collinearity (i.e. measuring essentially the same constructs). Specifically, multicollinearity was examined in the regression analyses through VIF (values >10 are typically considered problematic) and tolerance values (values <.10 are typically considered problematic; Cohen & Cohen, 1993; Cohen, 1988), for each predictor variable. Relatedly, inter-correlations across follow-up academic outcomes were examined to consider the extent of overlap across outcome variables.

Regression analyses. Next, hierarchical regression analyses were conducted to examine whether baseline/time 1 ADHD symptom severity significantly predicted follow-up academic functioning after controlling correlated demographic characteristics (e.g., gender). Specifically, for each academic outcome, significantly associated variables retained from the previous analyses will be entered on Step 1, followed by EF scales that significantly correlated ($p < .05$) with the outcome on Step 2. That is, hierarchal regression models will be conducted with EF scales as predictors and academic outcome measures as criterion variables, first controlling for demographic and ADHD symptom variables, both of which were assessed at baseline. Parent and student ratings of EF will be examined in separate regression models. Accordingly, five hierarchal regressions were run, two for each outcome variable: 1) Student-rated EF deficits and 2) Parent-rated EF deficits (with the exception of school maladjustment, which consisted of one model with student-rated EF deficits).

Aim 4: Incremental validity of each informant for predicting impairment. EF variables significant in these regression models were then retained for entry in a hierarchical regression analysis to examine incremental validity of individual informants. To test the third hypothesis, this study compared the incremental validity of parent and student ratings of ADHD and EF deficits within a multi-method, multi-informant assessment of academic and overall

impairment. To address this aim, we conducted hierarchical regression analyses to examine the relative incremental contributions of each informant in the prediction of academic impairment. Specifically, student-rated and parent-rated EF subscales that are determined significant predictors from the multiple regression analyses in the first aim will be entered in separate steps of the hierarchical regression model. This study explored whether parent-ratings of EF deficits add to the prediction of outcomes above and beyond student-ratings of EF. Student-ratings of EF will be added at Step 1, and parent-ratings of EF deficits enter the model at Step 2, to examine whether parent-ratings significantly improve a model already including student-ratings of EF deficits. We also examined the inverse relationship to examine whether student-ratings significantly improve a model already including parent-ratings of EF-deficits by including parent-ratings of EF at step 1, and then student-ratings of EF deficits at step 2. The likelihood ratio chi-square test and Nagelkerke's R^2 was examined to assess adequate model fit and relative strength of association between predictor and outcome variables, respectively at each step.

Aim 5: Mediation analyses. The fifth aim of this study was to evaluate an integrative model to elucidate key mechanisms associated with the relationship between ADHD symptoms and academic or overall impairment. Mediation models were conducted, guided by the process modeling strategies described by Hayes and colleagues (Hayes, 2013; Hayes & Preacher, 2013). A script developed by Hayes and Preacher (2013) was run in SPSS version 19 and used to test (1) the relation between the independent variable and the mediators, (2) the total effect of the independent variable on the dependent variable, and (3) the direct effect of the independent variable on the dependent variable after accounting for the indirect effect of the mediators (Hayes & Preacher, 2013; MacKinnon, 2008).

Specifically, the *MEDIATE* macro for SPSS (Hayes & Preacher, 2013) was used to test whether the association between ADHD symptom severity and academic outcomes including overall impairment and GPA was mediated by deficits in EF. The first mediation model tested whether baseline (time one) ADHD symptom severity predicted follow-up (time three) overall impairment, and whether baseline EF deficits significantly mediated these associations. EF deficits were included in each model to test their indirect (i.e., mediational) effect along with the direct effect of ADHD symptom severity (IV's) on overall impairment (DV). Mediators significantly correlated with the outcome at the bivariate level were included simultaneously in each model to determine the magnitudes of their relative indirect effects. This was done to take into account concurrent EF deficits, boost power for testing indirect effects, and to compare the sizes of the indirect effects through different mediators. The *MEDIATE* macro also tested the interaction effect between EF deficits in order to confirm the independent effects of each mediator. Analyses are summarized below and displayed in Figures 2 and 3. Within these models the outcome variable (e.g., school grades) at end of the year modeled as a function of baseline ADHD symptoms and correlated baseline EF subscales on the mediator. The effect on ADHD symptoms can then be partitioned into the direct effect on changes in academic or overall impairment at the end of the year and the indirect effects via the mediator (i.e., EF deficits).

The bootstrapping procedure was used to test the significance of the indirect (i.e., mediational) effect. An SPSS script developed by Preacher and Hayes (2013) was used to compute nonparametric bootstrap estimates and Monte Carlo confidence intervals. The bootstrapping procedure is recommended for tests of mediation and requires a single test of the hypothesis, which reduces the probability of Type II error (Preacher & Hayes, 2004; Preacher & Hayes, 2008; Hayes, 2013; MacKinnon, 2008). Bootstrapping involves multiple re-sampling of

the observed data with replacement to produce an estimate of an indirect effect. Multiplying component direct effects (i.e., the unstandardized regression coefficients) produces an estimate of the indirect effect and one bootstrap sample (Preacher & Hayes, 2004; Hayes, 2013). A large number of indirect effects are calculated and the distribution of these bootstrap estimates provides an approximation of the sampling distribution of the indirect effect and confidence interval. The estimates presented are based on 10,000 bootstrap samples. For these analyses, 95% confidence intervals (CIs) for the indirect effects are considered significant if they do not encapsulate zero. Standardized regression coefficients, bootstrap estimates, standard error estimates, and confidence intervals are reported. Standardized effect sizes were computed for indirect effects using the ratio of the standardized indirect effect to the direct effect (Preacher & Kelley, 2011). Bootstrapping tests of mediation 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 for indirect effects (denoted as *ab* below) do not assume normality of the distribution of sampled indirect effects in contrast to the Sobel test (Preacher et al., 2007).

Aim 6: Group differences in academic outcomes. Exploratory analyses evaluating differences on the outcome variables between participants with and without clinically significant EF deficits (based on self-report ratings on the five subscales) were conducted (see Table 10). 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 outcome variable.

Results

A flow diagram (see Figure 1) has been constructed to track participant flow through the study, as per CONSORT guidelines (Altman et al., 2001). In total, 139 students expressed interest in the study and completed the phone screen. Of these, 94 were eligible based on the phone screen and completed the inclusion/exclusion evaluation and 68 met full study inclusion criteria. Of these, 62 were enrolled in at least nine credit hours throughout the duration of the study and were included in analyses. Four participants did not have completed parent ratings of EF deficits and ADHD symptoms, and three participants did not complete follow-up measures.

Missing observations were checked to determine if missing at random, by testing whether any covariate had an effect on the missing information (Rubin, 1987). In comparing the demographic characteristics of those participants for whom parent EF ratings data were collected ($N = 58$) to those without parent EF data ($N = 4$), no differences were found for gender, race, age, year in school, family education level, family income, student employment, medication status, previous college schooling, high school grades, achievement scores, parent- and student-ratings of ADHD symptoms, or student-EF ratings ($ps > .05$).

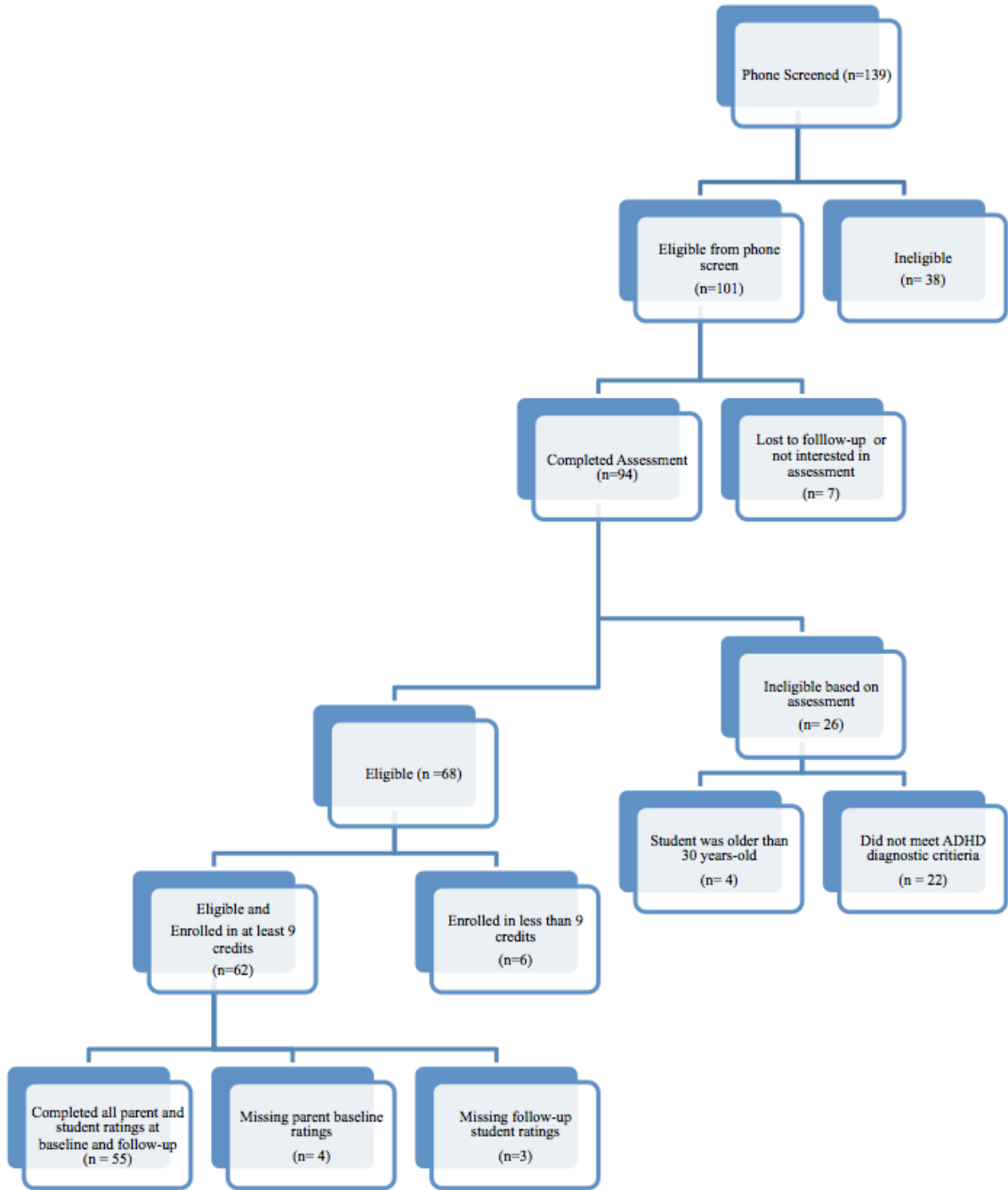


Figure 1. CONSORT Diagram of Participant Data Collection

Descriptive characteristics of sample participants are displayed in Table 1.

Approximately one quarter of the sample ($n = 16$) reported being a first-generation college student and half ($n = 32$) reported having part-time employment at the baseline assessment. Consistent with the university's percentage total minority enrollment (36%), approximately one third of the study sample ($n = 18$) self-identified as a racial or ethnic minority student. Fifty-eight percent of the participants ($n = 36$) were taking medication for ADHD symptoms when they enrolled in the study. In terms of service utilization history, 24% ($n = 15$) reported receiving accommodations in high school and 46.8% ($n = 29$) reported previously receiving psychotherapy. In terms of current service utilization, 33.9% ($n = 21$) reported currently receiving university accommodations through disability support services (e.g., extended time, note taking) and 32.2% ($n = 20$) had utilized campus tutoring services since starting college. The mean high school grade point average of the present sample ($M = 3.09$, $SD = .52$) is below the university's mean grade point average for incoming freshman during the concurrent year ($M = 3.52$). The total number of transfer students or those who had previously attended vocational or junior college ($n = 14$) of the study sample (22.6%) was higher than the overall university transfer enrollment rate (8.4%).

At the follow-up assessment (end of the school year; spring semester grades), students mean grade point average (GPA) was 2.30 (C to C+). Additionally, 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. Further, 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. Participant sex was significantly correlated with follow-up GPA such that females had higher GPAs compared to

males. As such, sex was included as a covariate in the regression and mediation analyses examining GPA.

Correspondence Between Student and Parent Ratings

Cross-informant correlations. Correspondence across student and parent informant ratings was first assessed using Pearson correlations (i.e., total impact of informants' rating similarity across the scales) and the results are displayed in Table 2. Although correlations across raters' scores on the Total ADHD Symptoms and BDEFS scales were all significant $p < .05$, these correlations are modest at best. In particular, for the BDEF ratings, parent-student correlations (r s) ranged from .26 to .43, with the lowest consistency for both sets of raters on the Self-Motivation ($r = .26$) and Self-Regulation of Emotion ($r = .28$) subscales.

Intraclass correlations. Intraclass correlations between parent and students for current ADHD symptom ratings were moderate (intraclass correlation range = .31-.43) and statistically significant (all p s $< .01$; see Table 2). Correlations on the BDEF scales were largest for self-restraint (intraclass correlation = .42, $p < .001$). The correlations across the BDEF scales were not statistically different ($p > .05$). Further, the magnitudes of the correlations for current ADHD symptom ratings were not significantly higher than the correlations observed on the BDEF executive function scales ($p > .05$).

Interrater agreement analyses. Students rated themselves significantly higher (more severe) than parents did on all ADHD symptom scales (all p s $< .01$) with the exception of the Current-BAARS Inattention scale, which approached statistical significance ($p = .07$). The differences reflect moderate effect sizes for disagreement (d s ranging .57 to .61; see Table 2). Students endorsed significantly more EF deficits in self-organization and problem solving in comparison to parents (p s $< .01$), and the magnitude of this difference was moderate ($d = .64$).

Table 2.

Correspondence Between Baseline Parent and Student Informant Ratings

	<i>Intraclass Correlation</i>	<i>Pearson Correlation</i>	<u>Students</u> <i>M^c ± SD</i>	<u>Parents</u> <i>M^c ± SD</i>	<i>t</i>	<i>ES</i>
<i>Current ADHD Symptom Ratings^a</i>						
Inattention	.43***	.50***	25.40± 4.93	24.81± 5.89	.78	.11
Hyperactivity	.31**	.32**	11.97± 3.48	9.78± 3.75	3.86***	.61
Impulsivity	.32**	.39***	9.47± 3.01	7.73± 3.11	4.11***	.57
Total ADHD Symptoms	.38***	.42***	46.84± 8.83	42.32± 8.76	3.66**	.51
<i>Deficits in Executive Functioning Ratings^b</i>						
Self-management to Time	.33**	.36***	62.78±12.28	57.61±13.94	1.13	.39
Self-organization/Problem Solving	.29**	.35**	59.86±14.61	50.49±14.78	4.06***	.64
Self-restraint	.42***	.43***	42.36±12.14	41.06±13.87	.53	.10
Self-motivation	.25*	.26**	28.84±8.45	27.52±9.72	.75	.14
Self-regulation of emotion	.27*	.28*	27.02±8.95	26.28±10.99	-.11	.08

Note. ADHD = Attention-deficit/Hyperactivity Disorder. *ES* = Cohen's *d* effect size. Sample size for informant comparisons varies across measures at baseline due to missing parent data (see Methods section for further description of specific *Ns*). a. Three parents did not return baseline ratings from the Barkley Adult ADHD Rating Scale (BAARS). Therefore, *n* = 59 participants with both student and parent-report on the BAARS were examined at baseline and subsequently participants without parent-ratings on the BAARS (*n* = 3) were excluded from these analyses. b. Four parents did not return baseline ratings from the Barkley Deficits in Executive Functioning Rating Scale (BDEFS). Therefore, *n* = 58 participants with both student and parent-report on BDEFS were examined at baseline and subsequently participants without parent-ratings on the BDEFS (*n* = 4) were excluded from these analyses.

c. Scale means are reported for BAARS and BDEFS.

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

Relation of EF, ADHD Symptoms, and Student Characteristics to Impairment

Bivariate correlations of predictors to impairment. Variable means, standard deviations, and correlations for all study outcome variables and participant demographic characteristics were examined for determining potential covariates and are presented in Table 3. Females had higher GPAs than males, and so gender was included as a covariate in the regression and mediation models predicting GPA. Participants who had previously attended college (e.g., transferred to current university) had higher overall impairment at follow-up, and so previous college schooling was included as a covariate in the regression and mediation models

predicting overall impairment. Participant age, race, employment status, living status, and medication status were not significantly correlated with any of the academic outcome variables and so are not considered further.

Table 3.

Correlations of Participant Demographic Characteristics with Follow-up Academic Functioning

Variable	GPA (2.30 ± 1.17)	School Maladjustment (51.93 ± 9.34)	Overall Impairment (47.58 ± 24.58)
Age	-.12	.15	.22
Sex	-.36**	.08	-.04
Race	-.03	-.07	-.05
Year in School	.05	.10	.24
Employment Status	.18	.04	.07
Employment Hours	.04	.01	-.12
Previous College Schooling	.07	.13	.27*
High school GPA	.07	-.17	-.09
College Achievement Test	-.08	-.09	-.02
Housing Status	-.10	-.15	.00
Parent Education Level	.01	-.22	.01
Family Income	.08	.06	.19
ADHD Medication Status	.04	.17	.07
Other Psychotropic Medication	.20	-.08	.10

Note. $N = 62$. Age is calculated in years. For sex, female = 0, male = 1. For race, Non-Caucasian = 0, Caucasian = 1. For employment status, 0 = participant not employed, 1 = participant employed. For employment hours, participants estimated the average number of hours worked per week. For previous college schooling, 1 = participant indicated having transferred to current university after attending another university or community college, 0 = participant indicated they did not previously attending any other college. ADHD medication status, 0 = not taking medication for ADHD, 1 = taking medication for ADHD. For other psychotropic medication, 0 = not taking other psychotropic medication, 1 = taking psychotropic medication for reasons other than ADHD. For housing status, 0 = participant not living at home, 1 = participant living at home. GPA = grade point average. * $p < .05$. ** $p < .01$.

Correlations for parent- and student-rated ADHD symptoms and EF deficits to all follow-up academic functioning outcome variables are shown in Table 4.

Table 4.

Correlations of Baseline ADHD Symptoms and Deficits in Executive Functioning with Follow-up Academic Functioning

Variables	Mean ± SD	GPA (2.30 ± 1.17)	School Maladjustment (51.93 ± 9.34)	Overall Impairment (47.58 ± 24.58)
<i>Independent Variables</i>				
PR Total ADHD symptoms	46.84 ± 8.53	-.07	-.02	.36**
SR Total ADHD symptoms	42.32 ± 8.76	-.08	.03	.37**
<i>Potential Mediator Variables</i>				
<i>Student-Rated EF Deficits</i>				
SR Self-management to time	62.78 ± 12.28	-.16	.09	.33**
SR Self-organization	59.86 ± 14.61	-.29*	.12	.32**
SR Self-restraint	42.36 ± 12.14	.05	.13	.35***
SR Self-motivation	28.84 ± 8.45	-.16	.28*	.47***
SR Self-regulation of emotion	27.02 ± 8.95	.01	.23	.47***
<i>Parent-Rated EF Deficits</i>				
PR Self-management to time	60.3 ± 14.71	-.13	.23	.29*
PR Self-organization	50.49 ± 14.78	-.02	.14	.06
PR Self-restraint	41.06 ± 13.87	-.16	.17	.28*
PR Self-motivation	27.52 ± 9.72	-.24*	.22	.10
PR Self-regulation of emotion	26.28 ± 11.00	.02	.19	.39**

Note. PR = parent-report. SR = self-report. GPA = grade point average. Sample size varies between 58-62 across measures/time-points (see Methods section for specific *N*s). *N*=62 were examined for student-ratings on ADHD symptoms and EF deficits. *N*=58 were examined for parent-ratings on ADHD symptoms and EF deficits.

Intercorrelations between predictors are shown in Table 5 and indicate no issues with multicollinearity (*r*s ranging from .02 to .69). Correlations between the BDEF, ADHD symptom measures, and academic outcomes were all in the expected direction.

Table 5.

Intercorrelations of Predictors and Mediator Variables

Variables			<i>Student-Rated EF Deficits</i>					<i>Parent-Rated EF Deficits</i>				
	1	2	3	4	5	6	7	8	9	10	11	12
1. SR ADHD Total symptoms	--	.42**	.51***	.50***	.54***	.35**	.37**	.08	.28*	.14	-.09	.05
2. PR ADHD Total symptoms		--	.30*	.08	.26*	.09	.29*	.56***	.43**	.56***	.40**	.32*
<i>Student-Rated EF Deficits</i>												
3. SR Self-management to time			--	.59***	.38**	.66***	.24	.36**	.36**	.21	.19	.16
4. SR Self-organization				--	.47***	.39**	.41**	.02	.35**	.04	-.21	.06
5. SR Self-restraint					--	.56***	.67***	.13	.11	.43**	.09	.30*
6. SR Self-motivation						--	.41**	.21	.04	.24	.261*	.25
7. SR Self-regulation of emotion							--	.08	.02	.25	.02	.28*
<i>Parent-Rated EF Deficits</i>												
8. PR Self-management to time								--	.52***	.47***	.67***	.30*
9. PR Self-organization									--	.40**	.34**	.21
10. PR Self-restraint										--	.56***	.69***
11. PR Self-motivation											--	.41**
12. PR Self-regulation of emotion												--
<i>Mean</i>	46.84	42.32	62.78	59.86	42.36	28.84	27.02	60.30	50.49	41.06	27.52	26.28
<i>SD</i>	8.53	8.76	12.28	14.61	12.14	8.45	8.95	14.71	14.78	13.87	9.72	11.00

Note. $N=62$ were examined for student-ratings on ADHD symptoms and EF deficits. $N=58$ were examined for parent-ratings on ADHD symptoms and EF. * $p < .05$. ** $p < .01$. *** $p < .001$.

Correlations were positive for predicting ratings of overall impairment and school maladjustment problems as higher scores on both the BDEF and ADHD Symptoms indicate higher levels of problems/impairment. Correlations were negative for predicting school grades (i.e. more ADHD symptoms and problems with EF = lower school grades).

As hypothesized, T1 student-rated deficits in EF were all significantly and strongly associated with T3 overall impairment (r s ranging from .32 to .47, p s $< .01$). Parent-rated deficits on Self-management to time, Self-restraint, and Self-regulation of emotion were significantly positively associated with overall impairment (r s ranging from .28 to .39, p s $< .05$). Of note, parent-rated self-organization and self-motivation were not significantly associated with

overall impairment ($p > .05$), and therefore are not included in subsequent regression or mediation analyses predicting overall impairment. Only parent-rated self-motivation and student-rated self-organization were significantly negatively associated with GPA ($r_s = -.24$ and $-.29$, $p_s = .03$ and $.01$, respectively), and therefore all other EF scales were not included in subsequent analyses predicting GPA. Similarly, student-rated Self-motivation was the only predictor significantly associated with school maladjustment ($r = .28$, $p = .01$) and retained for subsequent analyses. Although ADHD symptom severity was not significantly associated with GPA or school maladjustment, ADHD symptoms were retained for inclusion in the regression and mediation analyses in order to ensure that results were not attributable to differences in ADHD symptom severity across participants. Intercorrelations of baseline ADHD symptoms and baseline EF deficits within and across informants are represented in Table 5.

Hierarchical regression analyses were conducted to examine the independent effects of EF deficits and ADHD symptoms in predicting follow-up academic outcomes (i.e., overall impairment, GPA, school maladjustment). Across all regression analyses, no 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 et al., 2003), indicating that multicollinearity was not an issue.

Regression analyses for overall functional impairment. As displayed in Table 6, when the previous college schooling variable and parent- and student-rated ADHD symptom severity were simultaneously entered into Step 1 of the hierarchical regression analyses, these variables explained 20% of the variance in overall impairment ($p = .008$). When significantly correlated student-ratings of EF from the BDEFS (i.e., Self-management to time, Self-organization, Self-restraint, Self-motivation, and Self-regulation of emotion) were entered on Step 2, these

predictors explained an incremental 20% of the variance in overall impairment at follow-up, $\Delta F(5, 49) = 3.05, p = .01$, above and beyond the variance accounted for by ADHD symptom severity and previous college schooling. The student-rated Self-motivation, $\beta = .56, t(51) = 3.10, p = .003$, subscale and parent-rated ADHD symptom severity 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 to time, Self-restraint, and Self-regulation of emotion) were entered on Step 2, these predictors explained an incremental 10% of the variance in overall impairment at follow-up, $\Delta F(3, 48) = 2.30, p = .08$, above and beyond the variance accounted for by ADHD symptom severity and previous college schooling. The parent-rated Self-regulation of emotion, $\beta = .83, t(53) = 2.12, p = .04$, subscale was the only significant predictor of overall impairment in Step 2.

Table 6.

Hierarchical Regression Model of T1 Executive Functioning Predicting T3 Overall Functional Impairment Above and Beyond T1 ADHD Symptoms

<i>DV: T3 Overall Impairment</i>	Step 1 Model Summary				Step 2 Model Summary			
	<i>B</i>	<i>SE</i>	β	<i>t</i>	<i>B</i>	<i>SE</i>	β	<i>t</i>
<i>Student-Rated EF Deficits (N=59)</i>	$F(3,56) = 4.37, R^2 = .20^{**}$				$F(8,51) = 3.876, R^2 = .40^{***}$ $\Delta F(5,49) = 3.05, \Delta R^2 = .20^{**}$			
Previous College Schooling	8.82	7.55	.15	1.17	11.55	7.99	.20	1.45
T1 SR ADHD Total	.59	.38	.22	1.55	.41	.47	.15	.87
T1 PR ADHD Total	.71	.40	.24	1.76^a	.89	.41	.31	2.15*
T1 SR Self-management to time	--	--	--	--	-.62	.41	-.31	-1.53
T1 SR Self-organization	--	--	--	--	.14	.29	.08	.49
T1 SR Self-restraint	--	--	--	--	-.45	.41	-.22	-1.10
T1 SR Self-motivation	--	--	--	--	1.64	.53	.56	3.10^{**}
T1 SR Self-regulation of emotion	--	--	--	--	.59	.45	.21	1.30
<i>DV: T3 Overall Impairment</i>	Step 1 Model Summary				Step 2 Model Summary			
	<i>B</i>	<i>SE</i>	β	<i>t</i>	<i>B</i>	<i>SE</i>	β	<i>t</i>
<i>Parent-Rated EF Deficits (N=58)</i>	$F(3,55) = 4.08, R^2 = .20^*$				$F(5,53) = 3.35, R^2 = .30^{**}$ $\Delta F(3,48) = 2.30, \Delta R^2 = .10^a$			
Previous College Schooling	8.76	7.85	.15	1.12	6.34	7.79	.11	.81
T1 SR ADHD Total	.59	.39	.22	1.54	.07	.56	.02	.12
T1 PR ADHD Total	.70	.41	.24	1.72^b	.77	.38	.28	2.00^c
T1 PR Self-management to time	--	--	--	--	.29	.28	.18	1.04
T1 PR Self-restraint	--	--	--	--	-.18	.35	-.10	-.50
T1 PR Self-regulation of emotion	--	--	--	--	.83	.39	.37	2.12*

Note. Sample size varies across measures/time-points (see Methods section for specific *Ns*). *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. * $p < .05$. ** $p < .01$. *** $p < .001$. a is significant at $p = .08$. b is significant at $p = .09$. c is significant at $p = .06$.

Regression analyses for grade point average. As displayed in Table 7, when gender and parent- and student-rated ADHD symptom severity were simultaneously entered into Step 1 of the hierarchal regression analyses, these variables explained 20% of the variance in follow-up GPA ($p = .006$). When significantly correlated student-ratings of EF from the BDEFS (i.e., Self-organization) were entered on Step 2, these predictors explained an incremental 6% of the variance in GPA at follow-up, $\Delta F(1, 55) = 4.18, p = .04$, above and beyond the variance

accounted for by ADHD symptom severity and gender. The student-rated Self-organization, $\beta = -.29$, $t(55) = -2.04$, $p = .04$, subscale and gender, $\beta = -.43$, $t(55) = -3.39$, $p = .001$, were the only significant predictors of follow-up GPA in Step 2. Alternatively, when significantly correlated parent-ratings of EF from BDEFS (i.e., Self-motivation) were entered on Step 2, these predictors explained an incremental 2% of the variance in overall impairment at follow-up, $\Delta F(1, 54) = 1.18$, $p = .28$, above and beyond the variance accounted for by ADHD symptom severity and gender. However, gender, $\beta = -.42$, $p = .002$, was the only significant predictor of GPA in Step 2.

Table 7.

Hierarchical Regression Model of T1 Executive Functioning Predicting T3 Grade Point Average Above and Beyond T1 ADHD Symptoms

	Step 1 Model Summary				Step 2 Model Summary			
	<i>B</i>	<i>SE</i>	β	<i>t</i>	<i>B</i>	<i>SE</i>	β	<i>t</i>
<i>DV: Spring GPA</i>	$F(3,56) = 4.63, R^2 = .20^{**}$				$F(4,55) = 4.51, R^2 = .26^{**}$			
<i>Student-Rated EF Deficits</i>					$\Delta F(1,55) = 4.18, \Delta R^2 = .06^{**}$			
Gender	-1.03	.28	-.47	-3.67^{**}	-.94	.28	-.43	-3.39^{**}
T1 SR ADHD Total	.01	.02	.09	.69	-.01	.02	-.08	-.50
T1 PR ADHD Total	-.03	.02	-.25	-1.78 ^a	-.02	.02	-.19	-1.36
T1 SR Self-organization	--	--	--	--	.02	.01	-.29	-2.04*
<i>DV: Spring GPA</i>	$F(3,55) = 5.88, R^2 = .18^{**}$				$F(4,54) = 3.61, R^2 = .21^*$			
<i>Parent-Rated EF Deficits</i>					$\Delta F(1,54) = 1.18, \Delta R^2 = .02$			
Gender	-.99	.28	-.45	-3.53^{**}	-.92	.29	-.42	-3.22^{**}
T1 SR ADHD Total	.01	.02	.09	.68	.01	.02	.04	.28
T1 PR ADHD Total	-.03	.02	-.27	-1.90 ^b	-.02	.02	-.17	-1.06
T1 PR Self-motivation	--	--	--	--	-.02	.02	-.16	-1.09

Note. $N=59$ 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. * $p < .05$. ** $p < .01$. *** $p < .001$. a. is significant at $p = .08$. b. is significant at $p = .06$.

Regression analyses for school maladjustment. As displayed in Table 8, when parent- and student-rated ADHD symptom severity were simultaneously entered into Step 1 of the

hierarchical regression analyses, these variables explained 1% of the variance in follow-up School Maladjustment ($p = .70$). When significantly correlated student-ratings of EF from the BDEFS (i.e., Self-motivation) were entered on Step 2, this predictor explained an incremental 6% of the variance in GPA at follow-up, $\Delta F(1, 56) = 3.23, p = .08$, above and beyond the variance accounted for by ADHD symptom severity. However, the student-rated Self-motivation, $\beta = .26, t(56) = 1.80, p = .07$, subscale was only marginally significant in predicting follow-up School Maladjustment in Step 2.

Table 8.

Hierarchical Regression Model of T1 Executive Functioning Predicting T3 School Maladjustment Above and Beyond T1 ADHD Symptoms

	Step 1 Model Summary				Step 2 Model Summary			
	<i>B</i>	<i>SE</i>	β	<i>t</i>	<i>B</i>	<i>SE</i>	β	<i>t</i>
<i>DV: School Maladjustment</i>								
<i>Student-Rated EF Deficits</i>	$F(2,57) = .37, R^2 = .01$				$F(3,56) = 1.33, R^2 = .07$ $\Delta F(1,56) = 3.23, \Delta R^2 = .06^a$			
T1 SR ADHD Total	.07	.15	.07	.48	.03	.16	.03	.20
T1 PR ADHD Total	.14	.16	.13	.84	.11	.16	.10	.65
T1 SR EF Motivation	--	--	--	--	.28	.16	.26	1.80 ^a

Note. $N=59$ were examined for student-ratings on ADHD symptoms and EF deficits. No significant interaction effects of ADHD symptoms and EF deficits were found and therefore not reported above. a. is significant at $p = .08$.

Incremental validity analyses were only conducted for predicting overall functional impairment because overall impairment was the only outcome variable where both parent and student-ratings were significant predictors in the regression models. For predicting overall impairment, student-rated Self-motivation and parent-rated Self-regulation of emotion were significant in the regressions and were retained and examined along with ADHD symptom severity in the incremental validity analysis (see Table 9). In Step 1 of the regression, parent- and student-rated ADHD symptom severity ratings were entered as the predictors, followed by entering student-rated Self-motivation in Step 2. In Step 3, parent-rated Self-regulation of

emotion was added to see if it could incrementally improve the variance accounted for in the previous steps. In a second regression, the two measures were entered in reverse order to see if the student-rated Self-motivation could incrementally improve the variance accounted for by the parent-rated Self-regulation of emotion.

Table 9.

Hierarchical Regression Models Examining the Incremental Validity of T1 Parent and Student Ratings of Executive Functioning Predicting T3 Overall Functional Impairment

<i>DV: T3 Overall Impairment</i>	Step 1 Model Summary: $F(3,55) = 4.08, R^2 = .20^{**}$				Step 2 Model Summary: $F(4,53) = 4.82, R^2 = .28^{**}$ $\Delta F(1,53) = 5.86, \Delta R^2 = .09^{**}$				Step 3 Model Summary: $F(5,52) = 5.52, R^2 = .37^{***}$ $\Delta F(1,52) = 6.23, \Delta R^2 = .05^a$			
	<i>B</i>	<i>SE</i>	β	<i>t</i>	<i>B</i>	<i>SE</i>	β	<i>t</i>	<i>B</i>	<i>SE</i>	β	<i>t</i>
T1 SR ADHD Total	.59	.38	.22	1.55	.30	.38	.11	.80	.43	.37	.16	1.14
T1 PR ADHD Total	.71	.40	.24	1.76 ^a	.82	.38	.28	2.16 ^a	.50	.41	.17	1.23
T1 SR Self-motivation	--	--	--	--	1.05	.37	.36	2.84 ^{**}	.86	.37	.30	2.31 [*]
T1 PR Self-regulation of emotion	--	--	--	--	--	--	--	--	.53	.29	.25	1.90 [*]

<i>DV: T3 Overall Impairment</i>	Step 1 Model Summary: $F(3,55) = 4.08, R^2 = .20^{**}$				Step 2 Model Summary: $F(4,53) = 6.13, R^2 = .27^{**}$ $\Delta F(1,53) = 9.45, \Delta R^2 = .09^{**}$				Step 3 Model Summary: $F(5,50) = 6.32, R^2 = .37^{***}$ $\Delta F(1,50) = 5.33, \Delta R^2 = .07^*$			
	<i>B</i>	<i>SE</i>	β	<i>t</i>	<i>B</i>	<i>SE</i>	β	<i>t</i>	<i>B</i>	<i>SE</i>	β	<i>t</i>
T1 SR ADHD Total	.59	.38	.22	1.55	.31	.42	.11	.75	.43	.37	.16	1.14
T1 PR ADHD Total	.71	.40	.24	1.76 ^a	.77	.36	.38	2.10 [*]	.50	.41	.17	1.23
T1 PR Self-regulation of emotion	--	--	--	--	.74	.30	.33	2.50 ^{**}	.53	.29	.25	1.90 [*]
T1 SR motivation	--	--	--	--	--	--	--	--	.86	.37	.30	2.31 [*]

Note. $N = 58$. * $p < .05$. ** $p < .01$. *** $p < .01$.

When the student-rated Self-motivation was entered first, it accounted for significant variance in overall impairment, $R^2 = .29, p = .007$. When parent-rated Self-regulation of emotion was added in Step 3, significant variance was accounted for, $R^2 = .34, p < .001$, but the incremental validity of this step was only marginally significant, $\Delta R^2 = .05, p = .06$. When reversed, the parent-rated EF entered in Step 2 accounted for variance $R^2 = .27, p = .001$. When

the student-rated EF entered in Step 3, significant variance was accounted for, $R^2 = .37, p = .001$ and the incremental validity of this step was also significant, $\Delta R^2 = .07, p = .03$.

In order to reduce the number of parameters included the model EF subscales were only included as potential mediators if they were significantly correlated with the outcome of interest. EF subscales were included in each model to test their indirect (i.e., mediational) effect along with the direct effect of symptoms of ADHD on each academic outcome. Mediators were included simultaneously in each model to determine the magnitudes of their relative indirect effects. This was done to take into account concurrent parent and student-ratings of EF deficits. Analyses predicting overall impairment and grade point average are summarized below and displayed in Figures 2 and 3. Finally, 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.

Mediation model predicting overall impairment. First, a mediation model was conducted, which included baseline ADHD symptom severity as rated by both parents and students as the predictor variables, the significantly correlated baseline student-rated EF deficits (i.e., Self-management to time, Self-organization, Self-restraint, Self-motivation, and Self-regulation of emotion) and parent-rated EF deficits (i.e., Self-management to time, Self-restraint, and Self-regulation of emotion) were simultaneously entered into the mediation model as possible mediators with follow-up overall impairment as the outcome variable and previous college schooling entered as a covariate. Mediation results using the *MEDIATE* macro are summarized in Figure 2.

Although together, parent and student-rated ADHD symptom severity demonstrated an effect to T3 overall impairment ($F(3, 50) = 4.08, p = .01$), a total effect from student-rated

ADHD symptom severity to T3 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 2, 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 T3 overall impairment via T1 student-rated Self-Motivation (T1 ADHD symptom severity \rightarrow T1 Self-Motivation \rightarrow T3 Overall impairment, $ab = .19, SE = .11, 95\%CI = 0.020, 0.48$) over and above previous college schooling. 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 T3 overall impairment. Thus, the indirect effect from student-rated ADHD symptoms to overall impairment was specifically and uniquely through student-rated Self-motivation.

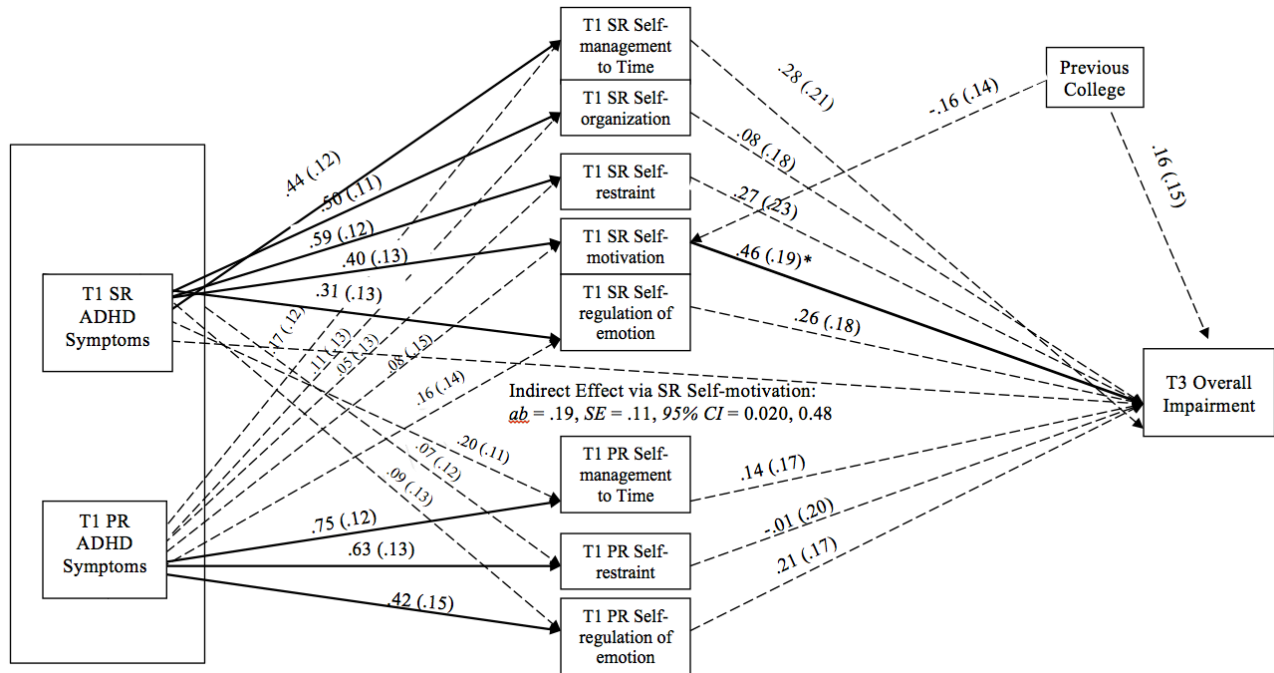


Figure 2. Parallel Multiple Mediation Model Predicting Follow-up Overall Functional Impairment

Note. Indirect effects of model of T1 ADHD symptoms predicting T3 grade point average via T1 deficits in EF domains ($N = 58$). Standardized coefficients shown outside parentheses; standard errors are shown inside parentheses. Dashed paths are nonsignificant ($ps > .05$). Analyses controlled for previous college, which in the final model was not significantly associated with any of the mediator or outcome variables. No significant interaction effects of EF deficits were found. $*p < .05$.

Mediation model predicting grade point average. Next, a mediation model was conducted predicting GPA with baseline ADHD symptom severity as rated by both parents and students as the predictor variables, the significantly correlated baseline student-rated EF deficits (i.e., Self-organization) and parent-rated EF deficits (i.e., Self-motivation) as possible mediators, with gender entered as a covariate. Mediation results using the MEDIATE macro are summarized in Figure 3. Although together, parent and student-rated ADHD symptom severity demonstrated an effect to T3 overall impairment ($F(3, 54) = 4.41, p = .007$), only a marginally significant total effect from parent-rated ADHD symptom severity to T3 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 3, 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 T3 GPA via T1 student-rated Self-organization (T1 ADHD symptom severity \rightarrow T1 Self-organization \rightarrow T3 GPA, $ab = -.17, SE = .08, 95\%CI = -0.034, -0.40$).

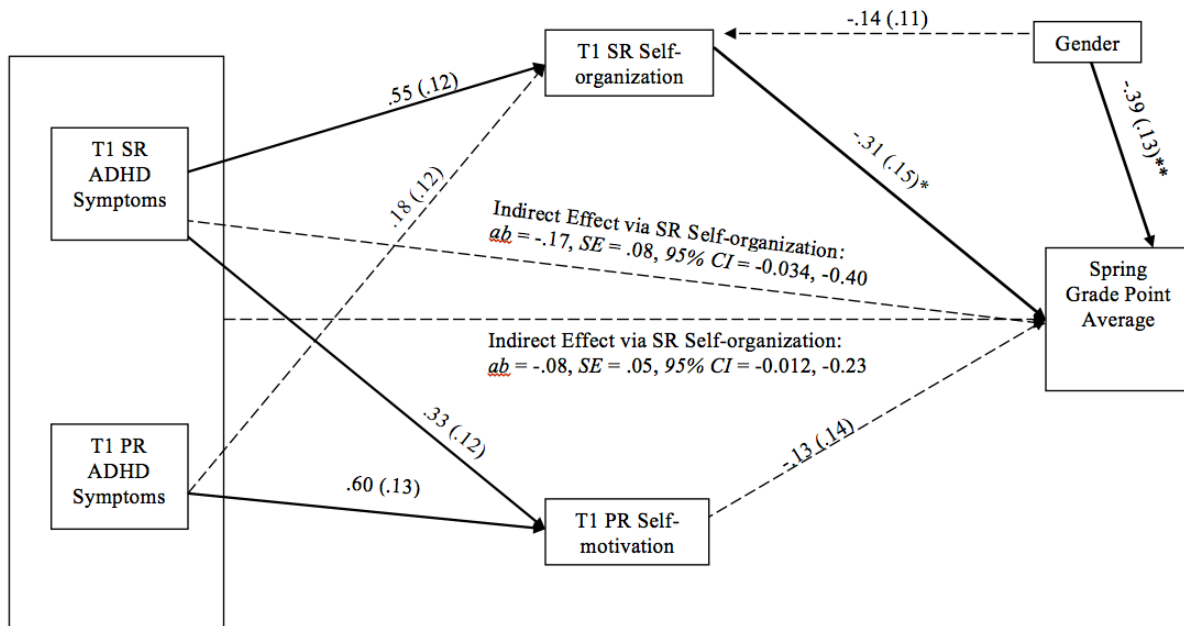


Figure 3. Parallel Multiple Mediation Model Predicting Follow-up Grade Point Average

Note. Indirect effects of model of T1 ADHD symptoms predicting T3 grade point average via T1 deficits in EF domains ($N = 58$). Standardized coefficients shown outside parentheses; standard errors are shown inside parentheses. Dashed paths are nonsignificant ($ps > .05$). Analyses controlled for gender, which in the final model was significantly associated with grade point average. No significant interaction effects of EF deficits were found. $*p < .05$.

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 to the ADHD and low EF deficit group ($ps < .05, ds$ ranging from .54 - .85; see Table 10). 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 to the ADHD and low EF deficits group ($M = 36.33$, $SD = 19.67$) and the magnitude of this effect was high ($d = .78$). Similarly, those with clinically significant deficits in Self-motivation ($M = 55.29$, $SD = 24.82$) had significantly higher levels of overall impairment in comparison to those with low EF deficits ($M = 36.33$, $SD = 19.76$) and the magnitude of this effect was high ($d = .85$). There were no significant group differences in those with or without high levels of EF deficits group in GPA or School Maladjustment.

Table 10.

Differences in Follow-up Academic Functioning for students with EF Deficits in the Clinical Significant Range on the Self-Reports of the BDEFS

	<i>Clinical EF Deficits</i>			<i>Non-Clinical EF Deficits</i>			<i>Group Differences</i>		
	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>t</i>	<i>p</i>	<i>ES (d)</i>
<i>Overall Impairment</i>									
SR Self-management to time	51.42	24.88	42	38.83	22.11	20	-1.85	.07	.54
SR Self-organization	53.79	25.03	39	36.33	19.67	23	-2.76**	.008	.78
SR Self-restraint	56.10	25.00	23	42.87	23.35	39	-2.03*	.04	.55
SR Self-motivation	55.29	24.82	37	36.33	19.76	25	-3.12**	.003	.85
SR Self-regulation of emotion	54.48	25.84	30	40.90	21.67	32	-2.19*	.03	.57
<i>GPA</i>									
SR Self-organization	2.21	.86	39	2.60	1.18	23	1.38	.17	.38
<i>School Maladjustment</i>									
SR Self-motivation	53.14	9.20	37	50.17	9.30	25	-1.21	.23	.32

Note. $N = 58$. * $p < .05$. ** $p < .01$. *** $p < .01$.

Discussion

This is the first prospective longitudinal study to evaluate the impact 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 GPA of 2.30 and high rates of D's or F's and course withdrawals. 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 to 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 4). The regression and mediation 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 our study hypotheses and prior work in the area.

The first aim of this study was to examine descriptive characteristics and outcomes because almost all prior research on the functioning of college students with ADHD has based diagnosis on self-report (see DuPaul et al., 2009 and Weyandt et al., 2013 for reviews). 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. Further, 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 Individualize Education Plan (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 (Barkley et al., 2008; Mannuzza et al., 1997; Kuriyan et al., 2012). In summary, despite the high rates of course failure and academic

warning status found in this sample, only half of the students were receiving services. Further, the most commonly received service was accommodations for which there is very little evidence-base supporting efficacy for students with ADHD (Harrison, Bunford, Evans, & Owens, in press). The poor academic functioning found in this sample along with the lack of evidence-based services highlights the need for treatment development.

Correspondence and Utility Across Self and Parent Informant Ratings

College students with ADHD rated greater severity in ADHD symptoms and EF deficits as compared to parent-report and agreement between self- and parent-report was low to moderate. The level of agreement found in this study is consistent with prior studies of young adult or college samples (e.g., Barkley et al., 2002; Barkley et al., 2008; Zucker et al., 2002). For example, Barkley and colleagues' longitudinal research found that hyperactive children followed into young adulthood had low agreement with parents ($r = .21$) at age 21 (Barkley et al., 2002) and that agreement increased with age (at age 27, $r = .43$; Barkley et al., 2008). The finding that students rated behaviors as more severe than parents is also consistent with prior work conducted with samples of students self-referred to college clinics for ADHD evaluations (e.g., Katz et al., 2009). In our sample, discrepancies were significant for the ADHD symptom domains of hyperactivity ($d = .61$) and impulsivity ($d = .57$), but not inattention ($d = .11$). Previous research has suggested that these discrepancies might reflect a subsample of students who are feigning or exaggerating their symptoms in order to receive academic accommodations or medication eligibility (Booksh, Pella, Singh, & Gouvier, 2010; Harrison, Edwards, & Parker, 2007).

Interestingly, when considering ratings of EF, discrepancies between self- and parent-report were only significantly different for one subscale, the self-organization scale and the magnitude of the difference was moderate to large ($d = .64$). However, there was significant incremental

utility to combining self- with parent-reports of EF in predicting outcomes. That is, both self- and parent-report of EF deficits uniquely made meaningful contributions to predicting overall functional impairment. This finding is in contrast to other studies that have demonstrated relative to young adults' self-reports of ADHD symptoms, parent-reported symptoms were more predictive of impairment in educational, occupational and social functioning (Barkley et al., 2002). One hypothesis for this finding relates to the discreet nature of the self-regulatory behaviors captured on the EF ratings. Specifically, it might be that various challenges posed by these EF deficits are less outwardly observable to others, making self-report of EF important, just as it is important to gather self-report when evaluating internalizing symptoms in children and adolescents. However, given the stated concerns related to the capacity of individuals with ADHD to adequately self-appraise and rate behavior (Barkley, 1997, 2002) and the fact that both self- and parent-reports of EF made significant contributions to predicting impairment in this study, future work with college students with ADHD should seek to obtain both self and parent ratings of symptoms and functioning.

Relation of EF and ADHD Symptoms to Impairment

As hypothesized, this study found significant positive relationships between ADHD symptom severity and overall impairment. These results are not surprising given past research on the academic and adjustment problems often faced by college students with ADHD (Norwalk et al., 2009; DuPaul et al., 2009). These findings also parallel the adult ADHD literature (e.g., Starvo et al., 2007), suggesting that inattentive symptoms account for the majority of variance in adaptive functioning. Contrary to prior studies (e.g., Norwalk et al., 2009; Schwanz et al., 2007), ADHD symptom severity did not predict school maladjustment or GPA. This may be due to the fact that previous studies examined adjustment and GPA using normative samples of college

students and this was an ADHD diagnosed sample and therefore there was restriction of range with the ADHD inattentive symptoms.

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 self-organization and parent-reported self-regulation of emotion were significant in predicting grades in the bivariate correlation analyses. In the regression models predicting overall impairment, self-reported self-motivation and parent-reported self-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 supports the importance of self-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 of inattention and academic performance and functional impairment (e.g., DuPaul et al., 2009). Findings from the current study build upon this work and suggest that in college students with ADHD, the relation between ADHD symptoms and functional impairment goes through motivation. The self-motivation subscale included in this study contains items related to resisting immediate rewards in order 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. Volkow et al., 2011; Reaser et al., 2007). Specifically, individuals with ADHD appear to be particularly sensitive to immediate rewards and to have a difficult time getting motivated to work towards 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 college students with ADHD.

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 organization 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 in order to be successful.

Group-based analyses comparing college students with clinical levels of EF deficits to those students with ADHD below the clinical threshold for deficits in EF yielded a similar

pattern of results as was found in the regressions and mediation analyses. In terms of effect sizes, students with ADHD and clinically significant EF deficits on any of the five domains experienced markedly higher rates of overall impairment (d s ranging .54 to .78) in comparison to individuals with ADHD alone. The magnitude of group differences across the academic outcomes was very large with most effect sizes exceeding one standard deviation. Further, students with ADHD and EF deficits in self-motivation experienced lower grades ($d = .58$) in comparison to students with ADHD alone. Overall, these data support past work suggesting that clinically significant EF deficits are not present in all individuals with ADHD but do occur more commonly than in the general population (Wilcutt et al., 2005). In this study, the majority of the sample was classified as having clinically significant deficits in each of the specific areas of EF with time-management being the most commonly reported deficit. These findings are important as they suggest that college students with ADHD and clinically significant EF deficits are most likely to struggle academically and to need treatment.

Limitations

The primary limitation of this study is the modest sample size ($N = 62$), which may have limited our ability to detect effects. 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 $M = 1111$). Further, while our sample was demographically representative of the university and state in which the study occurred, many of our participants came from middle-class families. 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. It is possible that a third confounding variable not considered in this study better explains and accounts for the variance in academic and overall impairment. For example, it is possible that other cognitive factors not measured in this proposed study such as intelligence or learning disabilities are important predictors of impairment. Further, comorbid internalizing mood, anxiety, or substance use disorders were not captured in the diagnostic evaluation and these factors could similarly negatively impact functioning (see future directions section below). Further, we did not obtain report from non-parent adult informants (e.g., significant others, roommates), who may play an important role in ADHD assessment for adults, especially for those participants who no longer lived at home. Future research should validate parent and student ratings of symptomology and EF deficits with additional objective measures of impairment to protect against method variance.

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 EF in an emerging adult sample over the course of one academic year.

However, longitudinal data collection using repeated measures collected 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 EFs and other markers of academic functioning in college such as grade retention and school dropout. Future longitudinal studies could also include a non-diagnosed sample of college students in addition to the diagnosed sample in order to compare the relative strength of the association between ADHD, EFs, and academic and overall functioning. If EF is indeed a neurological mechanism that is distinct from ADHD, the concomitant psychopathologies and correlates of EF must be examined in a range of normative and clinical samples in order to better delineate the role of EF in functioning at college.

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 in order 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). Further, as discussed above, college students with ADHD are more likely to choose immediate rewarding behavior (e.g., talking with friends, playing computer games) over larger, long-term reward (e.g., starting a paper that is due in a week, going to sleep in order 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; 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 EF skills are highly relevant for college students with ADHD, and have important clinical implications for assessment and treatment. Diagnostic assessment of college students suspected of ADHD should not only focus on symptom presentation but should also include measures of EF and impairment. Given the incremental validity data presented in this study, assessments should entail collecting ratings from both the parent and the student. Overall, the present study demonstrates that motivation and organization appear to be particularly important components of academic functioning for college students with ADHD. It appears likely that many young adults with ADHD will need intervention targeting goal setting, organization of materials and actions, working toward long-term goals, and managing emotional stress in order to be successful in college. Importantly, if the mediational relationships found in this study are confirmed in future research, this would suggest that solely providing college students with ADHD with medication, which primarily impacts symptoms (Epstein et al., 2010), would not be sufficient as the underlying causes of the impairment would not have been addressed.

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Vita

Melissa was born on May 9, 1988, in Columbus, Ohio, and is an American citizen. She graduated from Hilliard Davidson High School, Hilliard, Ohio in 2006. She received her Bachelor of Arts in Psychology from Ohio University, Athens, Ohio in 2010 and subsequently worked for two years as a research assistant for the School Mental Health Team at the University of South Carolina, Columbia, South Carolina.