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PREDICTORS OF READING ACHIEVEMENT IN A POPULATION OF SCHOOL-AGED CHILDREN WITH PARENT AND SCHOOL REPORTED ATTENTION-DEFICIT/HYPERACTIVITY DISORDER

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JULIA A. OGG

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PREDICTORS OF READING ACHIEVEMENT IN A POPULATION OF SCHOOL-AGED CHILDREN WITH PARENT AND SCHOOL REPORTED ATTENTION-DEFICIT/HYPERACTIVITY DISORDER

By

Julia A. Ogg

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ABSRACT

PREDICTORS OF READING ACHIEVEMENT IN A POPULATION OF SCHOOL-AGED CHILDREN WITH PARENT AND SCHOOL REPORTED ADHD

By

Julia A. Ogg

Attention-Deficit/Hyperactivity Disorder (ADHD) is the most prevalent childhood disorder (National Institutes of Health, 2000), and is also one of the most chronic health problems for school-aged children (Pastor & Reuben, 2002). Underachievement is experienced by as many as 80% of children with ADHD (DuPaul & Stoner, 2003). The current study examined reading achievement over time, among children eligible for special education, both with and without a parent and school report of ADHD, using latent growth modeling. The impact of demographic, student, and intervention variables on reading growth was examined. Findings suggest that schools play an important role above and beyond demographic characteristics of students when it comes to improving reading growth across a number of outcome measures. While externalizing behavior and stimulant medication status did not appear to have a significant impact on reading growth in the present study, positive student behaviors (e.g. completing homework on time) were related to growth on both a skill-based measure and on reading grades. Both academic and behavioral intervention variables were important factors in improving reading growth over time. The manner in which outcomes are measured is important and has implications for how growth is interpreted, as student reading grades were influenced differently than the skill-based measures. This study highlights intervention targets amenable to change in the school setting.

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Chapter 1

Introduction

The *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV-TR; American Psychiatric Association, 2000) reports that Attention-Deficit/ Hyperactivity Disorder (ADHD) effects 3-7% of the school-age population. In school-aged children, ADHD is the most common reason for a mental health referral (Barkley, 1998). Additionally, ADHD and related externalizing behavior accounts for the most referrals to school professionals (Phelps, Brown & Power, 2001). One possible reason for the high number of school-based referrals for ADHD is that academic underachievement is often considered one of the primary long-term outcomes of ADHD (DuPaul & Stoner, 2003). Despite the significant presence and detrimental impact that ADHD may have in schools, DuPaul and Eckert (1997) report that in comparison to other treatments for ADHD, school-based treatment is relatively understudied.

Academic and behavioral difficulties associated with ADHD often result in the need for specialized services and interventions within the school setting. One way that these services may be provided is through special education. Special education represents an important treatment option for children diagnosed with ADHD, by providing services within the school setting. In fact, the recognition within special education law of ADHD as a disability has been reported to account for one of the recent changes in the treatment of children with ADHD (Smith, Barkley & Shapiro, 2006). Children with ADHD are frequently eligible for special education under a number of different service categories. Some recent estimates suggest that as many as half of children in special education are diagnosed with ADHD (Bussing, Zima, Perwien, Belin & Widawski, 1998; Schnoes,

Reid & Marder, 2006). However, while special education services may be more accessible to children with ADHD within the school setting and a large number of students receive services, relatively little research has addressed the impact of school-based service delivery on academic outcomes for children diagnosed with ADHD. Additionally, the authors of a report by the President's Commission on Excellence in Special Education (2002) indicate that too often special education has an emphasis on the process versus outcomes. The authors of this report also suggest that the current system does not place enough emphasis on the consistent use of evidence-based practices.

Outcomes for Children Diagnosed with ADHD

Understanding the relationship between school-based services and academic achievement is important, as outcomes associated with a diagnosis of ADHD can be very negative across several areas of functioning. The manifestation of the three core symptoms of ADHD: inattention and/or hyperactivity and impulsivity may make school challenging for children with ADHD. In fact, Forness and Kavale (2001) suggest that the core symptoms of ADHD, "seem very often to be at the very center of what school requires of a child" (p. 224). DuPaul and Stoner (2003) cite academic underachievement as one of the most common correlates of ADHD with up to 80% of children with ADHD exhibiting academic performance problems. Academic difficulties in this population is demonstrated in a number of ways, including studies demonstrating that children with ADHD experience significantly more academic difficulty than children without ADHD (i.e., Deshazo Barry, Lymon & Klinger, 2002). Additionally, eighty-four percent of parents of children with ADHD reported that this disorder had impacted their child's academic or behavioral outcomes in school (LeFever, Villers, Morrow & Vaughn, 2002).

A number of academic difficulties are associated with ADHD, including underachievement as indicated by low and erratic grades and lower than expected achievement and intelligence test scores [American Academy of Child and Adolescent Psychiatry (AACAP), 1997; DuPaul & Stoner, 2003]. It has been hypothesized that these difficulties may be caused by a number of factors including, gaps in what a student has learned, difficulty sustaining attention, lack of attending to lectures or group-work, and difficulty with organization and study skills (AACAP). The AACAP also suggested that it can be difficult for students to take tests with core symptoms of inattention and impulsivity, and DuPaul and Stoner also cite poor test performance as a potential manifestation of ADHD. Finally, it has been suggested that a failure to turn in homework can lead to these negative outcomes (AACAP). This is particularly relevant when it comes to reading, as 25–40% of individuals with either ADHD or RD also meet criteria for the other disorder (Wilcutt et al., 2007).

ADHD and related academic underachievement are pervasive and present a set of chronic challenges. Children with ADHD do not "outgrow" the symptoms associated with disorder, as 70-80% of children with ADHD continue to exhibit significant deficits in inattention and impulsivity compared to same-age peers (DuPaul & Stoner, 2003). Half of these children also continue to exhibit symptoms into adulthood. There are a myriad of problems in adolescence that can accompany an ADHD diagnosis. The drop-out rate for children diagnosed with ADHD may be as high as 32% (Smith et al., 2006). The AACAP also suggests that difficulties associated with ADHD can result in higher than expected placement in special courses, suspension, and expulsion. The extant literature also reports that aggression and noncompliance can occur in adolescence

(DuPaul & Stoner). Students with ADHD and aggressive and oppositional behaviors are at greater risk for later delinquency and a diagnosis of Conduct Disorder (CD; Smith et al.). Additionally, for those who do develop comorbid CD, higher rates of substance use and abuse has been reported (Smith, et al.). Other outcomes in adolescents with ADHD that have been reported in the literature include higher rates of teen pregnancy in some studies, and an increased rate of automobile accidents and speeding citations (Smith et al.).

There is less data available for outcomes in adult populations with this disorder. However, there is evidence for interpersonal difficulties, criminal convictions, and higher than expected substance use disorders (Smith et al., 2006). In addition, within adults the rate of completing a university degree program is much lower in the population of individuals with ADHD compared to those without (review DuPaul & Stoner, 2003). It seems clear that both the short and long-term impact of this ADHD is associated with a greater level of risk for negative outcomes than for individuals without this disorder.

Predictors of Academic Achievement

Given the negative trajectory often associated with ADHD, it is essential to identify ways to alter this developmental trajectory and improve outcomes for children diagnosed with ADHD. DuPaul and Weyandt (2006) suggest a need for increased focus on improving outcomes for this population, versus the more common approach of reducing or eliminating problem behaviors. Therefore, a systematic research approach is needed to identify variables that predict academic achievement within this population, as well as how these variables may differ from students without ADHD. The extant literature has examined primarily how ADHD symptoms and cognitive mediators relate

to academic outcomes, however, a large portion of variance is unaccounted for in predicting academic outcomes within this population (DuPaul, Volpe, Jitendra, Lute, Lorah & Gruber, 2004). The role of additional variables in predicting academic outcomes is yet to be well understood.

Identifying predictors of achievement for students with ADHD can inform school professionals in meeting demands of increasing accountability. Emphasis on accountability is driven largely by the *No Child Left Behind Act of 2001* (2002; NCLB) and the *Individuals with Disabilities Education Improvement Act of 2004* (*IDEA*). While NCLB is focused on achievement at the level of the school, IDEA is focused on individual students, particularly those with disabilities. Within both laws, a means for accomplishing accountability is by using "scientific research" to informing intervention practices. However, DuPaul and Eckert (1997) report that research that examines interventions implemented specifically for ADHD in the school setting is sparse. Additionally, for significant portion of children diagnosed with ADHD, special education is an important route for service delivery. However, it has been suggested that there is little research that examines this area for children diagnosed with ADHD (Forness & Kavale, 2001) and special education has not consistently focused on the delivery of evidence-based practice (President's Commission on Excellence in Special Education, 2002). Further, DuPaul and Stoner (2003) suggest that there is currently ambiguity when it comes to what components should be included in an educational plan for special education students who are diagnosed with ADHD.

Current Study

The current study examines variables that relate to positive academic outcomes for children with ADHD within a special education population. This study can help address questions of concern to school professionals who seek to effectively provide services to promote academic success. Additional knowledge of important predictors of academic success and the relationships between the variables can be utilized for prevention, assessment, and intervention purposes. Additionally, this study is intended to provide a beginning point to further understand the relationship between special education and student outcomes within the ADHD population.

The purpose of the proposed study is to examine several predictors of academic outcomes. This study will utilize data from a large, nationally representative data set of children who are currently receiving special education services (Special Education Elementary Longitudinal Study, 2003). Specifically, the current study will examine the relationships between predictors of reading growth within a population of special education students with a parent and school reported diagnosis of ADHD, as well as comparing these relationships to children who do not have a reported diagnosis of ADHD. This study will build upon the extant literature in several ways. First, the nature of the sample adds several distinctions. This study would add to the extant literature by the use of a large, national sample of children. The longitudinal nature of this sample will also be an addition to previous studies, which have recommended the need for longitudinal data (DuPaul et al., 2004) in examining academic outcomes. By focusing on the special education population, the focus is on the children who are often most educationally impacted by their ADHD. Secondly, the current study will provide valuable insight into interventions as typically delivered within the school setting, which

can be compared to the impact of interventions within a highly controlled setting. One difficulty with the current literature is that most outcomes studies for ADHD have been conducted in a very controlled manner (DuPaul & Weyandt, 2006). This study instead is based on reported interventions from real classrooms. It is important to further understand the relationships between variables within the "real world" school setting.

The following chapters describe the relevant literature related to this topic and the methodology that is employed to answer the questions of interest. Chapter Two provides a review of the literature that addresses in more detail, models and predictor variables that have been identified in the extant literature to help delineate predictors of academic achievement. Chapter Three describes the methodology employed to answer the research questions. This chapter also focuses on methodological issues related to using a large data set, as well as describing the analytic strategies. Chapter Four provides the results from the analyses of interest, and Chapter Five provides a discussion of the conclusions that can be drawn from these results, as well as recommendations for future directions.

Chapter 2

Literature Review

Children diagnosed with ADHD frequently experience academic difficulty. This chapter will outline factors that have been proposed to ameliorate academic underachievement. A review of the empirically supported treatments for ADHD and the impact of each of these treatment modalities on academic outcomes will be provided. A second portion of the literature review will address research that has examined predictors and models that attempt to account for academic achievement within this population. This will be followed by a review of how interventions are provided to children within the school setting, with a focus on special education services. Finally, the current study will be discussed and the research questions will be outlined.

Evidence-Based Treatment for ADHD

It is important to understand best practices in the care of children with ADHD, by examining what treatments are empirically supported. Empirically supported treatments for children diagnosed with ADHD include stimulant medication, behavioral modification at home or school, and the combination of these two treatments (Pelham & Gnagy, 1999). These treatments also represent those that are most well-studied (DuPaul & Weyandt, 2006). In the context of the current study, it is important to examine the impact of empirically supported treatments on academic outcomes within the literature.

Stimulants, or methylphenidate, are currently the most commonly used treatment for ADHD and have been for at least the last 30 years (Pelham, et al., 2000). Rowland, Lesesne, and Abramowitz (2002) reported that over 1.5 million children were taking methylphenidate. Studies on the effects of stimulants have suggested that their impact

varies across symptoms with the strongest effects on attention, distractibility, impulsivity, and observable social and classroom behavior (Brown, 2005). However, Brown reports that stimulants have demonstrated less efficacy in the area of academic achievement, and that their effect in this domain is "modest" (pg. 121). As the current study is specifically interested in the impact on academic functioning, this area will be examined in more depth.

A recent review of ADHD treatment studies examined the impact of pharmacological intervention on academic outcomes in children diagnosed with ADHD (Ryan, Reid, Epstein, Ellis, & Evans, 2005). The authors cited a number of problems with the current literature on this topic that can make it difficult to draw strong conclusions. These include limited information on students, few studies with adolescents, few types of medications studied, inadequate dependent measures, and short-term interventions. An additional concern cited by the authors was that of those studies that did report this information only a small number were conducted within typical settings for students with ADHD, including general education, resource, or self-contained classrooms. Instead a majority of these studies were conducted in more restrictive settings, such as university settings, psychiatric hospitals, and other clinical settings. The results of the review indicated that medication intervention (83% methylphenidate) resulted in a small to moderate benefit (mean ES = 0.327) in the academic areas. Specifically 60% of the studies that reviewed led to an improvement in academic performance, while 7% led to a negative outcome, 19% indicated mixed results, and the final 14% reported no difference in academic performance. The results led to the largest effect size in the subject history (0.74), followed by writing (0.45), reading (0.38), and

math (0.18), with a small negative impact in spelling (-0.05). In sum, the results of this review suggested that medication does appear to have a moderate benefit on academic performance.

While most research has suggested that stimulant medications have been shown to be more effective than behavioral treatments, this is likely dependent on how the medication is delivered and on what outcomes are measured. In the largest study to date on ADHD, the Multimodal Treatment Study of ADHD (MTA), carefully titrated psychostimulant treatment was more effective in reducing symptoms of ADHD than routine community treatment (which may include treatment with psychostimulants) in the sample within the MTA study. This was the case when multiple outcomes such as academic, social, and family variables, were taken in to consideration (Jensen et al., 2001). Research that specifically examines the impact of carefully controlled psychostimulants on academic outcomes is important.

In addition to psychostimulants, behavioral treatments are empirically supported for treating ADHD. According to the American Psychological Association Division 12 (Clinical Psychology), behavioral parent training and behavioral classroom modification in the classroom are the only well established psychosocial treatments for ADHD (Ollendick & King, 2004). However, reviews of the literature related to this topic suggests that academic interventions, and to a lesser extent, social interventions have also demonstrated efficacy for improving school outcomes associated with ADHD (DuPaul & Eckert, 1997; DuPaul & Stoner, 2003; DuPaul & Weyandt, 2006).

One of the most comprehensive empirical references for school-based interventions for ADHD is a meta-analysis conducted by DuPaul and Eckert (1997).

These authors suggested that compared to other treatment modalities for ADHD, like stimulant medication, there has been relatively little research that examined school-based interventions for children with ADHD. Additionally, less is known about the impact of various school-based interventions. The authors reviewed 63 studies with 637 participants conducted between 1971 and 1995. The review addressed two primary research questions: 1.) do school-based interventions significantly change target behavior? 2.) does the type of intervention (contingency management, academic, or cognitive-behavioral) influence the impact of the intervention? The study also examined moderators (e.g. setting) from these studies that may influence outcomes. In reference to the first research question, the analysis of extant literature provided support that school-based interventions significantly change target behavior. The impact varied depending on the target behavior. The effect size for all interventions (contingency management, academic intervention, and cognitive-behavioral intervention) was more significant on behavior than on academic or clinic test performance outcomes. DuPaul and Eckert concluded that school-based interventions are effective in reducing ADHD-related behaviors. The effect size for behavioral outcomes was in the moderate to high range. Although school-based interventions are less effective in improving academic performance, this meta-analysis also revealed that these interventions can also have an impact in this area. The effect size for academic outcomes was in the low range.

The second research question addressed in this meta-analysis concerned the relative efficacy of several intervention types (contingency management, academic, cognitive behavioral). Their analysis indicated that contingency management and academic interventions were more effective than cognitive-behavior interventions in

improving classroom behavior, such as attention and disruptive behavior. There were no significant differences between the contingency management and academic intervention techniques for this purpose. This finding indicated that academic interventions offered a viable intervention strategy. To explain this finding, DuPaul and Eckert postulated that academic intervention may provide a replacement behavior (academic functioning) for the disruptive behavior.

In terms of addressing potential moderators, DuPaul and Eckert (1997) found that in some studies, interventions delivered within general education were less effective than those delivered within special education in terms of behavioral outcomes. However, this was only the case for the within-subject studies included within their review. There were no differences for the mediating effect of setting across the other study types and academic outcomes. The authors concluded that the latter result was promising given that many children with ADHD spent a majority of time in general education.

DuPaul and Weyandt (2006) examined behavioral, academic, and social interventions for ADHD. Behavior interventions presented the strongest evidence of effectiveness. Several types of behavior treatments were discussed, including antecedent-based strategies (e.g. modification of assignments), consequent-based strategies (e.g. token economies), and self-management strategies (e.g. self-monitoring). The authors also discussed academic interventions in this review, and suggested that these strategies are important as they focus not only on reducing inappropriate behavior, but also on improving positive outcomes. Academic interventions included changes in teacher instruction, as well as peer- and computer-mediated interventions. These strategies have demonstrated some efficacy with children diagnosed with ADHD, however, there is a

need for additional research examining the impact of these interventions. Lastly, social relationship interventions are discussed. DuPaul & Weyandt suggested that additional research in this area is needed, as typical social skills groups have not led to sustainable improvements in social functioning. There is preliminary support for more comprehensive social interventions, however, there is limited data at the present time. In a recent review of evidence based psychosocial interventions for ADHD, Pelham and Fabiano (2008) report that clinic-based social skills training have little impact, and are not currently considered an evidence-based intervention for ADHD. These authors did indicate that intensive behavioral interventions implemented in peer recreational settings, have established efficacy for children with ADHD.

DuPaul & Weyandt (2006) suggested that both behavior and academic intervention types have sufficient support within the empirical literature to support their use. There is a relative void of research on school-based social relationship interventions for children with ADHD. Although these interventions have shown less efficacy than the behavioral and academic interventions, their use is promising within the literature. Also implicated in this review was the need for multiple intervention targets. Many children experience difficulties across several areas, such as in social and academic tasks, and multiple intervention approaches are necessary.

Predictors of Academic Outcomes

In addition to research that has evaluated the empirical evidence for various treatment modalities for ADHD, there is also research that has examined various predictors of academic achievement. Unlike interventions, predictor is a more general term and includes any variable that is related to a particular outcome. This could include

variables such as gender and classroom placement. Predictors of academic success are also important to consider as they relate to outcomes and also may mediate the effects of intervention efforts. A consideration of variables that predict positive academic outcomes for children with ADHD is essential to improve outcomes.

The extant literature has demonstrated that both ADHD symptoms (i.e. inattention, hyperactivity, impulsivity) and cognitive variables predict academic underachievement (DuPaul et al., 2004). For example, studies have reported that symptoms of ADHD have a negative linear relationship with academic outcomes, with more excessive ADHD symptoms related to more negative academic outcomes (DeShazo Barry et al., 2002). Of the core symptoms, inattention is the most strongly tied to negative academic outcomes (Barkley, 2003). DuPaul et al. (2004) suggest that in addition to symptoms of ADHD, cognitive variables have often shown to play a role in predicting academic outcomes in the literature. For example, DeShazo Barry and colleagues (2002) reported that ADHD symptoms and cognitive variables accounted for 15% to 28% of academic outcomes across studies.

In addition to a focus in the extant literature primarily on cognitive and core symptoms as predicting academic outcomes, DuPaul et al., (2004) delineated some other limitations of the current literature on this topic. For example, many existing studies in this area focused only on one academic area (i.e. reading or math), they primarily used norm-referenced standardized measures of achievement, and often only examined how prediction within an ADHD population versus comparing the adequacy of predictors across ADHD and non-ADHD populations. To address the need to identify additional predictors, and current limitations with the existing literature, DuPaul et al. examined

predictor variables using hierarchical regression analyses. Specifically, they examined the predictive value of teacher ratings of ADHD symptoms, academic skills, achievement related behavior, social skills, direct classroom observations, ethnicity, and SES. Their analysis considered a model across two groups (ADHD and non-ADHD), two academic areas (reading and math), and two outcome measures (standardized assessment and report card grades). The analysis revealed that once ethnicity and SES was taken into account, only a few variables significantly predicted academic outcomes. Specifically, for both groups, teacher perceptions of academic skills was the strongest predictor of academic achievement. Additionally, academic enablers, inattentive symptoms, and observed off-task behaviors seemed to play a role in predicting outcomes. The predictors varied across groups (control vs. ADHD), academic area (math vs. reading), and criterion measure (report card grades vs. standardized assessments). Specifically, reading was more adequately predicted with their model than math. For children with ADHD, the model (including Ethnicity, SES, and teacher rating of reading skills) predicted 35% of the variance on a standardized measure of reading. For report card grades, the model (including Ethnicity, SES, teacher rating of reading skills, and teacher rating of academic enablers) explained only 24% of the total variance. Within the control group, there were differences in terms of what variables were included in the significant model, as well as for the predictive value of the model. The predictive value of the model in the non-ADHD population was stronger for the standardized criterion (R^2=0.55) and the reading report card grade (R^2=0.32).

The results of this study suggest that several factors predict reading outcomes, but that these vary across groups, academic areas, and outcome measures. Additionally, this

study is the first to indicate the importance of the academic enablers (DiPerna & Elliott, 2000) for the ADHD population, as these played a significant role in the model predicting report card grades in reading for children in the ADHD group. This was true even after their ADHD symptoms have been accounted for in report card grades. The teacher rating of academic enablers was not included in the significant model for a standardized measure of reading achievement. The authors suggested that this may indicate that academic enablers may play less of a role in skill attainment, but may be important variables in how teachers grade students. Future research on this topic is needed. An additional implication of this study was the importance of teachers' perceptions of a child's academic skills. This emphasizes the need to not only reduce behaviors associated with ADHD, but also to target the academic skills of these children. The results support the need for future research to consider academic skills and enablers, rather than just behavioral symptoms, in the assessment and implementation of interventions within this population.

ADHD Models

In addition to identifying predictor variables, it is also important to understand the impact of variables within a larger framework. A theoretical framework is essential for integrating empirical data and developing working hypotheses about the relationships between variables. The development of such models is essential to informing treatment practices, as they provide a framework for developing testable hypotheses that can guide intervention research. Models can help researchers and clinicians understand variables that are hypothesized to predict positive outcomes. These models can outline various

frameworks, including biological, psychological, and social variables that are hypothesized to impact development or outcomes.

Within the ADHD literature, many models have been developed to help explain the nature and development of ADHD. An etiological model can be helpful in understanding causal factors that are hypothesized to underlie the development of ADHD. For example, an etiological conceptual model articulated by Rapport, Chung, Shore and Isaacs (2001) suggested an underlying neurobiological system is responsible for the core features of ADHD which include hyperactivity, impulsivity and inattention. In this model, the authors hypothesized that the peripheral features of ADHD (e.g., poor social skills, academic difficulty and internalizing problems) are a consequence of dysfunction associated with the core features of ADHD. This model can be seen in Figure 1. The authors of this model also outlined the hypothesized impact of different interventions. For example, as seen in Figure 1, they hypothesize that methylphenidate acts on the neurobiological substrates underlying ADHD, which in turn acts on the symptomotology associated with ADHD. This model provides a comprehensive picture of how the symptoms of ADHD are hypothesized to relate to one another, and how modes of intervention may target different areas within this model.

Another prominent model for describing the dysfunction associated with ADHD is Barkley's Disinhibition Model (1997; 2003), as shown in Figure 2. This model suggests that the executive function of behavioral inhibition influences four other executive functions, including: deficits in nonverbal working memory; internalization of speech; self-regulation of affect, motivation, and arousal; and impaired reconstitution. In sum, it is hypothesized that these deficits across the executive functions impact the motor

actions. In particular, such deficits make it difficult to plan and execute actions in a goal-directed and systematic manner. Barkley hypothesized that these deficits lead to the behavioral manifestation of ADHD of impulsivity and hyperactivity. While models developed by Rapport et al. (2001) and Barkley (1997; 2003) have been influential in delineating better understandings of ADHD, models that are more specifically focused on academic achievement are helpful in understanding the relationship between ADHD and scholastic outcomes, and are of particular interest in the present study.

There are a number of theoretical and empirical models of academic achievement within the extant literature. The majority of these models have not been specifically assessed in the context of an ADHD population, yet provide valuable insight into thinking about the types of variables that may best predict academic achievement. Academic achievement models consistently report student, instructional, and environmental variables as impacting academic achievement (DiPerna, Volpe, & Elliott, 2002). Much recent work in this area has focused specifically on student variables. Rationale for studying student factors is that these variables have been shown to have the most significant impact on student outcomes (Wang, Haertel & Walberg, 1993; DiPerna et al., 2002). Within the school psychology literature, some of this research has focused on "Academic Enablers", which can be defined as "attitudes and behaviors that allow a student to participate in and ultimately benefit from academic instruction in the classroom" (DiPerna & Elliott, 2002, pg. 294). These include factors of motivation, interpersonal skills, engagement, and study skills. A model that describes the relationship between these variables is shown in Figure 3.

That model of "Academic Enablers" was evaluated based on data from 394 students (DiPerna et al., 2002). The sample was split into two groups, primary (K-2) and intermediate (3-6). The constructs of interest were measured using the *Academic Competence Evaluation Scales* (DiPerna & Elliott, 2000; ACES). Results of evaluation of this model indicated that there were similarities in model fit between the primary and intermediate samples. The most significant predictor across models was prior achievement, which accounted for a majority of the variance in current reading achievement. Motivation and engagement were the academic enablers that accounted for the most variance in the model. The magnitude of the effect size for these variables was in the large to moderate range. These authors suggested that research on academic enablers is valuable, as these are variables that are amenable to intervention within the school setting (DiPerna et al., 2002). It is further suggested that evaluation of models, such as the one in this study, are important to provide frameworks of testable hypotheses for future intervention research.

Another model that provides valuable insight into academic outcomes, specifically related to the ADHD population, is one developed by Fergusson and colleagues (Fergusson & Horwood, 1995; Fergusson, Horwood & Lynskey 1993) and replicated and expanded by Rapport, Scanlon, and Denney (1999). The expanded model focused on specific student variables that impact scholastic achievement. This model, the dual developmental pathways model, is shown in Figure 4. The authors hypothesized that there is both a cognitive and behavioral pathway that predict scholastic achievement in children exhibiting symptoms of ADHD. Specifically, they suggested that classroom performance mediates a behavioral pathway to scholastic achievement, and that vigilance

and memory mediate a cognitive pathway to scholastic achievement, which was defined in this study as scores on the Stanford Achievement Test. Findings indicated that the dual pathway model fit well with the data. Specifically, the data indicated that both behavioral and cognitive pathways mediate the relationship between IQ and ADHD with scholastic achievement. Overall, the findings indicate that this model accounts for 77% of the total variance. Interestingly, the direct impact of ADHD on scholastic achievement was smaller in this study than found in studies that did not examine the role of mediators between ADHD and achievement (standardized regression coefficient= -.07). However, there was a strong, significant relationship between ADHD and classroom performance (standardized regression coefficient= 0.33) and vigilance (standardized regression coefficient= -0.20). These findings indicated that both cognitive and behavior mediating variables largely account for the relationship between ADHD and scholastic achievement.

Recently, another model that further delineates the relationship between classroom behaviors, ADHD, and academic achievement was described. This model is more specific than Rapport et al.'s (1999) model in defining behaviors that relate to academic outcomes. Volpe and colleagues (2006) built upon a model of academic achievement developed by DiPerna, Volpe and Elliott (2002) and examined child variables in the classroom and how these mediate the relationship between ADHD and academic achievement. This model is shown in Figure 5. The authors of this model purported that ADHD has an impact on prior achievement, motivation, and interpersonal skills. Motivation is also impacted by prior achievement and interpersonal skills. Motivation, in turn, acts indirectly on current achievement, through its impact on study

skills and engagement. The impact of prior achievement on current achievement is also hypothesized. In evaluating this model, the authors found that the model accounted for 30% of the total variance in reading achievement, with all pathways being significant predictors, except for engagement. These findings suggest that while these academic enablers account for some of the variance in predicting academic outcomes, additional predictors remain.

There are a number of variables and models in the extant literature that explain a portion of the variance associated with academic outcomes for children diagnosed with ADHD. These include cognitive variables, ADHD symptoms, classroom behaviors, academic skills, academic enablers, and others. However, there is still unexplained variance in fully accounting for academic outcomes. Additionally, there is a need to further understand how intervention strategies influence academic outcomes. The school serves as an important context for considering both academic outcomes and intervention. Understanding how interventions may be provided within the school setting, is therefore an important compliment to understanding predictors of academic achievement, as it sheds light on how and where these predictors may be influenced.

School Based Service Provision for ADHD

Because academic underachievement and other negative school outcomes are often so salient for many children with ADHD, the school is often an important context for intervention. In fact, it has been reported that there have been recent changes in the treatment of ADHD in children, and that these changes are based in part on the recognition within special education law of ADHD as a disability (Smith et al., 2006). An additional reason why an understanding these services provided in the school setting

is essential is based on data that suggests that the school often serves as the primary services provider to children. For example, there is evidence that a majority of children with mental health needs do not receive services (Hoagwood & Johnson, 2003). In fact, it has been suggested that only six to twenty-five percent of children receive mental health services. Additionally, for a majority of children, the school is often the only service provider of such services (Hoagwood & Johnson). The next section will further explore what these services may look like for children diagnosed with ADHD.

Within the school setting, children with ADHD may receive both formal and informal services and these services can be widely variable. One avenue of services for children with ADHD is through special education. Historically, children with ADHD did not receive special education specifically as it related to this disorder. These children could and often were eligible under other special education categories, however, there was not a category that included ADHD until 1991 when ADHD was included as a subcategory in the Other Health Impairment (OHI) label. However, a diagnosis of ADHD is not sufficient for a student to be eligible for special education services. Within the law, special education is reserved for children where ADHD is not only present, but also where there is a need for special education services.

While it is clear that not all children with ADHD are eligible for special education, it is the case that many children with ADHD do enter the special education system. Children who are exhibiting the highest level of behavior or academic difficulties within the schools may often be referred for special education. A recent survey based on a national sample suggested that over 11% of children with ADHD, without learning disabilities, receive special education services. Additionally, among children with both

ADHD and LD, almost 65% were receiving special education (Pastor & Reuben, 2002). Starting in 1991, three routes for services were established for children with ADHD, which have been summarized by DuPaul and Stoner (2003).

- Children with ADHD could qualify under a special education eligibility category other than OHI (e.g. Specific Learning Disability (LD), Emotionally Disturbance (ED), Mental Retardation (MR)) if they met the eligibility criteria for that category. Certain categories are more common for children with ADHD. Forness and Kavale (2001) suggest that children with ADHD are often found in the Emotional Disturbance (ED) and LD categories, and account for over forty percent of children within these groups.
- Children with ADHD could also qualify under the eligibility category of Other Health Impaired (OHI). In 2002, approximately 7% of children in special education were qualified under the OHI category. This number of students qualified under this category has increased significantly from 1992 to 2002 (U.S. Department of Education, 2005) a result that has been attributed to the inclusion of ADHD in this category since 1991 (Forness & Kavale, 2001). The specific definition that makes this category appropriate for children with ADHD is that the other health condition results in "having limited strength, vitality, or alertness, including a heightened alertness to environmental stimuli, which results in limited alertness with respect to the educational environment" (Department of Education, 2006). To become eligible in this category, a child must also undergo a comprehensive evaluation by a multidisciplinary team, which includes a

physician. In addition, they must demonstrate a need for special education services.

- Although not a special education decision, a child could qualify for services within general education under Section 504 of the Rehabilitation Act. Unlike special education, there is not funding attached to this service. Fornees and Kavale (2001) suggest that the accommodations provided through this service are likely to be less intensive than those received within special education.

Given the focus on reviewing children with ADHD receiving special education services, only the first two areas of eligibility will be discussed within this review.

Recent research has examined what special education category children with ADHD are categorized under, as well as providing demographic and service delivery information on this topic. A study by Schnoes and colleagues (2006) suggested that children with ADHD are found across a number of special education categories. The sample in this study was drawn from the Special Education Elementary Longitudinal Study (SEELS), a nationally representative sample of elementary-aged students in special education, and includes data from parent report, teacher report, school report, and through direct assessment. The sample used for that study included children with the special education eligibility labels of LD, ED, Speech/Language Impairment (SLI), OHI, and MR. The rationale for selecting these categories, as described by Schnoes and colleagues, was due to the fact that these categories, particularly LD, ED, and OHI, are most likely to include children diagnosed with ADHD, based on prior research in this area. From this sample, only children where both parents and the school agreed that the child had ADHD were included. For the comparison group, children where both parents

and school report that they do not have ADHD were included. The total sample included 1419 children.

The prevalence of ADHD was reported for each disability category. The OHI category had the highest percentage of children with ADHD with approximately 66%, followed by ED (58%), MR (21%), LD (20%), and SLI (5%). In contrast to looking at the prevalence of ADHD within each disability category, this study also examined the disability categories reported for the ADHD population. Within the population of children with ADHD eligible for special education services, LD was the most common diagnosis with approximately half (50%) of children with ADHD in special education being eligible for services under the LD disability category. The percentage of children in the sample eligible under the LD label was similar for children with and without ADHD. Over 17% of children with ADHD in special education were eligible under the OHI category, and this percentage was much higher than for non ADHD children in special education (2%). A similar pattern was found for the ED category, where over 13% of children with ADHD were placed, compared to approximately 3% of children without ADHD in special education. In the SLI category, fewer children in the ADHD group were eligible for these services (7%) than in the non-ADHD group (35%). Within the MR category, a similar percentage of students with ADHD (12%) and without ADHD (12%) were found.

In terms of both where a high percentage of children with ADHD are placed, as well as categories in which ADHD are more likely to be placed compared to all students in special education, three categories stand out. These include the areas of LD, ED, and OHI.

ADHD & Learning Disabilities. ADHD and learning disabilities commonly overlap. This is logical given the fact that academic difficulties are a peripheral feature associated with ADHD. The overlap is also significant in the context of special education, as learning disabilities represent almost half of the children who are qualified for special education (U.S. Department of Education, 2005). Estimates for the overlap between ADHD and LD have ranged from 7 to 92 percent. However, Forness and Kavale (2001) suggested that the most appropriate comorbidity of these two diagnoses is likely between 10 and 20 percent. In a review of the literature, DuPaul and Stoner (2003) suggested that children with ADHD are three to four times more likely than their peers to exhibit learning disabilities. Additionally, the percentage of children with LDs that are diagnosed with ADHD is even higher. Children with learning disabilities are seven times more likely to exhibit significant symptoms of ADHD. Clearly, these disorders and symptoms of these disorders often co-occur.

In one of the largest studies to date that focused on children with Attention Deficit Disorder (ADD; the DSM-III precursor to ADHD) and a LD, Pastor and Reuben (2002) explored the relationship between these two diagnostic categories. Their study was based on the National Center for Health Statistics Survey from 1997-1998 and included more than 8600 children, that were representative of the U.S. population. The results of their study suggested that 2.6 million of children age 6-11 years were diagnosed with ADD or LD. Within these groups they found that 3% were diagnosed only with ADD and 4 percent with only LD. Additionally, there was another 4% with both ADD and LD. This underscores the idea that some but not all children with ADHD will experience learning difficulties. In this sample, seven percent of school-aged children had ADD, which is

consistent with the high end of the 3-7% of school-aged children reported in the DSM-IV-TR (APA, 2000). The fact that more than one-half of these children had a LD in addition to their ADD is important to consider.

Pastor and Reuben (2002) also reported on the service utilization of children with ADD and a LD. Children with both LD and ADD had highest rates of medication use and mental health services, followed secondly by children with ADHD. Pastor and Reuben (2002) also examined the service utilization in the school setting. Children with sole diagnosis of LD were five times more likely to be participating in special education than children with ADD only. The addition of LD to ADD may make a child more likely to have services both within the community and school setting.

There have been a number of other studies that have examined this relationship between ADHD and learning disabilities. DuPaul and Stoner (2003) provided several relevant conclusions based on their examination of these studies. First, they suggested that these studies provide support for a significant correlation between academic underachievement and symptoms of ADHD. They also suggested that this relationship is strongest in elementary children. Additionally, they suggested that of the externalizing behavior disorders the link between learning disabilities and ADHD is the strongest. Despite the fact that this relationship is supported in the literature, there are several methodological issues that make it difficult to draw conclusions about the overlap between ADHD and LD.

A particularly common learning disability for children with ADHD is a reading disability. In their review of the literature, Wilcutt and colleagues (2007) suggest that from 25-40% of individuals with either a reading disability or ADHD also meet the

criteria for the other disorder. This is significant as approximately 18% of the U.S. population of children will experience reading problems in the early school years (National Reading Panel Progress Report, 2000). To explain this high rate of comorbidity, previous research has revealed that both reading disabilities and ADHD have a significant genetic component, and that children with a relative with ADHD or a reading disability are 6-8 times more likely to have the disorder than children who do not have a relative with the disorder (review Wilcutt et al.).

A better understanding of the pathways that mediate the correlation between reading disabilities and ADHD is important. A recent study in preschool-aged children was important in shedding light on the developmental pathways through their use of young children (Wilcutt et al.) Wilcutt and colleagues found correlations between ratings of ADHD and reading measures in preschool children. Consistent with previous research, their study also revealed that the reading difficulties were more highly linked to difficulties with attention, as opposed to hyperactive and impulsive symptomatology. The authors concluded that this finding provides evidence against the idea that one disorder is the consequence of the other. Additionally, Wilcutt et al. found that inattention was not more strongly associated with any particular type of pre-reading task. In other words, they did not find one specific reading skill that was more highly correlated with ADHD.

Another area that is relevant to special educations service delivery for children with ADHD and LD is the recent changes in special education law that have changed the requirements for a child to be eligible for a specific learning disability. The Individuals with Disabilities Education Improvement Act of 2004 has changed the requirements for

determining children eligible for special education (U. S. Department of Education, 2006). The federal law now states that the discrepancy formula does not have to be used to identify children with learning disabilities, and that alternative methods may be used. A popular alternative for determining eligibility for special education is the response to intervention model [National Association of State Directors of Special Education (NASDSE), 2006]. This model uses a dual discrepancy model which relies on both learning rate and performance that is discrepant from peers. While there are several ways in which this model is conceptualized, service provision is provided largely outside of special education and when eligibility is considered it may be based on a lack of response to high quality intervention (NASDSE). Little is known regarding the implications of this change in the law specifically for children diagnosed with ADHD. Further research is needed to better understand the implications of this change on academic outcomes for students.

ADHD & ED. Compared to the amount of research that examines the link between ADHD and learning disabilities, Schnoes et al. (2006) reported that there is less research that has focused specifically on the relationship between ADHD and ED. This may be due to the fact that ED is not a psychiatric diagnosis, and is solely limited to the educational classification systems used within school settings. Schnoes and colleagues (2006) suggested that one reason children with ADHD are likely to receive services under the ED category because of the high rates of comorbidity between ADHD and other psychiatric diagnoses.

For children in special education programs for ED, there have been widely varying rates of ADHD reported. In their review of studies, Forness and Kavale (2001)

suggested that in the few studies that examine this overlap, estimates averaged out to approximately 43 percent of children with an ED eligibility with a diagnosis of ADHD. Other reviews have suggested the prevalence rates for the overlap for these disorders range from 25-44% of children in the ED category as having a diagnosis of ADHD (Schnoes et al., 2006). Within a recent study on this topic, almost sixty percent of the children qualified under the ED category were diagnosed with ADHD. After the OHI category, this was the highest percent in any special education category for children with ADHD in special education. As another way to examine the overlap, this study also reported that of the children with ADHD in special education almost 14% were eligible under the ED label. This was the third most frequent category after LD and OHI (Schnoes et al.).

The distinction between ADHD and ED is more ambiguous than that between ADHD and LD. For example, social difficulty is a commonly reported peripheral symptom of ADHD (DSM-IV-TR) and the "inability to build or maintain interpersonal relationships with peers and teacher" (Department of Education, 2006) is also a characteristic that can make one eligible as a student with an ED.

It seems clear that a number of children with ADHD receive special education services through the LD and ED categories. As such, children with ADHD may often exhibit behaviors within the school setting beyond the core symptoms of hyperactivity, impulsivity, and inattention. This has important implications for both diagnosis and treatment. For example, it appears that children with ADHD and a LD are more likely than children with just ADHD to receive services, particularly in the school setting. In addition to receiving special education services through the LD or ED label, children with

ADHD may receive services specifically related to their ADHD diagnosis under the OHI label.

ADHD & OHI. In addition to qualifying under another eligibility category, a second route children with ADHD are often qualified to receive special education services is through the OHI category. This is the category that is most specific to ADHD. DuPaul and Stoner (2003) suggested the OHI route is the most common way for children with ADHD to be classified. This eligibility requires that children not only have a diagnosis of ADHD, but also that these symptoms significantly impact their performance within an educational setting. DuPaul and Stoner suggested that if these guidelines are interpreted loosely, that many children with ADHD would qualify for special education services under the OHI label. DuPaul and Stoner also suggested that currently guidelines related to OHI are ambiguous, and require an outside diagnosis, a demonstrated difficulty in school, and a need for special education services. However, the school is left without specific procedures for determining eligibility.

It has been reported that there is very little data regarding the number of children with ADHD in the OHI category, as this category includes a heterogeneous group of children with a number of other health issues. However, several studies have attempted to answer questions related to the prevalence of ADHD within OHI. Forness and Kavale (2001) estimated the prevalence of ADHD in OHI by examining the yearly increases in the number of students eligible for services under the OHI label after ADHD was allowed as a diagnosis in this category beginning in 1991. This methodology yielded an estimate of approximately 40 percent of children in the OHI category as having ADHD. This estimate is low compared with a recent study (Schnoes et al., 2006) where an estimate

was obtained through the analysis of a nationally representative data set and examined the number of children eligible under OHI with home and school reported ADHD. Results of this analysis suggested over 65% of children in the OHI group are diagnosed with ADHD. In fact, this is the highest percentage across any eligibility category in this study. Within the group of children with ADHD children in special education almost 18% qualified under the OHI label and this number was much higher for this group than for the special education population without ADHD.

Summary. While an understanding of the category itself where children with ADHD are placed does not provide an understanding of the specific intervention services provided to these children within the school setting, it can help uncover the scope of services that children with ADHD are provided in the school. It can also speak to the number of children with ADHD who are having significant academic, behavioral, and emotional dysfunction, as a large number of children with ADHD are represented in special education. Another benefit to reviewing this data is that it can be linked to the literature regarding the specific kinds of interventions and accommodations received by children in special education. This can shed light on the types of interventions that children with ADHD are receiving within the school setting.

School Based Interventions

Beyond having knowledge of the diagnostic categories under which children with ADHD are often eligible, it is important to understand the actual services and interventions received by these children. Children with ADHD in special education may not always receive services specific to this disorder. In fact, DuPaul and Stoner (2003) suggested a need to better understand how school-based services for children with ADHD

differ from other disabilities. One study that examined the care that children diagnosed with ADHD who were placed in special education, found that only half of these children were receiving services specifically for this disorder (Bussing et al., 1998). Additionally, it has been reported that little research has examined the extent to which special education and general education teachers implement interventions for students with ADHD (Schnoes et al., 2006).

One study that has examined this question was conducted Reid, Maag, Vasa and Wright (1994). This study reported on the use of interventions and accommodations for children in general and special education settings. Their findings indicated that special education teachers reported using behavior modification, consultation, and one-on-one teaching significantly more than general education teachers. Both groups of teachers reported using modified seating equally. For general education teachers, the most common modification was a change in seating, while for special educators behavior modification was the most common. Teachers in special education also used the strategies at a much higher rate than teachers within general education. The correspondence of evidence-based practice used by special education teachers in this study is promising.

A recent evaluation of children with ADHD receiving special education services is particularly helpful in providing information on the types of services that children with ADHD receive (Schnoes et al., 2006). Like children in special education without ADHD, the majority of children with ADHD (63%) who were eligible for special education received most of their education within the general education classroom. Just over a quarter of children with ADHD (28%) eligible for special education received 80% or

more of their instructional time within the general education classroom, which was a significant difference from the non-ADHD group where 44% of the students received 80% or more of their instructional time within the general education classroom. This study found that two-thirds of children with ADHD (68%) received at least one form of nonacademic service both within and outside of the school setting, the most common of which was a behavior management program with over 37% of children receiving this service. This study also found that many of the children with ADHD in special education also received academic services, the most common of which was monitoring of progress by the special education teacher. Seventy-two percent of these children received this service. Almost half (49.3%) of the children received tutoring by the special education teacher. Additionally, close to half (45%) of the children received academic services from a teacher aide and just over 40% received learning strategies or study skills instruction. In addition to interventions, children with ADHD also received a number of educational accommodations. For example, in this study it was reported that 38% of children had modified grading standards. Over 80% had some form of testing accommodation (e.g. more time, modified tests, etc.). There were also accommodations to instruction and assignments, with extended time for assignments being the most common with over 71% of children receiving this service.

The Schnoes et al. (2006) study offers valuable insights into a population of children that is not well studied. However, Schnoes et al. do not report on the academic outcomes of this population. Given an emphasis on accountability within schools, it is increasingly important to understand the relationships between various interventions, particularly those administered through special education, and children's academic

outcomes. A focus on academic outcomes in particularly important with the ADHD population in order to move away from an emphasis on simply reducing negative behaviors, to improving outcomes. Further research on the relationships between various child and intervention variables and academic outcomes is warranted.

Current Study

Currently many children with ADHD are provided with services within special education, where the relationship between interventions and academic outcomes is unclear. The focus of the current study will be on academic outcomes in reading, as reading outcomes represent an essential developmental task for children, and is related to overall school achievement and adjustment (DuPaul & Stoner, 2003). Additionally, ADHD in the early years may predispose children to reading difficulties (Barkley, 2003) making it a particularly important academic area for study. The purpose is to develop a better understanding of the factors that relate to positive outcomes for children with ADHD, with an emphasis on variables that are amenable to change in the school setting. Also important to this study is an understanding of how these predictors are similar and distinct from other children exhibiting significant school dysfunction, but without a reported diagnosis of ADHD. The following research questions will be addressed:

An initial research question examines mean differences in reading over time and across groups. The purpose of this research question is to determine if there is growth over time and whether the change over time for children with a reported diagnosis of ADHD is similar to the change over time for children without a reported diagnosis of ADHD.

1.) Are there mean differences over time in reading achievement?

a. Are there significant mean differences in achievement over time across the ADHD and non-ADHD groups?

b. How do these means differ from children with and without ADHD in a special education population?

c. Are there interactions between Time and ADHD Status?

It is hypothesized that there will be mean differences between time one and time two, with a significantly greater mean at time two. It is further hypothesized that there will be mean differences between the groups with the non-ADHD population performing significantly higher than the ADHD population. It is also hypothesized that there will be an interaction between these relationships with the non-ADHD population showing a steeper rate of growth in reading performance.

A second set of questions examines how these variables predict academic outcomes in the context of other variables using latent growth modeling. This allows for the examination of the larger picture of relationships between the variables and is especially appropriate for non-experimental data (Keith, 1999). Additionally, the generation of models is useful in creating a framework for hypothesis testing (DiPerna et al., 2002). The factors can be tested not only in isolation, but also in how they impact the overall model. The rationale for the variables included in this model is based on prior research regarding variables that are hypothesized to impact academic performance.

2.) What factors relate to initial reading skills and growth over time?

a. How do the introduction of demographic, behavioral, or intervention variables impact the initial reading level?

i. Standardized assessments?

ii. Curriculum Based Assessments?

iii. Reading Grades?

b. How do the introduction of demographic, behavioral, or intervention variables impact the change over time in reading?

i. Standardized Assessments?

ii. Curriculum Based Assessments?

iii. Reading Grades?

c. How does the impact of the predictor variables differ between the ADHD and no-ADHD groups?

i. Standardized Assessments?

ii. Curriculum Based Assessments?

iii. Reading Grades?

The hypothesized model is outlined in Figure 6. It is hypothesized that there is linear growth over time in terms of the reading outcomes. It is also hypothesized that there will be differences in predictive value across outcome measures. Based on previous research comparing outcomes across grades and standardized measures (DuPaul et al., 2004) it is hypothesized that a stronger relationship between predictors and standardized assessments will be determined. Research in this area has not examined outcomes using curriculum based assessment (CBA) in the past, and the impact of these variables on CBAs is unknown. Further description of hypotheses related to this model can be found in Chapter Three.

Chapter 3

Methods

The relationships between various predictors of academic achievement are examined within a parent and school reported ADHD and non-ADHD sample. The following sections will describe the data set, sample, instruments, variables, and analytic techniques for this study. The analytic techniques are broken into down into two sections based on research questions. As described in the previous section, the first set of research questions explores mean differences over time and across groups using analysis of variance (ANOVA). A second set of research questions utilize latent growth modeling to evaluate a proposed model of reading growth

Data Set

In the present study data from the Special Education Elementary Longitudinal Study (SEELS; 2003) will be utilized. The SEELS is intended to provide the first national representation of longitudinal outcomes in special education students and includes data collected from parents, teachers, schools, and directly from the student. This SEELS includes a nationally representative, stratified, random sample. This data set was collected between 1999 and 2005. The sample was drawn at two levels: through local education agencies (LEAs) and individual students. At the LEA level, a sample was drawn from 245 districts and from 32 state-supported special schools. The LEAs were stratified by size (student enrollment), geographic region, and district/community wealth. The participating LEAs provided rosters of students in special education. The original eligible student sample included 11,512 children between the age of 6 and 12 and at least in the first grade at the start of the study, during the 1999-2000 school year. Parents of

these 11,512 students were contacted and data was originally collected from a total of 9,824 these students, representing a 85.3% response rate from the total eligible total sample. Of the non-respondents, there were three primary reasons cited for nonresponse: refusal (n=455), language barrier (n=156), and no response provided (n=1,077) (SRI International, 1999). Data was collected in three waves over five academic years. Wave one was collected during the summer of 2000 and during the 2000-01 school year. Wave two was gathered during the 2001-02 school year and wave three was collected during the 2003-04 school year.

As mentioned above, the SEELS sample was stratified by region (Northeast, Southeast, Midwest, and West), LEA Size (Very Large, Large, Medium & Small), and by LEA/Community Wealth (high, medium, low & very low). The region was defined by those criteria used by the Department of Commerce, the Bureau of Economic Analysis, and the National Assessment of Educational Progress (SRI International, 1999). LEA Size categories were defined by the following criteria. Very Large designates schools with estimated enrollment greater than 17,411 in grades one through seven. Large describes school with estimated enrollment from 4,707 to 17,411 in grades one through seven. Medium includes schools with estimated enrollment between 1,548 to 4,706 in grades one through seven. Small describes schools with estimated enrollment between 10 and 1,547 in grades one through seven. The LEA/Community Wealth was categorized using the Orshansky index, which is defined as the proportion of the student population living below the federal definition of poverty (SRI International) This variable was broken into the following categories: High (0-12% Orshanksy), Medium (13-34% Orshansky), Low (35-45% Orshansky), and Very Low (over 45% Orshansky).

This data set is appropriate for the current study for several reasons, including that there is little research that has examined the relationships between special education services and ADHD, despite the high number of children with ADHD in this population. The use of a nationally representative data set also allows for examination of the variables of concern within a diverse population of students. Additionally, previous research on school-based interventions has cited the use of cross-sectional samples as a limitation (Volpe et al., 2006), and the longitudinal nature of the SEELS adds to the extant literature.

Criteria for Selecting Sample

The present study includes a mixed sample of children who have a parent and school reported diagnosis of ADHD and those who do not have ADHD reported by either. A requirement for a diagnosis of ADHD is that the dysfunction is exhibited in two or more settings (APA, 2000). Therefore, only children where both parents and school report the presence of ADHD at Wave one were selected to represent the ADHD sample. Parents were asked the following question, "With what physical, sensory, learning, or other disabilities or problems has {child} been diagnosed?" For parents who do not mention ADHD, they are specifically asked, "has {child} been diagnosed with attention deficit disorder or attention deficit/hyperactivity disorder? These are sometimes called ADD or ADHD." A variable that was created that combines both of the responses to these questions will be used. The school report was based on responses provided school staff, to a question that provided them with a list of disabilities and they were asked to identify all of a student's disabilities. Children with a parent and school report of ADHD

will be referred to in this paper as children with ADHD, and those with a no from both parent and school will be referred to as no-ADHD.

Schnoes and colleagues (2006) suggest this methodology allows for the identification of students whom the school considers to have ADHD, which is an important factor in understanding school-based service delivery. Additionally, Schnoes et al. report that this methodology has been used by the United States Centers for Disease Control and Prevention (Pastor & Reuben, 2002) and other researchers (e.g., Redden et al., 2003) to identify children with ADHD. Pastor and Reuben (2002) recommend examining populations of school-aged children to help reduce inaccuracies in parents' reporting. Additional support for this method for selecting the current sample is provided by the results found by Schnoes et al. Their analysis of the SEELS Wave one data revealed that the demographics of the population of ADHD students, identified through parent and school report, were consistent with ADHD demographic data reported in the literature for male to female ratios and medication status.

The sample includes all children with a special education eligibility status under the following categories: Other Health Impairment (OHI), Learning Disabilities (LD), Emotional Disturbance (ED), and Speech and Language Impaired (SLI). Previous research, including a study with this sample of children (Schnoes et al., 2006) indicates that these eligibility categories are most common among children with ADHD in special education. Although previous research has also found a high percentage of children with a diagnosis of Mental Retardation (MR; 20.6%) having a diagnosis of ADHD, these children will be excluded from the current study. The rationale for this exclusion is that cognitive variables have been implicated in influencing academic achievement, and

excluding children with MR is hoped to control as much as possible the inclusion of children with extremely low cognitive abilities. Children who are eligible under the OHI, LD, ED, and SLI categories will be excluded if they are also classified with the MR label. Additional exclusions will include children with eligibility in the Autism, Developmental Delay, Traumatic Brain Injury, Visual Impairment, Hearing Impairment, and Multiple Disabilities categories, as defined by report from the school on a child's eligibility status in each of these areas. This is consistent with previous studies that have excluded these disabilities from studies that examine factors that relate to academic achievement within an ADHD population (DuPaul et al., 2004). No other exclusionary criteria will be applied. The original sample size for the study was 1029.

Instruments

For the SEELS data set, data was collected from several sources including the parent/guardian, teacher, school, and directly from the student (SRI International, 1999). The variables of interest in this study come from several different instruments. A brief description of each of the data collection tools is outlined below.

Parent/Guardian Interview. The parent survey was conducted over the phone or through a questionnaire sent through the mail. This survey gathered information including student characteristics, household characteristics, family involvement, academic progress, non-school activities, personal/social information, physical health, and school satisfaction.

Teacher Survey. A survey was conducted with teachers who provide language arts instruction to the SEELS student sample. This survey collected information regarding the language arts setting, instruction practices, assessment practices, behavior

and discipline data, accommodations/ modifications, support provision, student performance, and teacher background.

Survey of Student's School Program. This survey was completed by school personnel who were familiar with a student's school program and collected information about the school program, transitions, special education services, state and district tests, accommodations/modifications, support provision, performance/support, and parental involvement.

School Characteristics Survey. The School Characteristics Survey was completed by a school coordinator, principal, or a designee that could provide information about the schools. This survey provided general information about the schools that participated in this study. For example, it surveyed information regarding the school and community, students, staff, programs, special education policies/practices, and parent involvement.

Direct Student Assessment. Direct assessments were conducted with each child in the SEELS sample. Direct assessment procedures collected information regarding academics, including the Woodcock-Johnson Research Edition (Woodcock, McGrew & Mather, 2001) and curriculum-based measures of oral reading fluency. Additionally, information was collected on the student's self concept, attitudes, and friendships.

Transcripts. Transcripts were collected for students once they reached the secondary level. These were used to provide information on the courses that students take.

Variables to be Included in the Analysis

Variables for the current study include those taken from the Parent/Guardian Interview, the Teacher Survey, the School Programs Survey, the School Characteristics

Survey, and the Direct Student Assessment. No datum from the Transcripts was used within the current study. The variables that will be used in this study include:

- Group Variable
    - ADHD Status
- Predictor Variables
    - Teacher-Rated Student Behaviors
    - Stimulant Medication Use
    - Behavioral Interventions
    - Academic Interventions
    - Student Grade
    - Gender
    - Ethnicity
    - Household Income
    - Mother's Education
    - Reading Goals
    - Functional Skills
- Dependent Variable
    - Academic Achievement

These variables will be described in detail below.

Group Variables

The variables used to define the ADHD versus non-ADHD group have been described in the Sample section.

Independent Variables

Teacher-rated student behaviors. Within the SEELS Teacher Survey is a set of 24 behaviors rated by the child's language arts teacher. This variable contains items about many types of student behaviors, and includes items such as, "student easily transitions activities", "student fights with others", "student joins group activities", and "student has low self esteem". The items are rated on a three point scale with options of never (1), sometimes (2) and very often (3). Based on previous research on predictors of academic outcomes in children with ADHD, of interest in this study were both behaviors associated with ADHD, as well as behaviors associated with enabling academic success. The behaviors associated with ADHD were expanded to be more generally described as externalizing behaviors for several reasons. First, it was thought that this description may encompass behaviors that were not only relevant for the ADHD group, but also for the non-ADHD group, because it provided a more general description of behavior. Additionally, because there were a limited number of items specifically related to ADHD, this was expanded to include a range of externalizing behavior in order to include a greater number of items. Therefore, based on the items that were asked of the teachers, two distinct groups of items were created. The first group consisted of six items thought to represent externalizing behavior. Construction of this scale included a consideration of available items that appeared to fit within this construct. Items in the original analysis of this scale included: "student argues with others", "student fights with others", "student responds appropriately when hit or pushed", "student avoids trouble", "student controls temper", and "student acts impulsively". Items that were phrased positive (e.g. "student responds appropriately when hit or pushed") were reversed, so all items on this scale where phrased negatively.

A second set of nine factors was hypothesized to represent "student" behaviors, or behaviors that would help a student to be successful academically. An existing scale of student behaviors ("Academic Enablers"), the *Academic Competence Evaluation Scales* (DiPerna & Elliott, 2000), was considered for variables to include on the student scale, as well as a consideration of the items available that appeared to fit with this concept. Items in the original analysis of this scale included: "student keeps at task until done", "student does things on own", "student performs up to ability", "student completes homework on time", "student follows directions", "student asks for what she/he needs", "student easily transitions activities", "student gets easily distracted", and "student communicates thoughts/ideas". Only one item from this original set of variables needed to be reversed (e.g. "student gets easily distracted") to make all items on this scale phrased positively.

A confirmatory factor analysis (CFA) of the items within the current study sample has been conducted. The purpose of such an analysis is to define sets of variable that reliably measure behaviors of interest to the study. The CFA was conducted with these data using LISREL 8.80 (Joreskog & Sorbom, 2006). The analysis originally included 15 variables that were hypothesized to compose an "Externalizing" and a "Student" scale. Based on modification indices, changes were made to the loadings of the original items. This included removal of five items, two from the Externalizing scale; three from the Student subscale. The final factors and their standardized and unstandardized coefficients are shown in Table 1. The final model fit the data well. This is based on criteria for good fit recommended by Kline (2005). These indices include the model Chi-square, the Root Mean Squared Error of Approximation (RMSEA), the Comparative Fit Index (CFI), and the Goodness of Fit Index (GFI). Fit indices for the data included a

non-significant Chi-Square value of 39.65 (p=.55). Additionally, the RMSEA was equal to 0.02 (CI=0-.032), NFI=1.00, CFI=1.00, and GFI=0.99.

The reliability of this scale within the current sample has also been assessed using SPSS 15.0. This was conducted by examining the reliability of each of the subscales (Student Behavior & Externalizing Behavior). It has been suggested that a reliability coefficient greater than 0.7 is considered "adequate", above 0.8 is considered "very good", and above 0.9 is considered "excellent" (Kline, 2005). The Cronbach's alpha coefficient for this sample for the externalizing subscale was a=.802. The Cronbach's alpha coefficient for the student subscale was a=.841. Both reliabilities appear to be adequate for the current study.

Stimulant medication. This variable is a dichotomous (yes/no) created variable based on parent-report of various stimulant medication use. The created variable is described as that the student is taking one or more stimulant medications.

Behavioral intervention. DuPaul & Weyandt (2006) described several types of behavioral interventions. These included, antecedent, consequent, and self-management approaches. Within the current sample, there are several variables that fit into these approaches. The data are based on report from the language arts teacher and refer to intervention approaches implemented within that classroom. These data are dichotomous (yes/no) variables that indicate whether or not the intervention approach was implemented. These include responses to the question "the following were provided to the student to help in this class". Specific items selected were: behavior management program, shorter or different assignments, and more frequent feedback. These variables will be summed for analysis in the current study.

Academic intervention. DuPaul and Weyandt (2006) describe three types of academic interventions that have been empirically studied for improving outcomes for children with ADHD: modifications to teacher instruction, peer-mediated strategies, and computer assisted instruction. These three categories of intervention will compose the academic intervention variable. They are based on report from the language arts teacher, who is instructed to report these for their use in the language arts instructional setting. These include responses to the question "the following were provided to the student to help in this class". Responses were provided in a dichotomous (yes/no) format. These include, tutoring by an adult, whether the child has received peer tutoring, and whether computer software for student's unique needs will be used, or computer software designed for students with disabilities, or the use of computers for activities not allowed for other students. Additionally, a created variable that describes the teachers individualization in teaching practices for this student will be included, which is based on several summed items, and includes a scale from 2 (indicating no modifications) to 8 (often modified). These variables will be summed for analysis.

Demographic Variables

Several variables will be included in the analyses to control for their impact on academic achievement. These include grade, gender, ethnicity, household income, mother's education, reading goals, and functional skills. Grade, household income (16 categories), and mother's education (4 categories) are considered continuous variables. Based on preliminary analyses suggesting that approximately 74% of the sample consists of white children, Ethnicity was coded as a dichotomous variable of either white or non-white. Ethnicity is an important variable to consider in the context of the current sample,

as previous research using the National Longitudinal Transition Study-Two found that students with disabilities, who were classified as non-white, obtained lower academic achievement scores than did white children with disabilities (Wagner, Newman, Cameto, Levine & Gozales, 2006).

Student's goals for reading achievement were also considered. This is a variable that asked teachers the primary reading goal for their students. The response choices included: (1) reading at grade level, (2) improving reading skills, (3) developing functional reading skills, (4) building pre-reading skills, and (5) no goals for reading achievement. Thus lower scores on this measure are more desirable.

The students' "functional cognitive skills", as rated by the child's parent, was also included. This included ratings from 1-16 that indicated how high a student's functional cognitive skills were with 1 being low, 6 being medium, and 11 being high. Parents were asked to rate their child's ability to complete skills that are used in daily activity on a four point scale from "not at all well" to "very well". The specific skills that parents were asked to rate included, reading and understanding common signs, telling time on a clock with hands, counting change, and looking up telephone numbers and using the telephone. Wagner and colleagues (2006) suggest that these skills are called "functional cognitive skills" because of the requirement to use one's cognitive ability to "read, count, and calculate" (pg. 25). Additionally, Wagner et al. found that these skills were strongly linked to a child's academic performance.

Dependent Variables

Academic achievement. Academic achievement in reading is the outcome of interest in this study. Three different types of achievement variables will be examined by

running the model separately for each type: grades in language arts, standardized assessment in reading, and curriculum-based assessment. Previous research on academic achievement in students with ADHD has utilized both grades and standardized assessments as a measure of academic achievement (DuPaul et al., 2004; Volpe et al., 2006). In some cases, these different criterion have resulted in different outcomes, which provides the rationale for running models separately with each of these outcome measures. Previous research has suggested the use of CBAs as an outcome measure or predictor, as they may be a more direct measure of academic skills (DuPaul et al., 2004). The variable to define grades that will be used in the current study is the teacher reported grade in language arts, which can range from 1 to 4, with 1 indicating "Mostly As/As and Bs", a 2 indicating "Mostly Bs/Bs and Cs", a 3 indicating "Mostly Cs/Cs and Ds", and a 4 indicating "Mostly Ds and/or Fs".

The variables used to describe a standardized measure of reading achievement is composed of the standard score from the Letter-Word Identification and the Passage Comprehensions subtests from the *Woodcock Johnson-Third Edition* (WJ-III) research edition (Woodcock, McGrew & Mather, 2001). The Letter –Word Identification subtest requires a student to read isolated letters and words of increasing difficulty. The items are arranged in order of difficulty, beginning with the easiest items. The Passage Comprehension subtest requires an individual to read a short passage and to identify a missing word. The correct word choice or choices fit the context of the passage. The items are arranged in order of difficulty, beginning with the easiest items. For both the Letter-Word Identification and Passage Comprehension measures, the W score will be used. A W score is a transformation of the Rasch ability scale (Woodcock, McGrew &

Mather). The W scale is centered at 500, which is the approximate performance of a 10 year old. Reliability and validity evidence for the use of the WJ-III subtest is strong and is outlined in the manual. The median reliability coefficient alpha for the Letter-Word Identification subtest was .94, and for the Passage Comprehension subtest is .88. Test-retest reliabilities are higher for the Letter-Word Identification subtest and are above .90 for all age groups within a one year or less retest interval. For the Passage Comprehension subtest all values were above .80. As far as validity of the WJ-III, growth curves and confirmatory factor analysis support its use as a measure of achievement.

Finally, the CBA measure utilized in this study is the Oral Reading Fluency measure from the *Standard Reading Passages* (Marston & Deno, 1986). This requires a child to read a short passage in a set amount of time. This is a measure of the rate, or fluency, at which a student can progress through a passage. The words read correctly score will be used. This is calculated by subtracting the number of errors from the number of words read. Two passages were read at each wave, and the average words read correctly across these two passages at each wave will be used. The technical evidence for CBM has been developed by a number of authors. For example, Deno and colleagues (1982) found that ORF correlates highly with standardized measures of reading achievement with validity coefficients ranging from .73 to .93. Since that time the validity of CBM has been further established to relate to a number of standardized measures, include high-stakes testing. As far as reliability, this has been assessed in a number of studies on CBM. Marston (1989) summarizes a number of studies on the reliability of CBM, and reported reliability coefficients ranging from .82 to .97, with

most above .90. He also reports that parallel form estimates ranged from .84 to .96, with most above .90. Inter-rater reliability estimates were .99. This evidence supports their use in the present study.

A table of correlations between the variables was created and is shown in Table 4.

Data Preparation and Screening

Missing data. Tabachnick and Fidell (2001) suggest that if only a small number of data are missing from a large data set and that they are missing in a random pattern, the problem is likely not serious. However, based on the large sample and longitudinal nature of this study, some of the variables in the current study have a large number of missing data. The missing data was imputed, using the multiple imputation. Specifically the expectation maximization method was used to impute the data using LISREL 8.80. The variables of interest both with and without data imputed can be seen in Tables 2-3.

Assumptions. Several assumptions were assessed prior to the analyses. These include sample size, multicollinearity and singularity, outliers, normality, linearity, and homoscedasticity (Tabachnick & Fidell, 2001; Kline, 2005). The methods to check for these assumptions are described below.

Sample Size. Tabachnick and Fidell (2001) recommend the following equation for determining requirements for sample size. They suggest that $N > 50 + 8m$, where m=the number of independent variables. The final sample size in the present study of 1019 (ADHD=389; No-ADHD=630) is well above this criteria.

Multicollinearity & Singularity. Multicollinearity occurs when the variables are highly correlated or above $r > .85$ (Kline, 2005). A correlation matrix of all independent variables can be seen in Table 4. None of the variables were highly

correlated in the present study. Singularity is defined as occurring when one independent variable is the amalgamation of other independent variables. In the current study, this was not problematic.

Outliers. Because many statistical analyses are sensitive to outliers, screening for univariate and multivariate outliers was conducted. Univariate outliers are very large standardized scores (Tabachnick & Fidell, 2001). Tabachnick and Fidell suggest that univariate outliers can be defined as standardized residual values outside of the range of -3.29 to 3.29. In a large sample, these authors suggest that a few scores in excess of these values are expected. Univariate outliers can also be examined graphically using a histogram, where case or cases that are unattached to the rest of the distribution as a means for identifying an outlier. Based on this method, several cases were identified that exceeded the criterion (i.e., above 3.29 or below-3.29), however, just those cases that had a value outside this criterion on two or more of the variables were deleted. Variables with just one value above or below the criterion were kept in the analysis. This meant that six cases were deleted, and eight cases remained with standardized residual values outside of the -3.29 and 3.29 range. Multivariate outliers are cases with an unusual group of scores (Tabachnick & Fidell). To find multivariate outliers, Mahalanobis distance was calculated for each case. Tabachnick and Fidell suggest that the criterion for multivariate outliers is a significant Mahalobonis Distance at $p<.001$. As such, with 12 dependent variables, four cases falling outside of the critical value (32.91) were deleted. The final sample consisted of 1019 students.

Normality. Tests of univariate normality and multivariate normality were examined through SPSS. Multivariate normality is defined by Tabachnick and Fidell (2001) as "the assumption that each variable and all linear combinations of the variable are normally distributed" (p. 70). Using the Komogorov-Smirnov statistic, the only variable that was normal was the ORF variable at time 1. For the remainder of the variables this value was not significant, suggesting violation of the normality assumption. However, this can be common in larger samples (Pallant, 2007). Skewness and kurtosis are both components of normality and were assessed. A value of 0 would suggest a normal distribution (Pallant). The skewness value furthest away from 0 was -1.258 , and the kurtosis furthest from 0 was 3.655. Kline (2005) suggests that skewness values greater than 3.0 and kurtosis values greater than 10.0 are problematic. Therefore, these are not problematic in the current study. Also the shape of the distribution can be examined using histograms, Normal Q-Q plots, and Detrended Normal Q-Q plots. Examination of these plots revealed distributions falling within the normal parameters. Based on these analyses, there is some evidence of non-normality within the current data set.

Linearity & Homoscedacity. Homoscedacity and linearity are components of normality. Linearity is the assumption that the dependent variable scores should have a linear relationship with the residuals (Tabachnick & Fidell, 2001). Homescedacity refers to the idea that the variance of the residuals around the dependent variables should be the same for all predicted scores (Tabachnick & Fidell, 2001). Linearity and homoscedacity were examined using scatterplots

between pairs of dependent variables for each analysis and the plots showed some evidence of violations of these assumptions. For this analysis, the file was also split for analysis of non-ADHD and ADHD groups.

Analytic Techniques

The present study utilized several statistical techniques to answer the research questions. Descriptive statistics were calculated for each of the measures of academic achievement (ORF, grades, standardized measures), as well as for the other variables of interest. Latent growth modeling and ANOVA were the primary methods for data analysis to delineate the relationships between various predictors of academic achievement within a special education population. Data preparation and analyses were conducted using SPSS 15.0, LISREL 8.80, and MPlus 4.21.

Demographic Analyses

Before conducting the analyses of interest, demographic information about the groups is described. The means and standard deviations of the independent and outcome variables are presented. Additionally, the differences between the ADHD and no-ADHD groups on these variables were assessed through independent samples t-test for each variable. These are shown in Table 2 and Table 3. The correlations for the variables are provided in Table 4.

Analysis of Variance

The initial research question examines the mean differences within the populations of interest in this study. A Mixed Between-Within Design analysis of variance (ANOVA) examines both between group (ADHD vs. non-ADHD) and over repeated measures (Wave 1 - 3). This technique examines mean differences in academic

outcomes across ADHD vs. non-ADHD groups and over time. Additionally, the analysis was run separately across the four different types of academic achievement measures: language arts grades, standardized assessments of letter-word identification, standardized assessment of comprehension, and a curriculum-based assessment of oral reading fluency. In addition to examining the main effects of this analysis, interaction effects were investigated. This analysis was conducted using SPSS 15.0 statistical software.

Latent Growth Modeling

The complexity of the relationship between the variables of interest provides rationale for using latent growth modeling (LGM). LGM is a method of analysis within the framework of structural equation modeling (SEM). Specifically, a level and shape model was analyzed. In order to best understand the hypothesized relationships between ADHD, student classroom behaviors, school based intervention, and academic outcomes, the model shown in Figure 6 was analyzed quantitatively using LGM. This method allows for the evaluation of the adequacy of this theoretical model in explaining the data from the SEELS, or from a national sample of children who are receiving special education services. One rationale for using SEM is that it is an especially appropriate analysis technique for non-experimental data such as the SEELS (Keith, 1999). Additionally, SEM also offers the advantage of describing relationships free from measurement error, as this is something that is specifically estimated (Tabachnick & Fidell, 2001). It also allows one to examine the relationship between the variables in the context of other variables of interest.

The hypothesized model can be seen in Figure 6, and is a representation of the hypothesized relationships between the variables. Latent variables, or unobserved

variables, are represented in the diagram as ovals. Measured variables are represented as rectangles. The lines between the variables represent the hypothesized relationships. Lines with one arrow indicate a hypothesized direct relationship between variables. Lines with a double arrow indicate an unanalyzed relationship. Rather, these variables are hypothesized to be correlated. Two arrows, one in each direction between two variables indicates a reciprocal or non-recursive relationship. The absence of a line indicates that no relationship has been hypothesized.

Model specification. Model specification refers to using available theory and research to develop a hypothesized model or relationships between variables. This hypothesized model for the current study is shown in Figure 6. The primary variables of interest will include manifest, or observed, variables. These include Demographic Variables (Student Grade, Gender, Ethnicity, Household Income, Mother's Education, Reading Goals & Functional Skills), Student Variables (Total Externalizing behavior, Total Student behavior, Stimulant Medication Status), Intervention Variables (Behavioral Intervention & Academic Intervention), and Reading Outcomes (Reading grades, Letter-Word Identification standard score, Passage Comprehension standard score & ORF average score).

In addition to the manifest variables, the model will also include two latent variables. A model utilizing latent change analysis will be assessed. Specifically, a level and shape model would be assessed, which provides information on the correlates and predictors of change (Raykov & Marcoulides, 2006). The shape factor is a latent variable that provides information on the overall ability change (Raykov & Marcoulides, 2006). By looking at the relationships between the predictor variables and the shape factor,

information about the predictor variables and their relationship with overall change can be assessed. Several pieces of information can be gathered by examining the quantitative results of such a model. If the shape factor is positive, indicating that there is a positive mean change, and the relationships between the shape factor and other predictor variables are positive, individuals with high values are those who improve the most, while those with lower values show less improvement. If the relationships are negative, individuals with high values on the predictors are those who decline the most. Additionally, using a level and shape model across populations allows for the exploration of differences in variability and means of the starting level and change over time across the groups, as well as whether the demographics, behavior, and intervention variables of interest in the current study have equal predictive power in the change over time in reading across the groups (Raykov & Marcoulides, 2006).

The inclusion of the variables in the current study is based on both theoretical and empirical conceptions. The primary variables of interest can be grouped into three types: demographic variables, intervention variables, and behavior variables. These groupings are an effort to simplify the model and do not have a bearing on the analysis.

Model estimation. MPlus 4.21 (Muthén & Muthén, 2006) statistical software will be utilized to quantitatively examine the hypothesized model. A raw data file will be used for this analysis. While a multiple group model was initially proposed, differences between the ADHD and non-ADHD groups were found, and subsequent analyses included both single and two group analyses. Robust maximum likelihood (MLR) estimation will be used for the continuous variables to estimate the model parameters. Based on violations of normality, linearity, and homoscedacity found within the current

data set when the normality assumption was assessed, there is support for using this robust method. Estimation of the categorical outcome variable (reading grades) will be estimated using Unweighted Least Squares estimation.

Weighting. Because the sample was stratified, weights were included in the analysis. This takes into account the fact that there was not an equal probability of selection. Asparouhov (2005) suggests that if this is not taken into account, the parameter estimates may be biased. The SEELS data set has a weight for each instrument, and they recommend using the weight for the instrument with the least number of respondents. SRI (1999) report that the "student sampling weights are the product of the LEA sampling weights and the inverse of the student sampling fraction" (pg. 4-19). In the current study, the weight from the direct assessment at wave three was used as an initial starting point, and then the sampling weight for those with data missing was filled in from the direct assessment at wave one and two and from other instruments as needed. Using Mplus 4.21, all of the models were analyzed taking this information into account by using the SEELS weight.

Adequacy of Model. Several kinds of information regarding the adequacy of the hypothesized model are available (Jöreskog & Sörbom, 1996-2001). Several indices will be used to determine the goodness of the fit of the model in the current study. The first fit index that will be examined is the Comparative Fit Index. A value greater than 0.9 is generally considered adequate and will be utilized for this the current study (Kline, 2005). The model Chi-square will also be reported. Ideally, a non-significant Chi-square is indicative of a well fitting model. However, the chi-square value is sensitive to sample size Kline (2005). For this reason, the chi-square will be reported, but will be

considered with the other data to determine model fit. Finally, the Root Mean Squared Error of Approximation (RMSEA) will be reported. Kline reports that a value ≤ 0.05 suggest a close fit, while values between .05 and .08 indicate an adequate fit. However, some authors have suggested that a more relaxed criteria is appropriate (Hu & Bentler, 1999), and recent studies have utilized a criteria of .10 as indicative of adequate fit (Baker, Smolkowski, Katz, Fien, Seeley, Kame'enui et al., 2008). Therefore, the criteria of .10 will be utilized for the present study.

When working with a two group model the likelihood ratio test (LRT) was applied to test if restrictions are feasible. From this information, one can ascertain whether restrictions are equal across groups, and thus obtain information on the similarity and differences in the groups of interest. Because the MLR estimation is used a corrected chi-square difference test (CSCD test) must be used. This formula is similar to the LRT calculation, however, a correction factor generated by the MPlus 4.21 software is used to correct the values. The formula for this test requires you to divide the difference between the restricted and full chi-square values (multiplied by their correction factors generated by MPlus) by the difference between the degrees of freedom from the restricted to the full model (also multiplied by the correction factor). This product is then multiplied by the difference between the degrees of freedom without the correction factor (Raykov, 2007).

Chapter 4

Results

Descriptive Statistics

The ADHD and no-ADHD groups were compared across several characteristics including grade, gender, household income, ethnicity, mother's education, student behavior, stimulant use, and disability status. This analysis was first run without the missing datum imputed. The results of this unweighted analysis can be seen in Table 2. A second analysis was run with all of the datum imputed and the results of this analysis can be seen in Table 3. Independent samples t-tests between the ADHD and no-ADHD groups were done to determine if there is a significant difference in the means scores across the groups. With a majority of the variables, equal variance was not assumed. The grade level, age, functional cognitive skills, reading goals, and academic intervention variables at wave one were not significantly different. This was true with both the original data set and for the imputed data set. There were significant differences in terms of gender, ethnicity, income, mother's education, medication status, externalizing behavior, student behavior, and behavioral intervention at wave one between the ADHD and no-ADHD groups in both data sets. Additionally, all of the differences between membership in the four disability groups that were included in this study (SED, LD, OHI, SLI) were significant between the ADHD and no-ADHD groups. Given these differences between the groups, the model was run as both a single group model (ADHD only) and as a two group model.

Correlations between all the variables of interest were computed and are provided in Table 4. The means and standard deviations for the outcome variables are shown in

Table 5. Additionally, an independent samples t-test was run between the ADHD and no-ADHD groups comparing the scores. All of the scores were significantly different between the groups with the ADHD group scoring consistently higher on all of the outcome measures. The one exception was for ORF at wave three. The difference at this point between the ADHD and no-ADHD group was not significant.

Research Question 1

This set of research questions examined the mean differences over time in reading for the children with a parent and school report of ADHD versus those without a parent and school report of ADHD. The results are organized by the outcome measure.

Oral Reading Fluency. There was a significant effect for time, Wilks Lambda = .27, F(2,1016)=1402.94, P<.0005, multivariate eta squared =.73. This indicates a large effect size. Additionally, the main effect for group was significant F(1)=7.92, P=.005. There was also a significant interaction effect, Wilks Lambda = .98, F(2,1016)=0.84, P<.0005, multivariate eta squared =.02. This indicates that the change in scores over time is different for the two groups. Figure 2 shows the interaction effect for ORF. While the children in the sample with ADHD started at a higher rate for ORF, the students in the no-ADHD had a faster rate of growth from time one to time three.

Letter Word Identification There was a significant effect for time, Wilks Lambda = .28, F(2, 1016)=15.30, P<.0005, multivariate eta squared =.72. This indicates a large effect size. The main effect for group was significant F(1)=18.49, P<.0005, multivariate eta squared =.02. This indicates a small effect size. The interaction effect was not significant, Wilks Lambda = 1.00, F(2, 1016)=1.03, P=.357. This indicates that the change in Letter Word Identification scores over time was not significantly different

for the ADHD and no-ADHD groups. In summary, the ADHD group had higher scores on the LW task, and no significant differences in growth over time were noted between groups.

Passage Comprehension. There was a significant effect for time, Wilks Lambda = .511, F(2, 1016)=485.60, P<.0005, multivariate eta squared=.883. This indicates a large effect size. The main effect for group was significant F(1)=12.33, P<.0005, multivariate eta squared = .01. This indicates a small effect size. The interaction effect was not significant, Wilks Lambda = 1.00, F(2, 1016)=1.327, P=.226. This indicates that the change in Passage Comprehension scores over time was not significantly different across the ADHD and no-ADHD groups. Overall, the ADHD group had higher scores on the PC task, and no significant differences in growth over time were noted between groups.

Reading Report Card Grades. There was a significant effect for time, Wilks Lambda = .98, F(2, 1016)=8.04, P<.0005, multivariate eta squared =.02. This indicates a small effect size. The main effect for group was significant F(1)=25.29, P<.0005, partial eta squared= .02. This indicates a small effect size. The interaction effect was not significant, Wilks Lambda = 1.00, F(2, 1016)=0.555, P=.574. This indicates that the change over time in terms of reading report card grades is similar across the ADHD and no-ADHD groups. The ADHD group had higher grades, and no significant differences in growth over time were noted between groups.

In sum, reading scores were higher in ADHD group versus no-ADHD group across all four reading outcomes. Only on the ORF task was the growth over time different between the ADHD and no-ADHD groups, with the ADHD group showing a

slower rate of growth. For LW, PC, and reading grades, there was no interaction in scores across groups over time.

Research Question 2

The second set of research questions examine how the variables of interest predict initial reading skills and growth over time using a latent growth model. To answer this question, growth over time without the impact of the hypothesized predictors of change, is assessed. Three types of information are examined from the results of this modeling. This includes whether the model provides a good fit to the data, which determines whether the resulting parameters can be trusted. Next one can assess whether the shape (or in the special case of linear fit the slope values) is significant, and finally whether there are individual differences in the initial value and change over time.

Next the covariates of interest are added to the model. The overall fit of the model with the hypothesized predictor variables included is first assessed. Next the variables that are significantly predictive of starting value and growth over time can be examined. If the relationship between the predictors and the overall change is significant and positive, this suggests that individuals with a high value on the covariate will improve the most (Raykov & Marcoulides, 2006). For covariates that are significant and negative, high values are associated with a decrease in the growth factor. The results for the models are presented below organized by outcome measure.

Single Group Models

Oral Reading Fluency. The Level and Shape model provided the best fit to the model for the Oral Reading Fluency outcome. The overall model provided a strong fit to the data, demonstrated by a Chi-square value of 1.359 (p= 0.507). The RMSEA value

was 0.00 and CFI=1.00. The mean starting level and the rate of change from time one to time three was significant. Additionally, the starting value was significantly different across individuals, as was the slope.

When the predictor variables were added to the model the fit was strong: Chi-square value of 12.73 (p= .548). The RMSEA value was 0.000 and CFI=1.00. The impact of the predictor variables on the initial reading skills and reading growth over time is shown in Table 6. Several variables emerged as significantly predictive of the level, or initial reading skills, on the ORF measure. These included the child's grade and gender, which both had a positive impact. The functional skills, student behavior, and academic intervention had a negative impact on the initial reading skills. In terms of the impact of the covariates on the shape factor, or the growth over time, the child's grades were negatively associated. The child's reading goal was also negatively associated, which can be interpreted as a higher goal associated with a higher rate of growth (a lower score on the goal variable is more desirable).. The child's student behavior and behavioral interventions were related to positive growth over time.

Letter Word Identification. The Level and Shape model provided the best fit to the LW data. The overall model provided an adequate fit to the data, demonstrated by a Chi-square value of 9.238 (p= 0.009). Additionally, the RMSEA value was 0.096 and CFI=0.98. The mean starting level and the rate of change from time one to time three was significant. Additionally, the starting value was significantly different across individuals, however, the slope was not.

When the predictor variables were added to the model the fit was adequate: Chi-square value of 35.05 (p= .001). The RMSEA value was 0.062 and CFI=0.97. The

impact of the predictor variables on the initial reading skills and reading growth over time is shown in Table 7. Several variables emerged as significantly predictive of the level, or initial reading skills, on the LW measure. This included the child's grade, which had a positive impact. The child's household income and reading goal also had a significant positive impact. The functional skills, student behavior, and academic intervention had a negative impact on the initial reading skills. In terms of the impact of the covariates on the shape factor, or the growth over time, the child's grades were negatively associated. The child's behavioral interventions were related to positive growth over time.

Passage Comprehension. The Level and Shape model provided the best fit to the data. This model provided a good fit, indicated by a Chi-square value of 9.490 (p =.023). The RMSEA was equal to 0.075 and the CFI=.90. The mean starting level and the rate of change from time one to time three was significant. Additionally, the starting value was significantly different across individuals, as was the slope.

When the predictor variables were added to the model the fit was as follows: a Chi-square value of 49.008 (p= .000), an RMSEA value of 0.076 and a CFI=0.903. The impact of the predictor variables on the initial reading skills and reading growth over time is shown in Table 8. Several variables emerged as significantly predictive of the level, or initial reading skills, on the PC measure. This included the child's grade which had a positive impact. The mother's education also had a significant positive impact. The child's ethnicity, functional skills, and the academic intervention had a negative impact on the initial reading skills. Two variables were also related significantly to the Shape factor of the PC model. This included the grade, which had a negative association with

growth. The implementation of academic intervention also had a positive association with growth.

Grades in Language Arts. The Level and Shape model provided a good fit to the data, however, the Intercept and Slope Model provides a stronger fit, indicating linear change over time. The overall fit of the Intercept and Slope model was strong, as indicated by an insignificant Chi-square value of .911 ($p = 0.634$). The RMSEA was equal to .000 and the CFI=1.00. The mean starting level and the rate of change from time one to time three was not significant. The starting value was significantly different across individuals, while the slope was not.

When the predictor variables were added to the model the fit was as follows: a Chi-square value of .471 ($p= .493$). The RMSEA value was 0.000 and CFI=1.00. These values suggest a strong fit. The impact of the predictor variables on the initial reading skills and reading growth over time is shown in Table 9. Several variables emerged as significantly predictive of level, or initial reading skills. The child's functional skills had a significant positive impact. The child's student behavior had a negative impact on the starting value. In terms of the Slope factor, or change over time, mother's education had a negative impact. The child's student behavior had a significant positive impact on change over time.

Two Group Models

A two group model comparing the reported ADHD and no-ADHD group was also analyzed. This type of model allows for a comparison of the model across groups regarding initial status and change over time, as well as to see if the covariates of interest are equally predictive of change over time in reading achievement across groups.

Oral Reading Fluency. By fitting the model to the data with no cross-group constraints, the fit statistics are adequate: Chi-square value of 13.18 (p = 0.0104). The RMSEA was equal to 0.067 and the CFI=.98. When the restriction regarding group identity in terms of variances and covariances between the level and shape factors were applied the fit was as follows: Chi-Square=16.322 (p=.0223), RMSEA=.051, and CFI=.983. The resulting LRT was equal to 2.43 (df=3), which was not significant. This suggests that there were no group differences in individual variability on initial starting position and change in reading scores over time. Additionally, there are no group differences in initial true starting position variability, as well as true change over time. When the restriction of equal means in starting value and change over time across groups is applied, the fit of the model is adequate. This includes a Chi-square value of 20.967 (p = 0.0128). The RMSEA was equal to 0.051 and the CFI=.978. The LRT was not significant (LRT=6.89; df=5), which implies that there are were not significant group differences in terms of mean initial starting point and change over time.

When the predictors are added to the model for the ORF data without any constraints, the model provides an adequate fit to the data: Chi-Square = 57.042 (p=.0010), RMSEA = 0.045, and CFI = .986. The predictors for the ADHD versus the ADHD group were similar. For the ADHD group and gender were positively correlated with starting value in reading, while functional skills, student behavior, and academic intervention were negatively associated with the initial starting value. For children with no report of ADHD, grade and gender were again positively predictive, and functional skills and academic intervention were negatively predictive of initial reading skills. Additionally, mother's education was also positively predictive of initial reading skills.

In terms of growth over time, for the ADHD group, grade and reading goal had a negative impact on growth. Student behavior and behavior intervention both had a significant positive impact. For the no-ADHD group, grade had a negative impact. For this group, the only other significant predictor was income, which had a positive impact on reading growth. No other variables were significantly related to growth over time.

In order to test whether there were significant differences between the groups in terms of the impact of the covariates, this restraint was applied and the resulting fit statistics were as follows: Chi-Square = 91.656 (.0006), RMSEA=.039, and CFI=.981. The resulting LRT (32.84, df=24) was not significant, indicating no significant differences between the ADHD and no-ADHD groups in terms of how the initial reading skills and growth over time was impacted by the covariates of interest.

Letter-Word Identification. By fitting the model to the data with no cross-group constraints, the level and shape model provides a good fit to the data. The overall fit of the Level Shape model was adequate, as indicated by an insignificant Chi-square value of 13.162 (p = 0.0105). The RMSEA was equal to 0.067 and the CFI=.992. When the restriction regarding group identity in terms of variances and covariances between the level and shape factors were applied the fit is as follows: Chi-square =19.792 (p = 0.0060). The RMSEA was equal to 0.060 and the CFI=.988. The resulting LRT is not significant (6.64; df=3) indicating that there is not a significant difference between the ADHD and no-ADHD groups in terms of individual variability in starting position and change over time. Additionally, there were no group differences in initial true starting position variability, as well as true change over time. When the restriction of equal means in starting value and change over time across groups is applied, the fit is as follows: a

Chi-square value of 20.954 (p = 0.0129). The RMSEA was equal to 0.051 and the CFI=.99. The LRT was not significant (LRT=7.91; df=5), which implies that there are no significant group differences in terms of mean initial starting point and change over time.

When the predictors are added to the model for the LW data without any constraints, the model provides an adequate fit to the data: chi-square = 68.595 (p=.0003), RMSEA = 0.046, and CFI = .985. The predictors for the ADHD versus the ADHD group were similar. For the ADHD group, grade and income were positively correlated with starting value in reading, while functional skills, reading goals, and academic intervention were negatively associated with the initial starting value. For children with no report of ADHD, the same predictor was significant in the same direction, except the impact of income was not significant. However, mother's education was significant on the initial starting value for the no-ADHD group. In terms of growth over time, for the ADHD group, grade and ethnicity had a negative impact on growth. Behavior intervention both had a significant positive impact. For the no-ADHD group, grade had a negative impact. For this group, medication had a significant positive impact. No other variables were significantly related to growth over time.

In order to test whether there were significant differences between the groups in terms of the impact of the covariates, this restraint was applied and the resulting fit statistics were as follows: Chi-Square = 94.353 (.001), RMSEA=.037, and CFI=.983. The resulting LRT (25.09, df=23) was not significant, indicating no significant differences between the ADHD and no-ADHD groups in terms of how the growth over time was impacted by the covariates of interest.

Passage Comprehension. The Level and Shape model provides a good fit to the data, when no cross group constraints are imposed. The overall fit of the Level and Shape model was adequate, as indicated by a Chi-square value of 22.135 (p = 0.0011). The RMSEA was equal to 0.073 and the CFI=.946. When the restriction regarding group identity in terms of variances and covariances between the level and shape factors were applied the fit is as follows: Chi-square value of 24.551 (p = 0.0035). The RMSEA was equal to 0.058, and the CFI=.948. The resulting LRT was not significant (3.56; df=3) indicating that there is not a significant differences between the ADHD and no-ADHD groups in terms of individual variability in starting position and change over time on passage comprehension. Additionally, there were no group differences in initial true starting position variability, as well as true change over time. When the additional restriction of equal means in starting value and change over time across groups is applied, the fit of the model was adequate with a Chi-Square value of 27.236 (p = 0.0042). The RMSEA was equal to 0.054, and the CFI=.945. The LRT was not significant (LRT=5.67; df=5), which implies that there are not significant group differences in terms of mean initial starting point and change over time.

When the predictors are added to the model for the PC data without any constraints, the model provides an adequate fit to the data: Chi-Square = 107.553 (p=.0000), RMSEA = 0.064, and CFI = .937. The predictors for the ADHD versus the ADHD group were similar. For the ADHD group, grade, mother's education, and student behavior were positively correlated with starting value in reading, while ethnicity, functional skills, and academic intervention were negatively associated with the initial starting value. For children with no report of ADHD, the same predictors were

significant in the same direction. In terms of growth over time, for the ADHD group, grade had a negative impact on growth, and academic intervention had a positive impact. For the no-ADHD group, only grade had a significant negative relationship with the latent shape factor. No other variables were significantly related to growth over time. In order to test whether there were significant differences between the groups in terms of the impact of the covariate, this restraint was applied and the resulting fit statistics were as follows: Chi-Square = 135.258 (p=.000), RMSEA=.051, and CFI=.932. The resulting LRT (24.20, df=23) was not significant, indicating no significant differences between the ADHD and no-ADHD groups in terms of how the growth over time was impacted by the covariates of interest.

Grades in Language Arts. The chi-square difference test cannot be used with the ULS estimation method (Muthén & Muthén, 2006). Therefore, only the model with the predictors without cross-group constraints will be provided. When the predictors are added to the model for the report card data without any constraints the model provides a strong fit to the data: chi-square = 1.472 (df=3; p=.6887), RMSEA = 0.000, and CFI = 1.000. The predictors for the ADHD versus the ADHD group were similar. For the ADHD group functional skills were positively correlated with starting value in reading, while student behavior was negatively associated with the initial starting value. For children with no report of ADHD, only student behavior was negatively associated with the starting value. In terms of growth over time for the ADHD group, student behavior had a positive impact on growth. Mother's education had a significant negative impact. For the no-ADHD group, only student behavior had a positive impact on growth.

Chapter 5

Discussion

Mean Reading Growth

The first research question asked whether or not there were mean differences over time and across ADHD and no-ADHD groups on several measures of reading outcomes. This research question also asked whether or not there was an interaction between time and ADHD status. It was hypothesized that there would be mean differences over time. This was true for all outcome measures. It was also hypothesized that there would be mean differences between the groups with the no-ADHD population performing significantly higher than the ADHD population. This hypothesis was incorrect, as the ADHD group performed significantly higher on all four of the outcome measures. This is despite no significant differences across the groups in terms of their goals for reading and in terms of their functional cognitive skills. There were a number of demographic differences between the groups. These included the ADHD group having more males, more white students, higher household income, higher mother's education, higher levels of stimulant medication use, more externalizing behavior, and fewer student behaviors. Additionally, the distributions of the special education disability categorizations across the groups was dissimilar. The ADHD group included more students with a Severe Emotional Disturbance and Other Health Impairment, while the no-ADHD group had a greater percentage of students with a Learning Disability and a Speech and Language Disability. Schnoes and colleagues (2006) also used the SEELS sample, and although they relied on slightly different inclusion criteria their distributions of students with ADHD in each category in this study was similar.

One explanation for the higher performance of the ADHD group is the fact that the no-ADHD population included a significantly more students with learning disabilities, a difficulty which is defined by academic underachievement. This is a distinction of the current sample from most prior research on the topic, which compares children with and without ADHD, regardless of their special education eligibility status. Due to the increased comorbidity between ADHD and LD, an ADHD group typically has more students with LD than the non-ADHD comparison group (ex. DeShazo Barry et al., 2002). However, when the students were compared to other special education students, this was not the case.

It was also hypothesized that there would be an interaction between these relationships with the no-ADHD population showing a steeper rate of growth in reading performance. This was untrue for the norm-referenced, standardized measures of reading achievement (i.e. LW & PC) and for the reading grades. However, this hypothesis was supported with the ORF data. The ADHD students started at a higher level, however, the progress over time was less steep than for the no-ADHD group. This may be in part due to the fact that curriculum-based assessment is designed to be sensitive to change than the other measures of reading achievement in this study (Shinn, 1999). One explanation is that because this assessment is sensitive to change, the ORF is picking up on a more subtle pattern than the other norm-referenced measures. An alternative explanation is that fluency is the only skill exhibiting this particular pattern, and is therefore an area of particular dysfunction for children with ADHD. This explanation has not been supported in previous research, which does identify reading as an area of difficulty for children with

ADHD (DeShazo Barry et al., 2002), but has identified reading comprehension as an area of particular difficulty (Ghelani, Sidhu, Jain & Tannock, 2004).

In addition to exploring the interaction between the groups, it is also informative to examine the actual increase in reading fluency, as measured ORF, over the course of several years by the students in this sample. The time line of the SEELS direct assessment included one year between wave one and wave two data collection, and two years between wave two and three data collection (SRI, 1999). Deno and colleagues (2001) contrasted growth rates in samples using typical instructional practices versus effective instructional practices. They found that typical instructional practices for students in special education yielded gains of less than 1 word per week in first grade, and around 0.6 words per week in 2nd through 6th grade, while potential growth using effective practices was 2 words per week in 1st and 1 word per week in 2nd through 6th grades. When these standards are compared to the results in the current study, the findings are grim. Although the data in the present study is aggregated across grades and children , the ADHD group on average increased from 93 words per minute at wave one (data collected between 2/01-5/01) to 108 words per minute at wave two (data collected between 2/02-5/02). This is a gain of approximately 15 words over the course of one full academic year. In addition, from wave two to three (data collected between 2/02-5/02) the students gained approximately 19 words over two school years. These rates of growth are much closer and below those described by Deno when typical and not effective strategies are used, and suggest that the rate of growth for the children in this study are well below their peers not eligible for special education.

To further elucidate why the rate of growth appeared less steep for children with ADHD than for those with no report of ADHD in this study, it would be helpful to break these results down by grade level in future studies. Previous research has suggested that children with ADHD tend to experience increasing difficulty as they progress through school due to increased demands (Barbaresi et al., 2007). This phenomenon may underlie the findings in this study. Also interesting to consider would be how the rate of growth compares to other children not in special education, including those with ADHD. Previous research has revealed that the rate of growth for children in general education is approximately twice that of children in special education (Deno et al., 2001). This consideration makes it even more concerning that the children with parent and school reported ADHD in this study progressed a slower than typical rate for children in special education on a measure of ORF. Further exploration of the development of reading skills over time for children with ADHD, particularly those eligible for special education, is warranted.

Modeling of Reading Growth

An examination of these growth patterns within a more flexible modeling technique was carried out in the current study to provide more insight into initial reading level and reading growth over time. Specifically, the research questions asked about how the introduction of demographic, student, and intervention variables impact the initial reading level and growth in reading over time. Also of interest was how this varied between outcome measures. Several interesting findings emerged from the second set of research questions. A number of demographic, student, and intervention variables were significantly predictive of initial reading level and change over time.

Demographics. While a number of variables related to the student's initial reading status, fewer of the demographic variables related to the rate of reading growth over time. This is a promising finding, as it points to the important role of the school in supporting student reading growth over and beyond the impact of demographic variables. Those demographic variables that were significantly related to children's initial reading factor (with the direction in parentheses), included grade level (+), gender (+), household income (+), functional skills (+ and -), reading goal (-), mother's education (+), and ethnicity (-). Only grade level and functional skills were significant across more than one measure. Grade level was predictive of higher reading scores across three measures (LW, PC, and ORF). This is logical, given that the score used for each of these measures is not referenced to the child's age or grade level and increases as skill increases. Therefore, these results suggest that the higher the grade level, the higher the skill level. However, more important to consider is the rate of growth over time, which is a strength of a longitudinal analyses. This will be discussed in more depth in the next section.

Functional Skills had a less consistent relationship. They were significantly related to the initial status on ORF, LW, and PC in the negative direction, while they were significantly positively related to the initial status on grades. It would be expected that these skills are important to reading both at the initial level and to growth over time, and that higher functional skills would relate to increased scores. Previous research using this same scale of functional cognitive scales, suggested that these were related to achievement (Wagner et al., 2006). The functional skills were based on parent ratings and in the present study there was consistency between parent's perceptions of these skills and teacher's initial grades. However, there was a relationship in the opposite and

unexpected direction to the skill-based measures (ORF, LW & PC). Traditional, standardized and norm-referenced cognitive assessments are correlated moderately with academic achievement. For example, Sattler (2001) reports that across a number of studies the WISC-III Full Scale IQ was correlated at .65 with the Reading Composite from the WIAT, at .65 with the Reading from the WRAT-3, .53 with the Reading Composite from the K-TEA, and at .48 with reading grades. A good possibility is that the functional cognitive skills used in the current study are measuring something distinct from skills assessed on a cognitive assessment, such as the WISC-III, as this variable has previously related significantly to academic outcome measures in the expected direction. This difference may underlie the unexpected finding in this study. Alternatively, the lack of relationship in the expected direction of the functional skills and measures of academic achievement, may suggest a distinction in this population of children from those used in the standardization samples of the tests discussed above, that warrants further exploration.

In regards to growth over time, several factors were related to growth across the four measures. These included grade (-), mother's education (-), and reading goal (-). Grades were significantly related in the negative direction to the ORF, LW, and PC tasks. Grade level did not negatively impact the reading grades growth. Previous research has suggested that there is a decline in achievement over time for children with ADHD, due to increased cognitive and organizational demands (Barbaresi et al., 2007). Previous research has also demonstrated that on measures of ORF that the rate of growth decreases over time (Hasbrouck & Tindal, 2006). In addition, the commonly described "Matthew Effect", which suggest that strong readers continue to get stronger, while poor readers

continue to struggle (Stanovich, 1986), may be applied here. Individuals who are poor readers in early elementary tend to continue to be poor readers in later elementary and beyond (Juel, 1988; Shaywitz, et al., 1992; Francis et al., 1996). This speaks to the need for early intervention to improve growth over time. This contrasts with the traditional special education identification model of reading disability (or any specific learning disability), which required a "severe discrepancy" between ability and achievement, which often is not present in children in early elementary grades and therefore may delay prevention or early intervention efforts (NASDSE, 2006). This perpetuates a "wait to fail" system; however, recent changes in the law no longer require this discrepancy (IDEIA, 2004). This change creates opportunities for schools to implement alternative methods for supporting children who are not achieving at grade-level that can be utilized earlier.

Mother's education also had a significant negative impact on the growth latent factor for reading grades only. In other words, the higher the mother's education, the lower the rate of growth on reading grades. Mother's education is one commonly used factor to measure socioeconomic status. Socioeconomic status has been reported to play a role in academic achievement (DuPaul et al., 2004), however, in the current study the finding was in the opposite direction of that which would be expected. Follow-up to determine distinction of the impact of mother's education on grades versus skill-based measures would be helpful. Having a higher reading goal only influenced the ORF measure. This may again be related to the sensitivity of the ORF measure to assess change. This also speaks to a larger point made in the literature, which calls for the combination of CBM and specific and measureable goals. A concern that traditional IEP

goals are vague, not measureable, and not related to current achievement has been voiced (Shinn, 2002).Research that has suggested that the use of CBM in writing (IEP) goals has led to improved academic outcomes (Shinn). In fact, the effect size for the use of CBM in writing goals, has exceeded .5 (Shinn). This study supports the notion that CBM may be a helpful and valuable tool for measuring growth toward academic goals.

Student Variables. The impact of externalizing behavior, student behavior, and medication status was considered under the heading of "student variables". Higher scores on the "student" behavior scale were significantly related to lower initial reading scores for the ORF, LW, and reading grades. This was unexpected, as it would be expected that these skills would relate to a higher or neutral initial score, as opposed to a decrease. However, this same variable was linked to positive growth on reading grades and ORF. A previous study comparing the impact of the "academic enablers" on grades and skill measures found that these only impacted grades (DuPaul et al., 2004). The results of this study suggests that improved student behavior, positively impacts teacher's ratings of their grades, and also relates to some skill-based measures. This finding raises a number of questions. It might be expected that improved persistence, following of directions, and homework completion would relate to improvements in skills on standardized measures of reading achievement. However, this conclusion has not been supported in previous research (DuPaul et al.), nor consistently in this study. Alternatively, these types of behaviors do improve reading grades, which are given by the teacher, who may be influenced by positive behavior on behalf of the student. Unfortunately, this may not necessarily translate into improved skills. A unique finding in the present study was that these skills also had a positive impact on one skill-based

measure. A previous study that explored the impact of academic enablers on academic achievement did not use CBAs as an outcome measure (DuPaul et al., 2004). The finding in the current study may highlight another area of distinction between traditional, norm-referenced measures of academic achievement and CBA. An alternative explanation is that the impact of these academic enablers could be different for fluency, than for measures of letter and word reading and reading comprehension. Follow-up to this pattern could highlight not only potential intervention targets, but could also provide insight into ways to monitor progress in this area.

Externalizing behavior and medication status were not linked to improvements across any of the outcome measures. This finding is not consistent with previous research that links increased ADHD behaviors to decreased academic outcomes (DeShazo Barry et al., 2002), and medication use to moderate improvements in reading outcomes (Ryan et al., 2005). Possible explanations could have to do with lack of variability on the externalizing measure, as the range of possible scores was small. It is unclear why the impact of medication was not significant. Without information regarding the dose or adherence to the medication, there are number of reasons why medication was not significantly predictive, that are unable to be further explored within the current study. The difference could also be related to the population of students examined in this study, or those in special education, compared to previous studies on the topic. For example, the sample used to determine a clear linear effect between ADHD symptom severity and ADHD (DeShazzo Barry et al.) used a sample where only a portion of the students with ADHD were in special education (42%) and the students all met the diagnostic criteria for ADHD (versus parent and school report). While in a meta-

analysis that examined the impact of medication on academic achievement (Ryan et al.) the sample included some students in general education, resource, or self-contained classrooms, however, many of the participants were from university settings, psychiatric hospitals, or other clinical settings. The students in the current study are likely those with the most educational dysfunction, as they are all eligible for special education, and the impact of medication or externalizing symptoms could be different for those students than for other students without the same level of educational impact.

Intervention Variables. Academic intervention was associated with lower initial reading scores on the ORF, LW, and PC measures. This is logical and suggests that those students with the lowest reading scores were being provided with the most academic support. Behavioral or academic intervention were related to improved rate of growth on all three skill based measures, but not to reading grades.

Academic intervention was related to improvements on the PC measure. Some authors have suggested that comprehension is an area of particular difficulty for children with ADHD, as it represents a high-order process (Ghelani, Sidhu, Jain, & Tannock, 2004). In fact, Sattler (2001) suggests that passage comprehension requires the highest level of functioning of all reading tasks. From the present findings, it can be hypothesized that academic intervention efforts are needed to address this higher level skill, but that behavioral intervention is sufficient to lead to improvements in sight word recognition and reading fluency. In the context of Rapport and colleagues model (1999) the trickle down effect described may be adequate to improve lower level academic outcomes, but not for higher level peripheral features of ADHD. Further exploration is important to highlight specific types of interventions that can best address deficit areas.

Behavioral intervention was significantly predictive of higher rates of growth on the ORF and LW measures. This suggests that by improving behavior, there is an academic benefit. While authors have criticized the focus in schools on only a reduction in negative behaviors associated with ADHD versus an emphasis on improving positive outcomes, such as grades, (DuPaul & Weyandt, 2006), this study does provide support for increasing rates of growth in reading through the use of behavioral intervention. While it is unknown if the behavior actually improved as a result of the behavioral intervention, the findings in the current study indicate that reading fluency and letter/word identification did improve.

Both academic and behavioral interventions have promise in improving academic outcomes for children in special education. Previous research shows that academic interventions have a positive impact on behavioral outcomes, as much as behavior interventions do (DuPaul & Eckert, 1997). This speaks to the utility of academic interventions in addressing student difficulties. The finding by DuPaul & Eckert calls into question the model proposed by Rapport and colleagues (1999), which suggests that treatment directed at peripheral symptoms of ADHD would only impact those areas, and not have an impact on the core symptoms. Alternatively, DuPaul and Eckert suggested that academic interventions may provide a replacement behavior for a display of the core symptoms of ADHD. Additional research is needed to address the types of academic interventions that yield the most positive benefit for students for both academic and behavioral outcomes. In addition, this study suggests that different skills may be affected differentially by the type of intervention employed. As discussed by DuPaul and Weyandt (2006), interventions can be moderated through the teacher, other students, and

through technology. There are therefore a wide variety of strategies available that have been empirically-supported for children with ADHD that can be applied to the specific presenting problem.

Academic and behavioral interventions did not have a significant impact on grades. Grades are not commonly used as an outcome measure in studies in this content area. Intervention studies typically examine the performance of a specific skill. However, it is important to consider that grades are perceived as an indicator of student outcomes. DuPaul and colleagues (2004) did examine the impact of teacher perceptions of academic skills, and found that these were predictive of report card grades in reading. The DuPaul study implies that an increase in skill would result in a higher grade. As found in the present study, academic intervention did increase scores in reading comprehension, while behavioral intervention increased performance on the ORF and word identification tasks. Yet these improvements were not also seen in reading grades. It is possible that the student's teachers did not perceive an improvement in skill. Alternatively, this particular population of students may not have been as impacted by their teacher's perception of their skills as those in DuPaul and colleagues sample. Report grades are often a primary way that student achievement is relayed to parents and other individuals outside of the school system, and plays an important role in admissions to programs and post-secondary opportunities. Grades are also often considered when determining special education eligibility, as a measure of academic relevance. Yet in this study they were not found to be sensitive to improvement garnered from interventions in the same way that skills measures were. While it is challenging to determine growth from grades, as there is significant diversity in how student grades are

determined, it is relevant to consider that grades serve as important indicators of academic achievement for students.

Outcome Measures

Differences between outcome measures have arisen in this study. The difference between direct skill measures and reading report card grades was particularly clear. Specifically, the report card grades were unique when it came to functional skills, grade level, mother's education, student behavior, and intervention variables. As hypothesized above, the fact that the functional skills relate positively to initial reading grades may suggest more similarities between parent and teacher perceptions versus parent perceptions of functional skills and reading skill. The student's grades were also impacted less by grade level than the skill based measure, suggesting that the Matthew Effect is not portrayed through grades, despite this effect occurring on skill-based measures within the same sample of students. As discussed previously, mother's education was predictive of report card grades in the unexpected direction, and follow-up of these results is needed. Some of these findings replicate earlier findings. For example, DuPaul and colleagues (2004) found that academic enablers related only to grades, but not skill based measures. Another important and unique finding for grades was that skill measures were influenced by intervention and the report card grades were not. The implication for this finding is that outcome measures need to be appropriately matched to goals. If a goal is to measure student progress in response to a particular intervention, grades, and even traditionally written IEP goals, are not be an appropriate tool to do so. A number of studies have shown that by data-based goals and monitoring improves student achievement (Shinn, 2002), therefore schools are obligated to use tools that

facilitate this. Complexities relating to measuring growth using reading grades, may have also played a role in the unique nature of these findings. For example, grades are not standardized, are filtered through teacher perceptions, and many students in special education receive modified grades. This speaks to the importance focusing on outcome measures that appropriately measure the types of effects that are targeted through intervention.

Group Differences

The final research question asked whether there were group differences in how the predictor variables influenced initial reading skills and growth over time. There were fewer group differences than expected, despite differences in the composition of the groups on factors such as gender, ethnicity, income, mother's education, stimulant medication status, externalizing and student behavior, and behavioral intervention. There were no differences across the ORF, LW, and PC measures in terms of individual variability on the level or shape factor. There were also no differences in the mean of the level and shape factors across the groups. Finally, there were no differences between the groups in terms of the impact of covariates on the level and shape factors on the overall model. At the predictor level, there were a few differences on the impact on the level and shape factors across the groups. However, when the overall model was assessed to examine differences between groups in terms of the impact of the covariates, no significant differences were found. Previous research has documented differences between children with and without a diagnosis of ADHD (ex. DuPaul et al., 2004), however, there were not consistently significant outcome differences in this study. This may suggest that the children's status as a child eligible for special education may be

more salient than their ADHD status. For example, Deno and colleagues (2001) found that general education students experienced growth on ORF at a rate twice that of their special education peers. As discussed earlier, much of the literature on academic achievement in students with ADHD has not specifically focused on students eligible for special education (ex. DeShazo Barry et al., 2002; Ryan et al., 2005). Or in studies focused on children with ADHD in special education, the emphasis has been on demographic variables and not on achievement (Schnoes et al., 2006). Perhaps this population, who is most academically impacted (and thus eligible for special education) is distinct from other students with ADHD. Also, along the same lines, this finding may not generalize to children with and without ADHD who are not eligible for special education. Special education status may be an important are to consider when it comes to exploring predictors of achievement for students with ADHD.

Limitations

This study has a number of limitations. These included limitations with the available data, possible informant differences, generalizability of the sample, and the amount of missing data. Given the use of a pre-existing data set, the variables that served to operationalize the variables of interest were not always ideal. One benefit of using data from a large and diverse sample is that it provides insight into what typical services look like for students with disabilities within school systems. This can help us better understand the current practices, yet limits the kinds of information that one has access to. For example, the created externalizing behavior scale consisted of only four items. This limits the variability in responses that can be provided, which makes it less sensitive to differences between groups. A more extensive measure may have highlighted

differences not found in the present study. Another limitation in being limited in the types of data available in an existing data set, is that there was no information available beyond parent and teacher report of interventions that were in place. There was no available information regarding the actual implementation of behavior or academic intervention or for the integrity with which the stimulant medication was delivered. This makes it challenging to assess whether the intervention itself was effective or ineffective versus the extent to which it was carried out as being the influential factor. Another challenge related to working with an existing data set is that number of data collection points is limited. While three data points improves on cross-sectional research on this topic, with three time points, there is less flexibility in modeling growth.

Another limitation to consider is the potential differences between parent and teacher reports of behavior. For example, in the present study, the children's functional skills were reported by the parents. Unexpectedly, functional skills did not play a significant role in student achievement. One possible explanation is that parent's reporting of functional skills is not consistent with teacher perceptions of a child's ability It is also possible that parents are not reliable reporters of their child's functional abilities. The reliance on parent and teacher report could also have impacted the report of who has ADHD versus who does not in the study. The question does not ask if the child has a verified diagnosis from a mental health provider, and some parents may describe their child's active behavior as ADHD, when in fact the child may not meet the diagnostic criteria for the disorder.

Despite the large size of the data set, the restriction to children with both a parent and school report of ADHD, resulted in a much smaller sample. Although there were not

strict inclusion criteria outside of parent and school report, it is felt that these children do represent those that the school feels has ADHD. However, implying that these results generalize to all children with ADHD is unwarranted, as no diagnostic procedures were employed in this study. Additionally, the number and type of comorbid conditions in these children are not known. The subtypes of ADHD were also unknown in the current study. Previous research has suggested that there are differences between the subtypes in terms of the reading skills, with children with the Predominantly Inattentive subtype of ADHD, experiencing more academic difficulties than those with a diagnosis of ADHD, Predominantly Hyperactive/Impulsive subtype (Wilcutt et al., 2007). More specific understanding of the interplay between the ADHD subtypes and special education would be useful to further determine how to differentiate services for children exhibiting these distinct constellation of symptoms. Also important to consider as a limitation is the fact that the ADHD status of the children was assessed at wave 1, but not at wave 2 and 3. This means that there could have been children who were diagnosed with ADHD at wave 2 or 3, included in the control sample. Additionally, while ADHD is thought to be a long-term disorder, it is possible that children who were diagnosed with this disorder at wave 1, were no longer diagnosed at wave 2 or 3.

Additionally, given the longitudinal nature of the sample, there was a large amount of missing data. For this reason, a large quantity of data was imputed, which could have influenced the results of this study. However, examination of the missing data sample versus the sample with the missing data imputed (Tables 2 & 3) reveals small differences in means and standard deviations, supporting the use of the imputed data.

Conclusions

Valuable information about how students achieve in schools can be obtained through the use of large data sets. The sample sizes that are available in these data sets would not be possible for many researchers to obtain, and thus they are extremely useful. However, follow-up studies in more highly controlled conditions are warranted to further ascertain the specifics regarding student achievement.

The findings from this study suggest that schools play an important role above and beyond demographic characteristics of students when it comes to improving reading skills across a number of outcome measures. This was demonstrated by several demographic variables having a positive impact on initial reading skills, but less so when it comes to growth over time. Additionally, while externalizing behavior did not appear to have a significant impact on reading growth in the present study, positive student behaviors were related to growth on both a skill-based measure (i.e. ORF) and on reading grades. Both academic and behavioral intervention variables were important factors in reading growth over time. However, this was only true on the skill-based measures and not for reading grades. This study highlights several factors amenable to change within the school setting that are important to academic outcomes for children with ADHD. Additionally, these findings for children with parent and school reported ADHD were not distinct from children with no report of ADHD in the sample, suggesting the fact that these students are in special education is an important variable to consider when designing interventions, as this was the common thread between both groups. While this study and another using this sample (Schnoes et al., 2006), found that characteristics such as gender distribution and medication status were similar to the general population of

individuals with ADHD, the results of this study were different in some ways from previous studies on children with ADHD.. This may suggest that this sample of children (those in special education) may be a distinct group from the overall population of children with ADHD. Finally, the manner in which outcomes is measured is important and has implications for how growth is interpreted.

Given the large number of students with ADHD that are impacted academically, additional research needs to further delineate predictors of academic achievement in this population. Of particular interest are those variables that are amenable to intervention within the educational system. The results of this study suggest that variables that can be altered within the school setting can play an important role in student outcomes, including student behavior and intervention variables. The President's Commission on Excellence in Special Education (2002) suggests that our current system of special education has not been always focused on the use "evidence-based practice". As such, studies have also revealed effect sizes below .5 for the impact of special education (Kavale & Forness, 1999) suggesting that change is needed. An emphasis on reforming this system for one of the most frequent diagnoses for the school-aged population is imperative to improve the negative trajectory often associated with ADHD.

APPENDICES

Appendix Table 1

Measurement Model Confirmatory Factor Analysis

	Externalizing		Student	
Item	Estimate	R^2	Estimate	R^2
Impulsive	0.47	.65		
Temper	0.38	.60		
Trouble	0.48	.80		
Responds	0.50	.78		
Directions			0.33	.67
Performs			0.42	.77
Own			0.43	.70
Keeps			0.45	.74
Homework			0.40	.66
Communication			0.28	.49
Cronbach's Alpha	.802		.841	
Chi Square (*df; p*)	39.65 (*27; .055*)			
NFI; GFI; CFI	1.00; 0.99; 1.00			
RMSEA (CI)	.02 (.00; .032)			

Appendix Table 2

Descriptive Characteristics of ADHD & no-ADHD without Imputed Data

	ADHD			No-ADHD			
Variable	N	Mean	Std.	N	Mean	Std	Sig
Grade	389	4.85	1.81	630	4.81	1.94	.746[t]
Gender[a]	389	1.20	0.39	630	1.38	0.48	.000[t*]
Ethnicity[b]	389	1.22	0.42	630	1.30	0.46	.008[t*]
Household Income[c]	354	9.30	4.77	579	8.42	4.64	.005*
Mother's Education[d]	351	2.66	0.89	583	2.44	0.96	.000*
Stimulant Status[e]	389	0.70	0.46	630	0.01	0.10	.000[t*]
Externalizing Behavior[f]	334	8.15	1.92	544	6.64	2.18	.000[t*]
Behavior Intervention[g]	341	1.43	1.05	534	0.10	0.93	.000[t*]
Academic Intervention[h]	335	5.56	2.27	523	5.45	2.47	.534[t]
Student Behavior[i]	333	12.71	2.45	550	13.98	2.79	.000[t*]
Functional Skills[j]	382	7.34	2.71	621	7.21	2.69	.482
Primary Goal for Reading[k]	346	1.69	1.01	565	1.70	0.98	.827
Disability Status[l]							
Serious Emotional Disturbance	389	0.24	0.43	630	0.08	0.28	.000[t*]
Learning Disability	389	0.44	0.50	630	0.60	0.49	.000[t*]
Other Health Impaired	389	0.30	0.46	630	0.16	0.37	.000[t*]
Spch./Lang. Impairment	389	0.15	0..36	630	0.40	0.49	.000[t*]

Ŧ = equal variances not assumed; a = (1=male; 2=female); b = (1=white; 2=nonwhite); c = (1=low. .16=high); d = (1=low-4=high) e = (0=no; 1=yes); f = (higher=more negative); g = (range =0-3 ; higher equals more intervention); h = (range =2-11; higher equals more intervention); i = (higher=more positive); j = (1=low; 6=medium; 11=high); k = (1=reading at grade level. . . 5= no reading goals); l = (0=no; 1=yes); *significant (p<.05)

Appendix Table 3

Descriptive Characteristics of ADHD & no-ADHD with Imputed Data

	ADHD			No-ADHD			
Variable	N	Mean	Std.	N	Mean	Std	Sig
Grade	389	4.85	1.81	630	4.81	1.94	.746[t]
Gender[a]	389	1.19	0.39	630	1.37	.48	.000[t*]
Ethnicity[b]	389	1.22	0.42	630	1.30	.46	.008[t*]
Household Income[c]	389	9.26	4.60	630	8.32	4.53	.001*
Mother's Education[d]	389	2.65	0.87	630	2.42	0.95	.000*
Stimulant Status[e]	389	0.70	0.46	630	0.01	.10	.000[t*]
Externalizing Behavior[f]	389	8.12	1.84	630	6.64	2.07	.000[t*]
Behavior Intervention[g]	389	1.41	1.01	630	.99	.88	.000[t*]
Academic Intervention[h]	389	5.54	2.17	630	5.39	2.34	.295[t]
Student Behavior[i]	389	12.74	2.32	630	13.99	2.65	.000[t*]
Functional Skills[j]	389	7.34	2.70	630	7.22	2.70	.465
Primary Goal for Reading[k]	389	1.71	0.96	630	1.71	.94	.958
Disability Status[l]							
Serious Emotional Disturbance	389	0.24	0.43	630	0.08	0.28	.000[t*]
Learning Disability	389	0.44	0.50	630	0.60	0.49	.000[t*]
Other Health Impaired	389	0.30	0.46	630	0.16	0.37	.000[t*]
Spch./Lang. Impairment	389	0.15	0..36	630	0.40	0.49	.000[t*]

Ŧ = equal variances not assumed; a = (1=male; 2=female); b = (1=white; 2=nonwhite); c = (1=low. .16=high); d = (1=low-4=high) e = (0=no; 1=yes); f = (higher=more negative); g = (range =0-3 ; higher equals more intervention); h = (range =2-11; higher equals more intervention); i = (higher=more positive); j = (1=low; 6=medium; 11=high); k = (1=reading at grade level. . . 5= no reading goals); l = (0=no; 1=yes); *significant (p<.05)

Appendix Table 4

Correlation Matrix for no ADHD (upper) & ADHD (lower) Groups

	1	2	3	4	5	6	7	8	9	10	11	12
1		.005	-.028	-.044	-0.80*	-.058	-.280**	.029	-.055	.054	-.023	.135**
2	.059		-.077	-.026	-.052	.025	.012	-.190**	.125**	.027	-.110**	-.074
3	-.085	-.006		-.387**	-.254**	.008	.025	.210**	-.130**	.009	.156**	.130**
4	.067	.025	-.338**		.550**	-.025	-.131**	-.225**	.238**	-.031	-.183**	-.285**
5	.041	.002	-.153**	.463**		-.026	-.074	-.091*	.194**	.019	-.128**	-.225**
6	-.033	-.011	-.042	.044	.055		.035	.112**	-.031	-.005	.039	.054
7	-.367**	.011	.005	-.214**	-.142**	-.066		.035	-.121**	.107**	.161**	.274**
8	-.133**	-.122*	.247**	-.333**	-.182**	.038	-.044		-.510**	.040	.244**	.172**
9	-.044	.114*	-.015	.131**	.041	.054	.014	-.399**		-.085*	-.203**	-.211**
10	.146**	.058	.064	-.091	-.053	.000	.040	.009	-.108*		-.018	.101*
11	-.207**	-.016	.170**	-.256**	-.174**	-.038	.213**	.218**	-.078	.015		.495**
12	-.059	-.033	.196**	-.255**	-.172**	-.018	.295**	.066	-.020	.059	.458**	

Note. 1=grade; 2=gender; 3=ethnicity ; 4=household income wave 1; 5=mother's education wave 1; 6=med status wave 1 ; 7=functional skill wave 1; 8=externalizing behavior wave 1; 9=student behavior wave 1; 10= reading goal wave 1; 11= behavior intervention wave 1; 12=academic intervention wave 1; *significant (p<.05); ** significant (p<.01)

Appendix Table 5

Reading Achievement Across Groups

	ADHD (n=389)		Non-ADHD (n=630)		
Variable	Means	SD	Means	SD	Sig
Letter-Word Identification[a]					
Wave 1	89.21	14.78	85.73	15.24	.000*
Wave 2	90.24	15.17	85.99	15.69	.000*
Wave 3	91.09	15.48	86.90	15.67	.000*
Passage Comprehension[a]					
Wave 1	88.80	13.45	86.00	13.60	.001*
Wave 2	88.90	13.84	86.58	14.98	.012[t*]
Wave 3	89.22	12.35	86.79	12.98	.003*
Oral Reading Fluency					
Wave 1	93.11	44.92	82.49	43.38	.000*
Wave 2	107.59	45.59	99.88	45.38	.009*
Wave 3	127.31	44.05	121.80	44.50	.054
Reading Grades					
Wave 1	2.32	0.80	2.14	0.82	.001*
Wave 2	2.37	0.76	2.12	0.71	.000[t*]
Wave 3	2.43	0.78	2.25	0.80	.000*

Ŧ = equal variances not assumed; *significant (p<.05); a = although standard scores are reported here for ease of interpretation, analyses were completed using W scores

Appendix Table 6

Impact of Covariates on Oral Reading Fluency

	Initial Reading Status			Reading Growth		
	Unstand. Estimate	S.E.	Stand. Estimate	Unstand. Estimate	S.E.	Stand. Estimate
Grade	5.902	1.334	.250*	-2.268	0.708	-.219*
Gender	13.706	5.997	.111*	0.353	2.495	.009
Ethnicity	-3.209	5.894	-.031	-3.632	3.873	-.106
Household Income	0.819	0.651	.088	-0.124	0.418	-.040
Mother's Education	5.131	3.480	.104	1.654	2.658	.102
Functional Skills	-4.600	0.901	-.266*	-0.215	0.798	-.037
Reading Goal	-4.574	3.282	-.089	-4.130	1.464	-.242*
Externalizing Behavior	0.071	1.393	.003	-0.022	1.069	-.003
Student Behavior	-3.084	.917	-.168*	1.763	0.728	.290*
Medication Status	4.183	4.345	.045	0.718	3.158	.023
Behavioral Intervention	-2.282	2.646	-.050	3.801	1.819	.250*
Academic Intervention	-7.358	1.199	-.361*	0.148	0.768	.022

*significant ($p<.05$)

Appendix Table 7

Impact of Covariates on Letter Word Identification

	Initial Reading Status			Reading Growth		
	Unstand. Estimate	S.E.	Stand. Estimate	Unstand. Estimate	S.E.	Stand. Estimate
Grade	5.303	0.983	.308*	-2.536	0.515	-.660*
Gender	-1.249	3.826	-.014	1.839	2.396	.092
Ethnicity	-2.895	4.352	-.038	-4.186	2.388	-.248
Household Income	1.143	0.508	.168*	0.188	0.277	.124
Mother's Education	3.181	2.283	.089	0.316	1.374	.039
Functional Skills	-3.816	0.660	-.303*	0.020	0.367	.007
Reading Goal	-5.222	1.819	-.139*	-0.933	1.371	-.111
Externalizing Behavior	-0.219	0.933	-.013	-0.183	0.681	-.048
Student Behavior	-1.829	0.772	-.136*	0.628	0.709	.209
Medication Status	0.248	3.511	.004	2.474	2.347	.164
Behavioral Intervention	-1.747	1.978	-.052	3.755	1.159	.501*
Academic Intervention	-3.941	0.938	-.265*	0.724	0.528	.218

*significant p<.05

Appendix Table 8

Impact of Covariates on Passage Comprehension

	Initial Reading Status			Reading Growth		
	Unstand. Estimate	S.E.	Stand. Estimate	Unstand. Estimate	S.E.	Stand. Estimate
Grade	3.853	0.484	.362*	-1.671	0.207	-.452*
Gender	-1.999	4.792	-.036	0.954	2.230	.049
Ethnicity	-5.579	2.539	-.119*	0.648	0.841	.040
Household Income	0.378	0.259	.090	-0.201	0.127	-.137
Mother's Education	3.230	1.557	.146*	-0.092	0.696	-.012
Functional Skills	-1.562	0.375	-.200*	-0.150	0.174	-.055
Reading Goal	-2.167	1.208	-.093	-0.166	0.479	-.021
Externalizing Behavior	0.324	0.606	.031	-0.410	0.273	-.113
Student Behavior	0.705	0.507	.085	-0.379	0.245	-.131
Medication Status	-0.933	2.263	-.022	1.632	0.883	.113
Behavioral Intervention	1.540	1.558	.074	-1.071	0.664	-.149
Academic Intervention	-2.270	0.537	-.247*	0.614	0.204	.192*

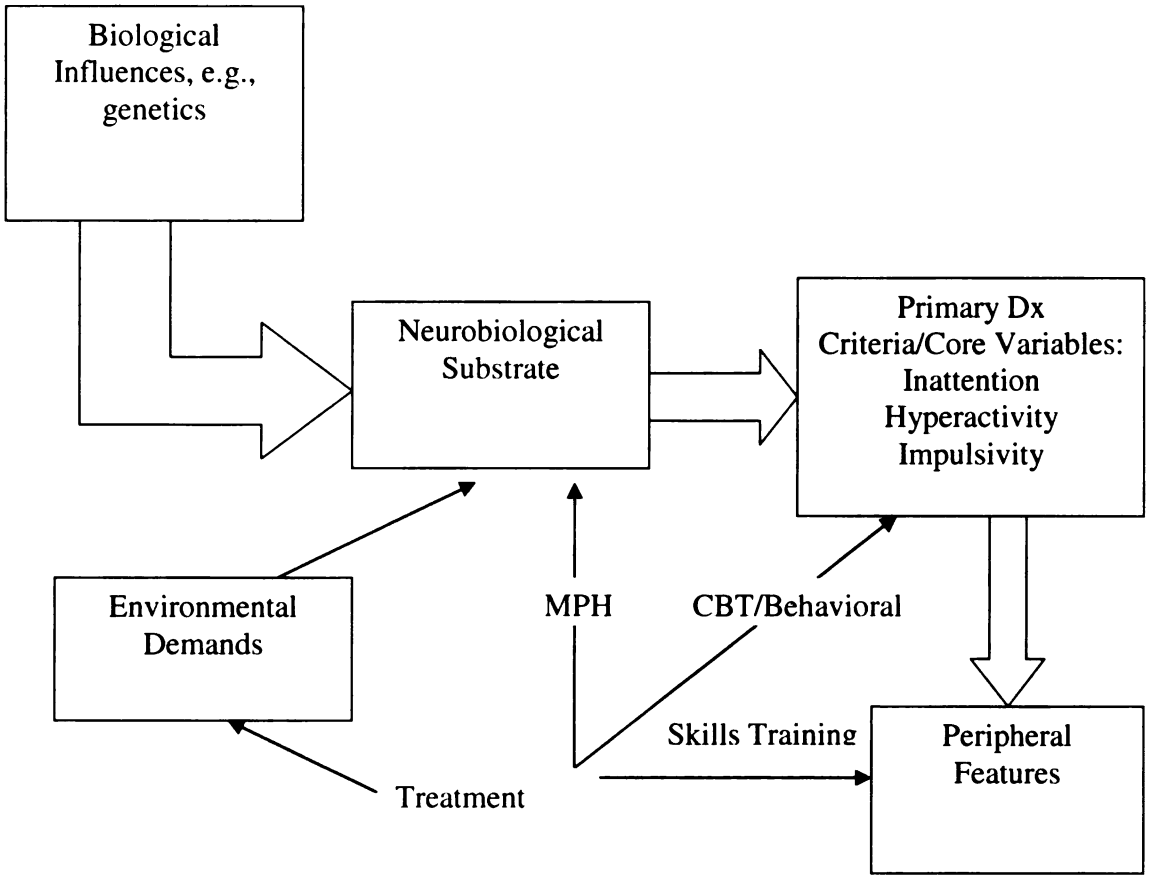
*significant p<.05

Appendix Table 9

Impact of Covariates on Reading Grades

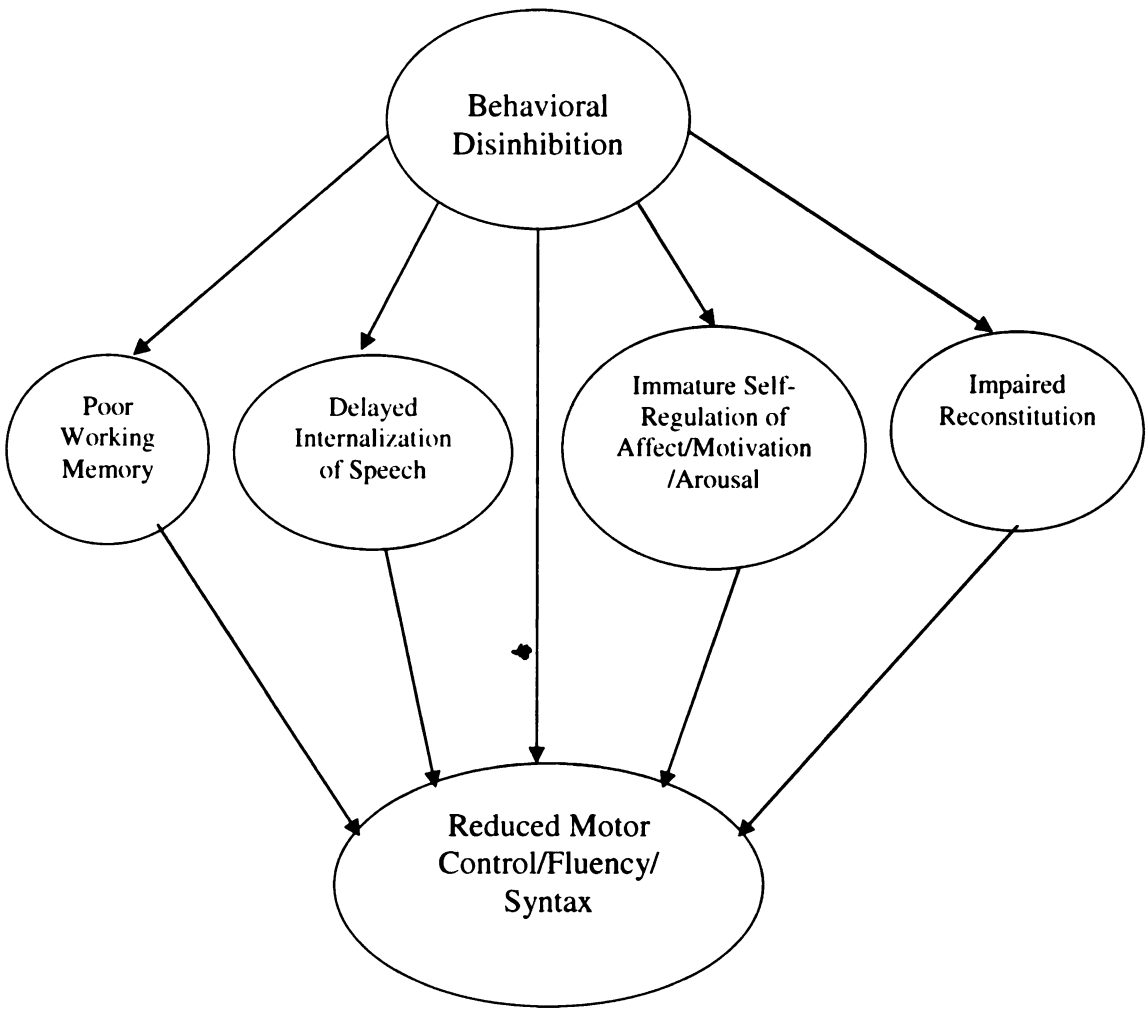
	Initial Reading Status			Reading Growth		
	Unstand. Estimate	S.E.	Stand. Estimate	Unstand. Estimate	S.E.	Stand. Estimate
Grade	0.113	0.063	.186	0.000	0.040	.000
Gender	-0.239	0.225	-.075	0.000	0.124	.000
Ethnicity	0.140	0.271	.053	-0.042	0.144	-.046
Household Income	-0.004	0.024	-.016	-0.008	0.016	-.092
Mother's Education	0.065	0.111	.051	-0.160	0.072	-.364*
Functional Skills	0.105	0.043	.235*	-0.040	0.023	-.256
Reading Goal	0.177	0.094	.133	-0.044	0.049	-.095
Externalizing Behavior	-0.048	0.059	-.081	0.010	0.033	.048
Student Behavior	-0.311	0.058	-.657*	0.092	0.029	.561*
Medication Status	0.139	0.207	.058	-0.138	0.126	-.167
Behavioral Intervention	-0.082	0.118	-.069	0.019	0.083	.046
Academic Intervention	-0.074	0.047	-.140	0.028	0.029	.156

*significant p<.05



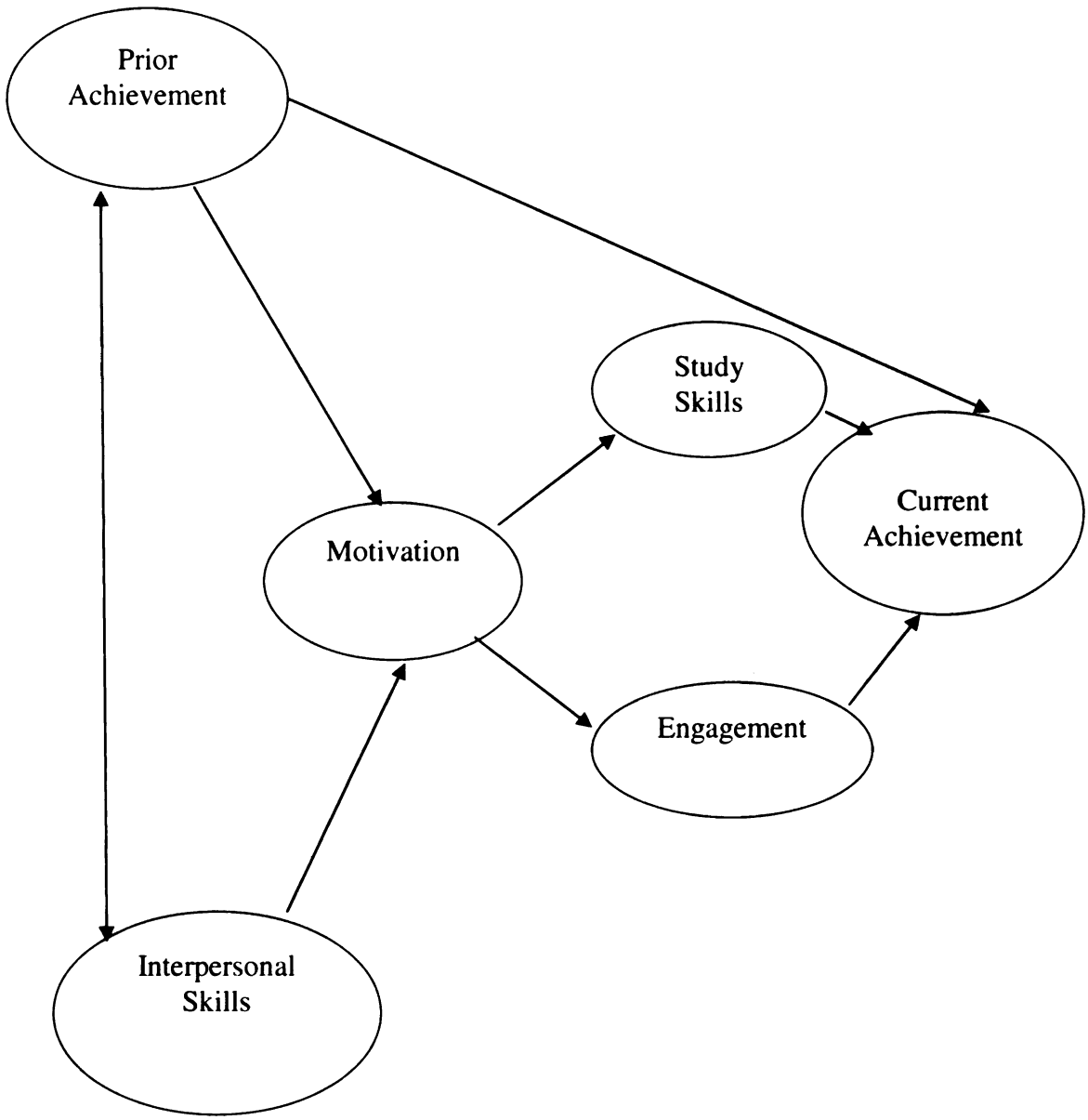
Appendix Figure 1

Conceptual Model of ADHD (Rapport, Chung, Shore & Isaacs, 2001)



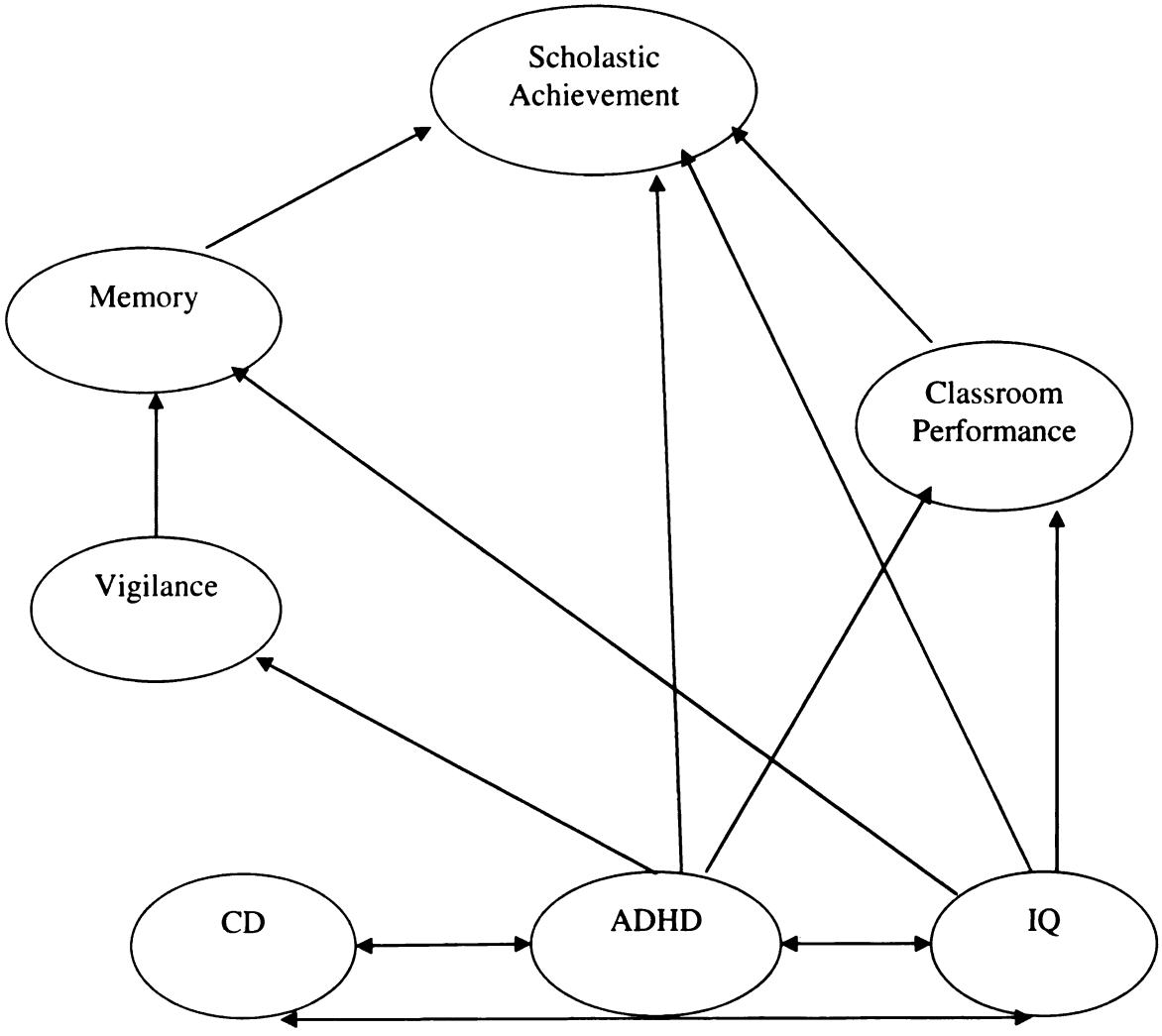
Appendix Figure 2

Disinhibition Model (Barkely, 1997)



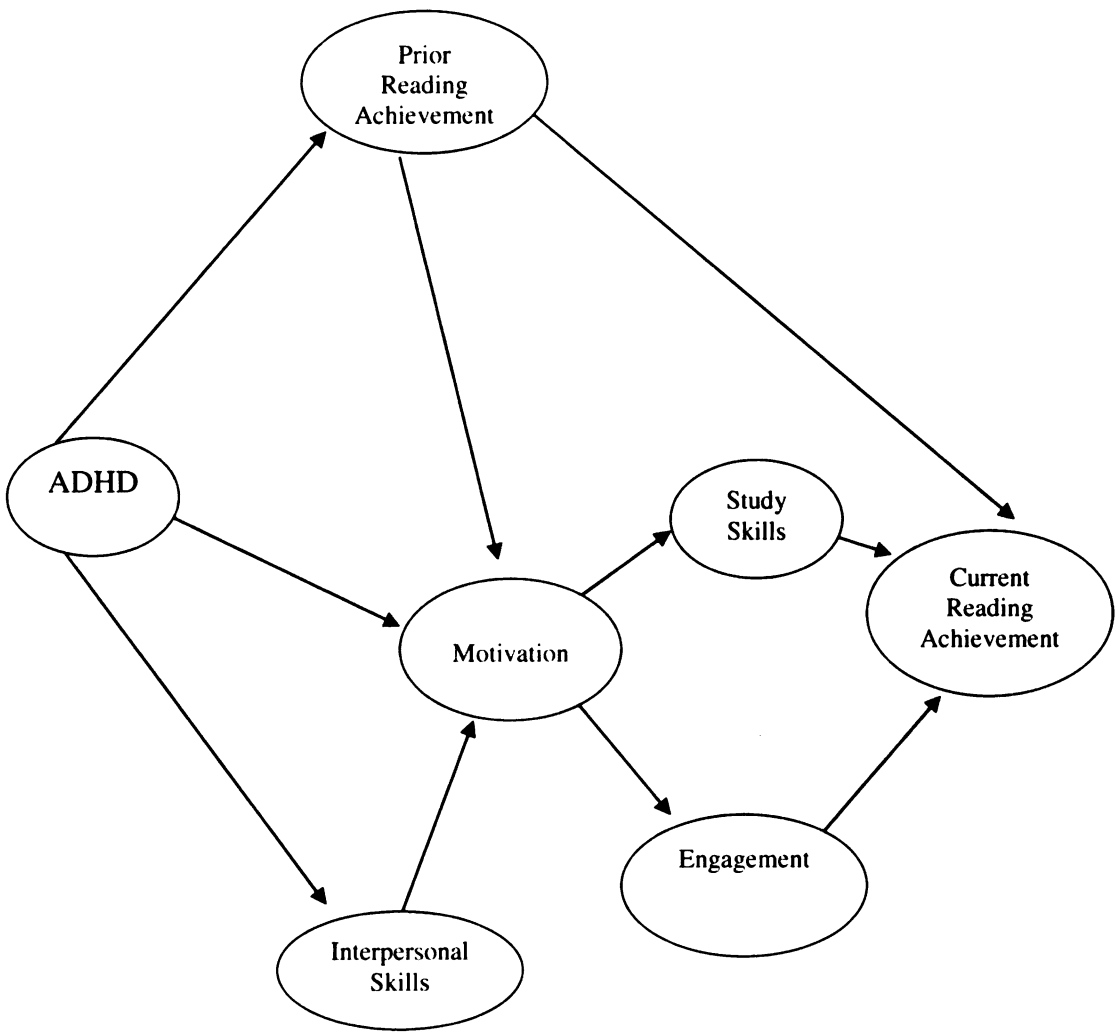
Appendix Figure 3

Model of Academic Enablers (DiPerna, Volpe & Elliott, 2002)



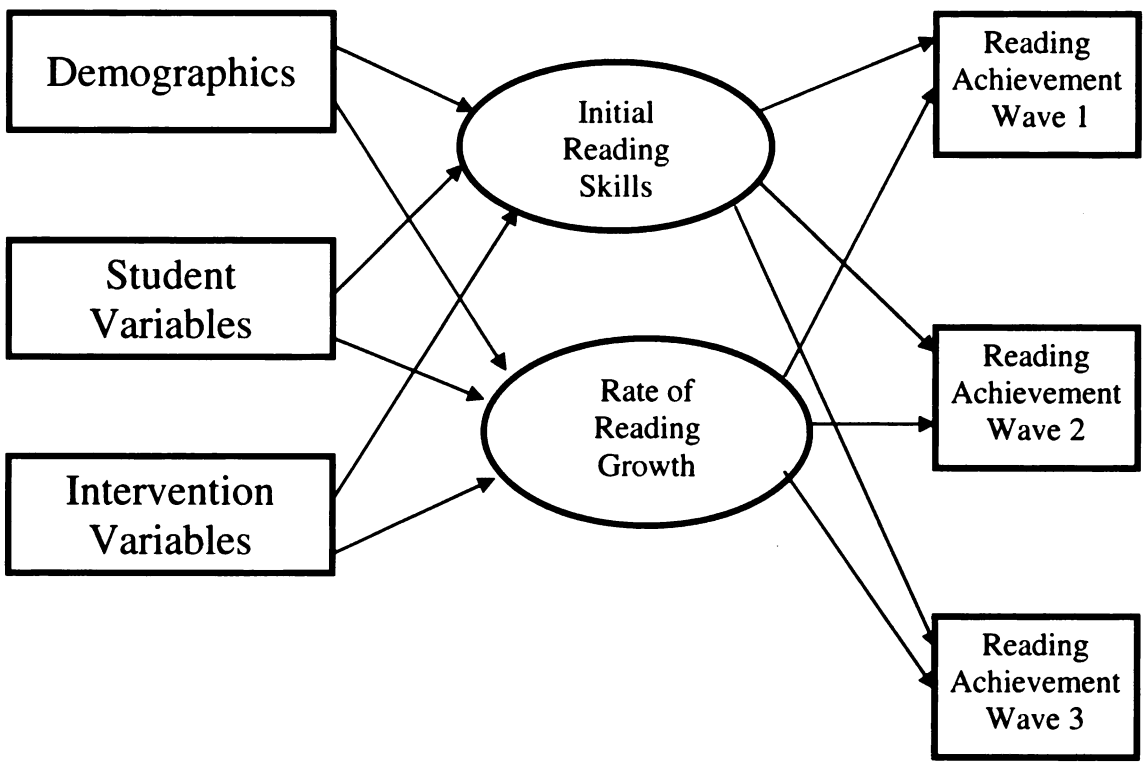
Appendix Figure 4

Model of Dual Developmental Pathways (Rapport, Scanlon & Denney, 1999)



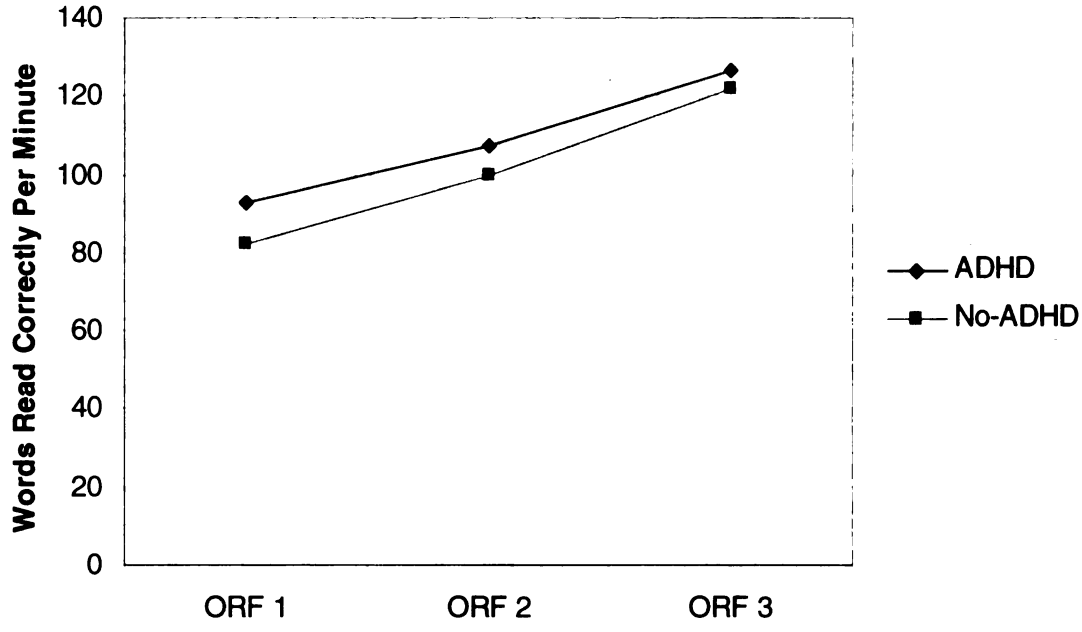
Appendix Figure 5

Model of ADHD & Academic Enablers (Volpe et al., 2006)



Appendix Figure 6

Hypothesized Latent Growth Model of Reading Achievement



Appendix Figure 7

Means of ORF over time and between groups

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