ABSTRACT

ASBECK, STEPHANIE ANN. The Relationship of Inattention and Hyperactivity/Impulsivity to Basic Early Literacy Skills. (Under the direction of Ann Schulte.)

This study examined the relationship of inattention and hyperactivity/impulsivity to phonemic awareness and mastery of the alphabetic principle in kindergarten children. Teacher rating scales were used to evaluate symptoms of inattention and hyperactivity/impulsivity and two subtests of the Dynamic Indicators of Basic Early Literacy Skills were used to assess children’s fluency in two basic literacy domains, phonemic awareness and mastery of the alphabetic principle. It was predicted that classroom behaviors related to the two dimensions of Attention Deficit Hyperactivity Disorder (ADHD) would be negatively related to children’s acquisition of both early literacy skills. After controlling for demographic differences and classroom assignment, multiple regression analyses indicated that inattention was negatively related to children’s mastery of the alphabetic principle. This relationship remained when verbal ability was added as a control variable. The hypotheses related to other relationships among early literacy skills and hyperactivity/impulsivity and inattention were not confirmed. Results are discussed in terms of their implications for explanations of the ADHD and reading disability comorbidity, and future research on the topic of the relationship between the dimensions of ADHD and the acquisition of early literacy skills.
THE RELATIONSHIP OF INATTENTION AND HYPERACTIVITY/IMPULSIVITY TO BASIC EARLY LITERACY SKILLS.

by

STEPHANIE ANN ASBECK

A thesis submitted to the Graduate Faculty of North Carolina State University in partial fulfillment of the requirements for the Degree of Master of Science

SCHOOL PSYCHOLOGY

Raleigh

2006

APPROVED BY:

_____________________________       ____________________________
Chair of Advisory Committee
BIOGRAPHY

Stephanie Ann Asbeck was born in San Juan, Puerto Rico on September 27, 1978, the second child born to John and Magdalena Asbeck. She has an older brother, John Richard; a sister-in-law, Karen; and a 4-year-old nephew, Athan. Given her father’s employment, she had the opportunity to live in Puerto Rico and Mexico.

Stephanie graduated magna cum laude from the University of Puerto Rico- Mayaguez Campus in 2000, with a Bachelor of Arts degree in Psychology. After some brief traveling, she decided to pursue a degree in School Psychology. She is continuing graduate work in the doctoral program in School Psychology at North Carolina State University.
ACKNOWLEDGEMENTS

There are many people I would like to thank for enabling me to complete this master’s thesis. First is my advisor Dr. Ann C. Schulte, who offered continuous support, guidance, and motivation throughout the completion of this thesis. Without her patience and humor, this process would’ve been difficult. Likewise, the other committee members, Dr. Patricia Collins and Dr. Mary Haskett, have been a source of encouragement. I thank my committee for all of their support. They are extraordinary professional women who have helped me in many different ways through this learning process.

I would like to thank those in the School Psychology program as well as other graduate students in other fields of psychology at North Carolina State University. I am grateful for their unending encouragement. I would like to thank Melinda Rupard, Anna Datta, Kendrea Hart, Athena Franks, Justin Parker, Andrea McPherson, Lisa Ahern, Caryn Ward, and Jeff Smith for sharing their knowledge, experience, and optimism. Specifically, I’d like to thank Cristina Andreassi for her unconditional support and most importantly, for her love and friendship. Her phone calls, emails, and camaraderie have helped me through these years of study.

I’d like to thank several long-distance friends who have provided much love and support from afar. This includes Ana C. Laborde, Angelica Soto, Carol Leong, Sarah Loinaz, Luis Carlos Robles, and Carlos Toledo who were there to encourage me and cheer me on along the way. I am honored to have friends of such caliber.
Finally, I’d like to thank my family for all of their love and support. They have influenced me since day one and continue to do so. My mother and father have always believed in me and encouraged me to follow my dreams. The rest of my immediate and extended family have helped me in numerous ways. The emails, phone calls, and well wishes were greatly appreciated. My family is my backbone. Thankfully, I have great friends that fall into that category as well. I feel indescribably grateful and blessed to have all of them in my life. Without their love, patience, and support this degree wouldn’t have been possible. This is for them.
TABLE OF CONTENTS

List of Tables........................................................................................................... v

Ch. 1  Introduction................................................................................................... 01

Ch. 2  Literature Review......................................................................................... 05

ADHD..................................................................................................................... 05
  Prevalence........................................................................................................... 05
  Primary Symptoms............................................................................................. 06
  Controversies surrounding ADHD’s primary symptoms.............................. 07
  DSM-IV diagnostic criteria and subtypes....................................................... 09
  Developmental course of ADHD.................................
  Associated problems...................................................................................... 13

Reading Disability............................................................................................... 15
  Prevalence........................................................................................................... 15
  Primary Symptoms............................................................................................. 16
  RD diagnostic criteria...................................................................................... 17
  Developmental course of RD............................................................
  Associated problems...................................................................................... 22

ADHD and RD: Comorbidity and Causal pathways........................................... 23
  Factors important in investigating comorbidity........................................... 24
  Comorbidity estimates...................................................................................... 28
  Causal models.................................................................................................. 32
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal studies</td>
<td>34</td>
</tr>
<tr>
<td>Big Ideas in Beginning Reading</td>
<td>48</td>
</tr>
<tr>
<td>Phonemic awareness</td>
<td>49</td>
</tr>
<tr>
<td>Alphabetic principle</td>
<td>50</td>
</tr>
<tr>
<td>Accuracy and fluency</td>
<td>51</td>
</tr>
<tr>
<td>Vocabulary</td>
<td>51</td>
</tr>
<tr>
<td>Comprehension</td>
<td>52</td>
</tr>
<tr>
<td>Ch. 3 Research Aims</td>
<td>54</td>
</tr>
<tr>
<td>Statement of the problem</td>
<td>54</td>
</tr>
<tr>
<td>Research questions and hypotheses</td>
<td>56</td>
</tr>
<tr>
<td>Question 1. Are teacher ratings of classroom behavior symptomatic of ADHD related to early literacy skills?</td>
<td>56</td>
</tr>
<tr>
<td>Question 2. When controlling for verbal ability, are teacher ratings of children’s classroom behavior symptomatic of ADHD related to children’s early literacy skills?</td>
<td>57</td>
</tr>
<tr>
<td>Question 3. Are symptoms of inattention and hyperactivity/impulsivity differentially related to early literacy skills?</td>
<td>58</td>
</tr>
<tr>
<td>Ch. 4 Method</td>
<td>60</td>
</tr>
<tr>
<td>Participants</td>
<td>60</td>
</tr>
<tr>
<td>Materials</td>
<td>61</td>
</tr>
</tbody>
</table>
Ch. 6 Discussion............................................................................................................. 81

Inattention, Hyperactivity/Impulsivity, and Early Literacy................................. 82

Inattention and the alphabetic principle................................................................. 82
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyperactivity and the alphabetic principle</td>
<td>84</td>
</tr>
<tr>
<td>Inattention, hyperactivity/impulsivity, and phonemic awareness</td>
<td>86</td>
</tr>
<tr>
<td>Classroom effects on early literacy skills: An explanation for conflicting findings?</td>
<td>88</td>
</tr>
<tr>
<td>Study Limitations</td>
<td>91</td>
</tr>
<tr>
<td>Implications for Practice</td>
<td>93</td>
</tr>
<tr>
<td>Future Directions for Research</td>
<td>94</td>
</tr>
<tr>
<td>References</td>
<td>96</td>
</tr>
<tr>
<td>Table</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>---------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Table 1</td>
<td>Behavioral Characteristics Used in the Diagnosis of Attention Deficit Hyperactivity Disorder</td>
</tr>
<tr>
<td></td>
<td>(American Psychiatric Association, 1994)</td>
</tr>
<tr>
<td>Table 2</td>
<td>Characteristics Used in the Diagnosis of Reading Disorder</td>
</tr>
<tr>
<td></td>
<td>(American Psychological Association, 1994)</td>
</tr>
<tr>
<td>Table 3</td>
<td>ADHD and RD Comorbidity Estimates</td>
</tr>
<tr>
<td>Table 4</td>
<td>Demographic Characteristics of the Sample</td>
</tr>
<tr>
<td>Table 5</td>
<td>General Descriptive Statistics</td>
</tr>
<tr>
<td>Table 6</td>
<td>Correlations of Primary Variables</td>
</tr>
<tr>
<td>Table 7</td>
<td>Prediction of PSF by Inattention (Hypothesis 1)</td>
</tr>
<tr>
<td>Table 8</td>
<td>Prediction of PSF by Hyperactivity/Impulsivity (Hypothesis 2)</td>
</tr>
<tr>
<td>Table 9</td>
<td>Prediction of NWF by Inattention (Hypothesis 3)</td>
</tr>
<tr>
<td>Table 10</td>
<td>Prediction of NWF by Hyperactivity/Impulsivity (Hypothesis 4)</td>
</tr>
<tr>
<td>Table 11</td>
<td>Prediction of NWF by Inattention when Vocabulary is controlled for (Hypothesis 7)</td>
</tr>
<tr>
<td>Table 12</td>
<td>Increase in Prediction of NWF with Inattention (Hypothesis 10)</td>
</tr>
<tr>
<td>Table 13</td>
<td>Mean NWF Scores and Ratings of Inattention by Teacher/Classroom</td>
</tr>
</tbody>
</table>
CHAPTER ONE: INTRODUCTION

Reading disabilities and attention disorders are among the most frequent disorders in school-age children. Prevalence estimates for attention deficit hyperactivity disorder (ADHD) in the school-age population range from 3% to 5% (American Psychiatric Association, 1994), while prevalence estimates for reading disabilities (RD) range from 5% to 10% (American Psychiatric Association, 1994).

Both disorders have serious consequences. Children with ADHD are less successful in school, more likely to drop out of school, and more likely to engage in criminal behavior (Ferguson & Horwood, 1995; Flanagan, Bierman, Kam, & Conduct Problems Prevention Research Group [CPPRG], 2003; Mash & Barkley, 1996; National Institute of Mental Health, 1996). Reading disabilities are related to poor scholastic attainment, grade retention, school drop out, and difficulty finding steady employment.

Although generally thought to reflect deficits in different cognitive processes (Pennington, 1993; Torgesen & Wagner, 1998), RD and ADHD co-occur more frequently than would be expected by chance alone (Hinshaw, 1992; Purvis & Tannock, 2000). Comorbidity estimates vary depending on the stringency of diagnostic criteria for both disorders, whether an epidemiological or clinic sample is examined, and whether rates of ADHD in children with RD or rates of RD in children with ADHD are examined. Typical rates of comorbidity reported in the literature range from 8% to 45% (Lyon, 1996, as cited in Moats, 1998; Purvis & Tannock, 2000; Schulte, Conners, & Osborne, 1999; Semrud-Clikeman et al., 1992, as cited in Aaron, Joshi, Palmer, Smith, & Kirby, 2002).

In efforts to understand how ADHD and RD are related, a number of investigators have completed more fine grained analyses of symptom overlap between the two disorders.
In general, researchers have found that behaviors reflective of inattentive rather than hyperactivity dimensions of ADHD are more closely associated with reading difficulties (McGee, Williams, & Silva, 1985; Rabiner, Coie, & Conduct Problems Prevention Research Group, 2000). For reading, some researchers have found that comprehension difficulties are more characteristic of children with ADHD and RD (Shaywitz, Fletcher, & Shaywitz, 1994). Others have found that word identification difficulties are characteristic of children with both disorders (Aaron et al., 2002).

Explanations of the higher than expected overlap between the two disorders fall into four logical categories: (a) RD contributes to the development of ADHD, (b) ADHD contributes to the development of RD, (c) both disorders predispose children to develop the other disorder, and (d) a third variable is related to the development of both disorders (Hinshaw, 1992). To date, there is some research evidence for each of these propositions (e.g., Hinshaw, 1992; McGee, Williams, & Silva, 1984b; McGee et al., 1985; Halperin, Gittelma, Klein & Rudel, 1984). However, investigations often have been limited by the use of measures of ADHD that do not discriminate between the inattention and hyperactivity dimensions of the disorder, and reading measures that do not discriminate between component skills of reading. In addition, most research has been conducted with children who have already learned to read (e.g., McGee et al., 1984; McGee et al., 1985; Halperin et al., 1984). Only a few studies have assessed children’s attentional problems and preliteracy skills before exposure to reading instruction (Fantuzzo, Bulotsky, McDermott, Mosca, & Noone Lutz, 2003; Hinshaw, Morrison, Carte, & Cornsweet, 1987; Jorm, Share, Maclean, Matthews, 1986; Jorm, Share, Matthews, Maclean, 1986; Palfrey, Levine, Walker, &
Sullivan, 1985). Early literacy studies are important because demonstrating a relationship between poor early literacy skills and attention problems would lend support to a comorbidity explanation that focuses on the role of attention in developing reading skills, or on the presence of a third variable that leads to early difficulties in both areas, eventually resulting in the development of both disorders.

The present study used a recently developed early literacy measure, the Dynamic Indicators of Basic Early Literacy Skills (DIBELS), to examine kindergarten children’s prereading skills and their relationship to the inattention and hyperactivity dimensions of ADHD. The inattention and hyperactivity dimensions of ADHD were assessed with a standardized, norm-referenced teacher checklist (DuPaul, Power, Anastopoulos, & Reid, 1998) whose content focuses on behaviors characteristic of ADHD in the classroom. Rather than assessing ADHD and early reading difficulties as categorical variables, both were treated as continuous variables. With this design, the relationships between the two constructs, ADHD and early reading, could be examined in a broad sample of kindergarteners. It was predicted that higher teacher ratings on behaviors related to ADHD would be associated with lower early literacy skills, and that inattention would be more strongly related to poor early literacy skills than hyperactivity. Results of the study may have implications for models of the relationship between the two disorders, as well as for early intervention efforts related to both disorders.

Prior to describing the present study in detail, Chapter 2 provides a review of research relevant to the study. First, the disorders of ADHD and RD are briefly described. Second, studies of the comorbidity between the two disorders are summarized, including studies that have examined ADHD symptoms and their link to early literacy skills. These studies provide
the background for the present study. Third, new research regarding the processes underlying early literacy and skilled reading is summarized. Chapter 3 provides a statement of the problem and hypotheses for the current study. Chapter 4 provides a detailed description of the present study and data analyses procedures and Chapter 5 summarizes results of the analyses. The study concludes with a discussion of results in terms of their implications for explanations of the ADHD and reading disability comorbidity, limitations of the study, implications for the practice of psychology, and future research on the topic of the relationship between the dimensions of ADHD and the acquisition of early literacy skills.
CHAPTER TWO: LITERATURE REVIEW

Attention-Deficit/Hyperactivity Disorder

It is common for children, especially young preschool children, to be active, energetic, and to shift from one activity to another. In addition, they easily get bored or off-task, demonstrate poor self-control, and act without much planning (Barkley, 1996). Although these behaviors are common in young children, when they are persistent and appear at levels that are not age-appropriate, they may be indicative of the behavior disorder, Attention Deficit Hyperactivity Disorder (ADHD). The purpose of this section is to provide an overview of ADHD by describing its prevalence, primary symptoms, developmental course and common comorbidities.

Prevalence

ADHD, once referred to as hyperkinesis or minimal brain dysfunction, is one of the most common mental disorders among school age children (Gaub & Carlson, 1997; National Institute of Mental Health, 1996). The prevalence of ADHD has been estimated to be between 3% and 5% of the population (American Psychiatric Association, 1994), affecting as many as 2 million American children (National Institute of Mental Health, 1996). Estimates of male: female ratios range from 4:1 to 9:1 (American Psychiatric Association, 1994). Individuals with ADHD are usually depicted as having problems with hyperactivity, impulsivity, and inattention. These three primary symptoms are sometimes depicted as the “holy trinity” of ADHD (Barkley, 1998, p.57). Each will be discussed briefly in this section.
Primary Symptoms

Hyperactivity-impulsivity

Current diagnostic formulations of ADHD treat hyperactivity and impulsiveness as a single dimension. However, in order to more fully describe each construct, they will be separated here.

Hyperactivity. In early formulations of ADHD, hyperactivity, or excessive motor or vocal output, was viewed as the primary symptom of the disorder (Barkley, 1998). Although recent conceptualizations of ADHD have focused more on developmental difficulty inhibiting responses (Barkley, 1998), overactivity still remains a primary symptom of ADHD (Kendall, 2000), and part of the diagnostic criteria for the disorder (American Psychiatric Association, 1994). Many children with ADHD seem restless and carry out pointless body movements (American Academy of Pediatrics, 2001). Compared to their same age peers, they may have difficulty staying seated when required, may run and climb in situations where it is not appropriate, talk excessively, and distract others by humming and/or making noises (Barkley, 1996).

Impulsiveness or behavioral disinhibition. Impulsivity refers to difficulty in restraining behavior, hindering a response, or delaying gratification. It is often viewed as incapacity to hold back overriding reactions or prepotent responses. Children with ADHD generally respond hastily to situations or events without waiting for directions to be completed or adequately taking notice of what is required in the situation (Barkley, 1998). Because of this impulsivity, children with ADHD often make careless errors. In addition, these children may fail to think through all possible consequences prior to acting upon a decision. This impulsivity frequently leads children with ADHD to engage in risky
behaviors, which is why many of them experience injuries and accidents (Barkley, 1996). Children with ADHD may carelessly damage others’ property and have difficulty waiting for their turn. When working on tasks deemed as boring or aversive, children with ADHD generally take shortcuts, using the least amount of effort and performing in ways that take the least amount of time (National Institute of Mental Health, 1996). These children often interrupt others and blurt out comments or responses without thinking prior to verbalizing. Sharing, cooperating, and working in groups is many times problematic.

**Inattention**

The third and final primary symptom of ADHD is inattention. In comparison to other children their own age, children with ADHD frequently exhibit difficulties sustaining attention or staying on task, both in play activities or academic tasks. In free-play activities, this is evidenced by shorter periods of play with a specific toy and frequent shifts among various play activities (Barkley, 1998). In classrooms, children with ADHD are more likely to be off-task, and less likely to complete work than non-ADHD classmates (American Academy of Pediatrics, 2001). They may be described by teachers as daydreaming, failing to listen, and unable to work without frequent monitoring and redirection (Association of American Pediatrics, 2001; Barkley, 1998). Parents may complain that they do not complete chores, are disorganized, and frequently lose things (Association of American Pediatrics, 2001; Barkley, 1998).

**Controversies Surrounding ADHD’s Primary Symptoms**

How the three primary symptoms of ADHD are related, and the specific behaviors that fall within each of the primary symptom areas remain points of controversy within the field of ADHD. In the present diagnostic formulation (American Psychiatric Association,
In earlier conceptualizations of ADHD, hyperactivity and impulsivity were viewed as separate dimensions of ADHD, but were grouped together when factor analyses of ADHD symptoms were unsuccessful in distinguishing impulsivity and hyperactivity as distinct dimensions (Achenbach & Edelbrook, 1983; DuPaul et al., 1998; DuPaul et al., 1997; Milich & Kramer, 1985, as cited in Barkley, 1998). In other words, hyperactive children are also impulsive and impulsive children are also hyperactive. This core dimension of ADHD is often depicted as reflecting poor sustained inhibition of responding, poor delay of gratification, and an inability to adhere to guidelines to control and restrain behavior in social settings (Barkley, 1998).

Inattention is the second core dimension of ADHD in the present diagnostic conceptualization of ADHD (American Psychological Association, 1994) and children may be diagnosed with ADHD if they display markedly elevated levels of hyperactivity/impulsivity, inattention, or both. However, debate continues about whether children showing problems only in the area of inattention are truly ADHD, or whether they have a separate disorder. For example, in previous versions of the Diagnostic and Statistical Manual (American Psychiatric Association, 1968, 1980, 1987), Attention Deficit Disorder was classified as a distinct disorder, separate from ADHD, and Barkley (1996) suggested that more weight should be given to the impulsive and hyperactive characteristics of the disorder than to inattention when conceptualizing ADHD.

There is some evidence that inattention is associated with a different neuropsychological deficit than hyperactivity-impulsivity (Barkley, 1998), and may be
differentially related to particular types of school difficulties (Gaub & Carlson, 1977; Merrell & Tymms, 2001). Because a focus of the present study is the differential relationship of inattention and hyperactivity-impulsivity to reading difficulties, research related to this topic will be discussed in a separate section of the literature review.

**DSM-IV ADHD Diagnostic Criteria and Subtypes**

Table 1 lists the specific behaviors that must be evidenced under each of the three primary symptom areas for a diagnosis of ADHD in the current diagnostic formulation, Diagnostic and Statistical Manual, 4th edition (APA, 1994). A diagnosis of ADHD (APA, 1994) requires that six or more of the symptoms of inattention and/or hyperactivity-impulsivity be present for at least six months, to a degree that is maladaptive and inconsistent with the individual’s developmental level. In addition, it is essential that the hyperactive-impulsive or inattentive symptoms that have caused impairment be present before 7 years of age and that some impairment from the symptoms is present in two or more settings (e.g., at school [or work] and at home). There also must be clear indications of significant impairment in social, academic, or professional functioning. It is critical that the symptoms of inattention and/or hyperactivity-impulsivity do not occur exclusively during the course of a Pervasive Developmental Disorder, Schizophrenia, or other Psychotic Disorder and are not better accounted for by another mental disorder (e.g., Mood Disorder, Anxiety Disorder, Dissociative Disorder, or Personality Disorder).
Table 1.

Behavioral Characteristics Used in the Diagnosis of Attention Deficit Hyperactivity Disorder (American Psychiatric Association, 1994)

I. Inattention

1. often fails to give close attention to details or makes careless mistakes in schoolwork, work, or other activities
2. often has difficulty sustaining attention in tasks or play activities
3. often does not seem to listen when spoken to directly
4. often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (not due to oppositional behavior or failure to understand instructions)
5. often has difficulty organizing tasks and activities
6. often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (such as schoolwork or homework)
7. often loses things necessary for tasks or activities (e.g., toys, school assignments, pencils, books, or tools)
8. is often easily distracted by extraneous stimuli
9. is often forgetful in daily activities

II. Hyperactivity-Impulsivity

A. Hyperactivity

1. often fidgets with hands or feet or squirms in seat
2. often leaves seat in classroom or in other situations in which remaining seated is expected
3. often runs about or climbs excessively in situations in which it is inappropriate (in adolescents or adults, may be limited to subjective feelings of restlessness)
4. often has difficulty playing or engaging in leisure activities quietly
5. is often “on the go” or often acts as if “driven by a motor”
6. often talks excessively

B. Impulsivity

7. often blurts out answers before questions have been completed
8. often has difficulty awaiting turn
9. often interrupts or intrudes on others (e.g., butts into conversations or games)
As noted earlier, in the present conceptualization of ADHD in the DSM-IV, there are three specific subtypes of ADHD. The first subtype, Attention-Deficit/Hyperactivity Disorder, Combined Type (ADHD-C), is diagnosed if six or more behavioral symptoms of inattention and six or more symptoms of hyperactivity-impulsivity have been present for the past 6 months (and other diagnostic criteria have been met). The second subtype, Attention-Deficit/Hyperactivity Disorder, Predominantly Inattentive Type (ADHD-PI), is diagnosed if six or more symptoms of inattention have persisted over the past 6 months, but fewer than six symptoms of hyperactivity-impulsivity are present. The third subtype, Attention-Deficit/Hyperactivity Disorder, Predominantly Hyperactive-Impulsive Type (ADHD-PHI) is diagnosed when six or more symptoms of hyperactivity-impulsivity are present, but fewer than six symptoms of inattention have persisted for at least the past 6 months.

Developmental Course of ADHD

The problematic behavioral symptoms of ADHD are believed to arise early, before the age of seven, and in most cases are persistent throughout the child’s development (Mantzicopoulos & Morrison, 1994; Merrell & Tymms, 2001). Research indicates that difficulties with disinhibition and hyperactivity arise first (between three and four years of age) with inattention characteristics emerging later (between five and seven years of age), or by entry into formal schooling or middle elementary school grades if inattention is the primary difficulty in the individual (Merrell & Tymms, 2001).

Preschool children with ADHD are often disruptive, aggressive, and have difficulties being controlled and guided by pre-school personnel (Barkley, 1998; Mantzicopoulos & Morrison, 1994). These children often are talkative, vocal, interruptive, and active.
Entering elementary school, students with ADHD may not have appropriate levels of school readiness skills in academic areas such as pre-reading skills, simple mathematical concepts, and fine motor abilities (Barkley, 1998). The symptoms of ADHD make it difficult for children to sit still for a period of time, listen attentively, follow directions, stay on-task, complete assignments, be organized, interact appropriately with peers, and control impulsive behaviors (Association of American Pediatrics, 2001; Barkley, 1998). These symptoms may result in gaps in knowledge, difficulty finishing tasks, and poor grades, and lower than expected achievement scores, and intelligence scores (Barkley, 1998). If the child with ADHD has a co-occurring learning disability, it is not unusual for it to go unnoticed for some years, until academic tasks become more demanding (Barkley, 1998). Teachers and parents often find themselves monitoring, supervising, redirecting children with ADHD and assisting them with tasks.

In addition to the academic challenges children with ADHD may face, many are also disruptive, impulsive, and aggressive in school and playground settings, leading to conflict with peers, teachers, and other school staff. As a result, they are at risk for social rejection and isolation within the classroom and other settings (Ferguson & Horwood, 1995; Flanagan, Bierman, Kam, & Conduct Problems Prevention Research Group [CPPRG], 2003).

Entering adolescence, the academic outcomes of adolescents with ADHD vary greatly from those adolescents without the disorder. Low academic achievement, grade retentions, suspensions, and expulsions are more common in adolescents with ADHD. Approximately 29.3% of adolescents with ADHD fail a grade, 46.3% are suspended, 10.6% are expelled (Barkley, 1998), and 10% quit school (Barkley, Fischer, et al. 1991; as cited in Barkley, 1998). In addition to the impact of ADHD on the adolescent’s schooling,
adolescents with ADHD are more prone to be involved in automobile accidents, smoking, substance use and abuse, pregnancy, antisocial activities, and criminal behavior (Barkley, 1996; Ferguson & Horwood, 1995; Flanagan et al., 2003; National Institute of Mental Health, 1996).

As adults, individuals with ADHD on the average have a lower level of educational attainment and socio-economic status than non-ADHD adults (Ferguson & Horwood, 1995). They may experience work and marital difficulties as impulsivity, difficulty with organization, and lack of follow through affect their functioning in employment and home settings (Ferguson & Horwood, 1995).

In sum, the influence of ADHD on an individual’s life and education is pervasive. Children, adolescents, and adults with ADHD are at risk for a broad range of impairments that negatively impact every facet of their lives (Barkley, 1996).

Associated Problems

ADHD is frequently comorbid with other psychological disorders. Comorbidity refers to the co-occurrence of two or more conditions in the same individual (Hallahan & Kauffman, 2000).

ADHD is comorbid with a number of externalizing disorders, including oppositional defiant disorder (ODD), conduct disorder (CD), antisocial personality disorder (ASP), and Tourette’s syndrome at higher levels than expected by chance (Barkley, 1996). Approximately 35% to 60% of clinic-referred children diagnosed with ADHD will have concurrent ODD by 7 years of age or later (Barkley, 1996) and 30% to 50% of these children will eventually meet the diagnostic criteria for conduct disorder (CD) (Barkley, 1996). A small percentage of children with ADHD qualify for a diagnosis of antisocial personality
disorder (ASP) in adulthood (Barkley, 1996). Externalizing disorders are more likely to co-occur in children that have primarily hyperactive/impulsive and combination types of ADHD (American Academy of Pediatrics, 2001) rather than the primarily inattentive subtype.

In addition to externalizing disorders, ADHD co-occurs beyond levels expected by chance with several internalizing disorders such as anxiety and depression. Anxiety disorders affect about 25 to 40% of children with ADHD (Barkley, 1996). About 40 to 50% of individuals with ADHD will eventually develop a mood disorder (Barkley, 1996) and approximately 18% of children with ADHD suffer from depression (American Academy of Pediatrics, 2001). A familial risk for one disorder increases the chances of developing the other disorder. Coexisting mood disorders may put children at higher risk for committing suicide, particularly during adolescence. Internalizing disorders are more common among children with the inattentive and combined type of ADHD (Barkley, 1998).

It is not surprising that the symptoms of ADHD can often result in difficulties with educational endeavors, the learning process, and overall school performance (Frick et al., 1991; Mantzicopoulos & Morrison, 1994). Approximately two thirds of adolescents with ADHD fall behind in basic academic subjects due to the lack of practice needed to develop academic proficiency (Faraone, Biederman, & Kiely, 1996), with 19 to 26% diagnosed with at least one type of learning disability (Barkley, 1996). Of children with ADHD, approximately 8 – 45% are expected to have a reading disability, 12 – 30% a math disability, and 12 – 27% a spelling disorder (Barkley, 1998). Of particular interest in the present study is the relatively high rate of reading disabilities in children with ADHD. In the next section, the characteristics of reading disabilities are summarized.
Reading Disability

Reading is a critical skill whose mastery is key to academic success. Despite its importance, many children struggle to learn to read (American Federation of Teachers, 1999). When these difficulties are prolonged and significant, the child may meet the criteria for a reading disorder. The purpose of this section is to provide an overview of reading disabilities by describing the disorder’s prevalence, primary symptoms, developmental course, and associated problems.

**Prevalence**

Reading disability definitions vary and these variations affect estimates of the prevalence of reading disabilities in the general population. Under a stringent definition of RD, the prevalence ranges from 5% to 10% (American Psychiatric Association, 1994; Barkley, 1990). However, under more lenient diagnostic criteria, the prevalence rises to approximately 20% (Lyon, 1996).

The gender ratio, in addition to overall prevalence rate of RD, has also been the source of much debate. The male-to-female ratio also depends on the defining criteria of RD and the population studied. Male students are more likely to be referred to clinical facilities and be identified with a reading disability than females because of a higher incidence of co-occurring externalizing behaviors (Badian, 1999; Duane, 1991; Lyon, 1996; Schulte et al., 1999). Thus, although clinics may report a high male-to-female ratio, longitudinal and epidemiological studies indicate that there are no significant gender differences in reading disabilities (Badian, 1999; Duane, 1991; Lyon, 1996). In Shaywitz, Shaywitz, Fletcher, & Escobar (1990) epidemiological study of reading disability, for example, the male-to-female ratio was 1.2:1.
Primary Symptoms

Reading is often characterized as consisting of two primary skill areas, word recognition and reading comprehension. Word recognition skills include the use of knowledge of sound/symbol relationships to decode unknown words, and the ability to rapidly and effortlessly translate written words into their spoken equivalents (Moats, 1998). Reading comprehension refers to the ability to use prior knowledge and linguistic knowledge to decipher the message expressed in print (Moats, 1998).

A considerable body of research has indicated that the proximal cause of most reading problems is word identification and mastery of the sound-symbol relationships that underlie word identification (Torgesen & Wagner, 1998). In turn, poor word identification interferes with reading comprehension. As the child grows older, deficits appear in a wider range of areas of intellectual and academic functioning, because difficulty with reading leads to less exposure to advanced vocabulary, complex syntactic structures, and general information (Stanovich, 1986). The range of areas that difficulty with word identification affects accounts for the early difficulties identifying the core deficit in reading disability (Stanovich, 1986). Until recently, the presence of a wide range of deficits in older readers resulted in considerable debate about the primary deficits underlying poor reading (Fletcher et al., 1998; Torgesen & Wagner, 1998).

The difficulty in identifying words that is thought to underlie most cases of RD (Torgesen & Wagner, 1998) arises generally due to deficiencies in the ability to process the phonological features of oral and written language (Jenkins & Bowen, 1994; Purvis & Tannock, 2000; Torgesen & Wagner, 1998; Vellutino et al., 2004). These deficiencies include difficulty with phonological awareness, phonological short-term memory, and speed.
of access or rapid automatic naming (Torgesen & Wagner, 1998). A variety of studies (e.g., Purvis & Tannock, 2000; Torgesen & Wagner, 1998) suggest that phonological processing deficits are the core etiological factor for most reading disabilities (Lyon, 1996; Mody, 2003; Torgesen et al., 1999). The influence of phonological processing deficits in RD will be discussed in more detail in a later section.

Reading Disorder Diagnostic Criteria

Reading disabilities fall within the domain of both mental health professionals, because their presumed underlying cause is often a cognitive deficit, and educators, because the remediation of reading problems falls within the role definition of educators. Therefore, both groups provide diagnostic criteria for the diagnosis of reading disabilities (APA, 1994; United States Office of Education [USOE], 1997). In the past, diagnostic criteria developed within both professional groups have relied heavily on the notion of a discrepancy between expected achievement in reading, based on a child’s intellectual functioning, and actual achievement, for defining a reading disorder or disability (APA, 1994; Lyon et al., 2001; USOE, 1997). However, recent research has called this diagnostic criterion, an ability/achievement discrepancy in reading, into question. In this section, the current diagnostic criteria for diagnosing reading disorder contained in the DSM IV (APA, 1994) will be summarized. This section will be followed by a brief summary of the controversy surrounding the ability/achievement discrepancy contained in this and most other definitions of RD.

DSM-IV Reading Disability Diagnostic Criteria

Table 2 lists the specific criteria that must be evidenced for a diagnosis of Reading Disorder in the current diagnostic formulation, Diagnostic and Statistical Manual, 4th edition.
A diagnosis of RD (APA, 1994) requires that there is a substantial discrepancy between the student’s achievement in reading and the student’s ability given their age, measured intelligence, and age-appropriate education (APA, 1994). This condition requires the presence of below average reading ability, while having average or above average intelligence. Table Two provides more specific information on the DSM-IV diagnostic criteria for RD.

Table 2.

*Characteristics Used in the Diagnosis of Reading Disorder (American Psychiatric Association, 1994)*

I. Reading achievement, as assessed through individually administered standardized tests of reading, is considerably below that which would be expected given the individual’s age, intelligence, and age-appropriate education.

II. A difficulty in Criterion I has to significantly interfere with academic achievement and activities that demand reading skills

III. Reading deficits create additional difficulties if sensory deficits are already present.

*Controversies Surrounding the Discrepancy Criterion for RD*

General intelligence and language ability are both related to reading (Stanovich, 1986). As a result, most definitions of reading disability have required that the child evidence poor reading skills that could not be accounted for by low intelligence (Lyon, 1996). This requirement was intended to prevent overidentification of children with reading skills that were normal, but in the low range due to individual differences in intelligence. It was assumed that the cause of reading difficulties in children with average and above average intelligence differed from the cause of reading disability in the lower intelligence group.
However, research indicating that difficulties processing the phonological features of words underlie most children’s reading difficulties (Mody, 2003; Torgesen et al., 1999), have lead researchers and policy makers to question the validity of the discrepancy between ability and achievement as a diagnostic criterion for reading disability (Fletcher et al., 1998; Lyon et al., 1996; Torgesen & Wagner, 1998). Critics of the discrepancy criterion argue that: (a) the proximal cause of poor reading is the same in both groups (Fletcher et al., 1998), (b) lowered intelligence and language skills are largely the result of poor reading skills not the cause, and (c) when more domain-specific skills are used to predict reading skills, the association between intelligence and reading is diminished considerably, particularly in younger children (Fletcher, et al., 1998). As a result, many researchers (Lyon, 1996; Lyon et al., 2001) have suggested that in the early grades reading disability simply be defined by low reading achievement (e.g., reading achievement below the 25th percentile).

This rethinking of the diagnostic criterion for reading disability has important implications for understanding the relationship between ADHD and reading disability. First, it calls into question many existing studies of the comorbidity of ADHD and reading disability because these studies have often used an ability/achievement discrepancy criterion to define reading disability. Second, it complicates an understanding of how the two disorders are related, because lower intelligence is associated with both ADHD and reading problems. When using an ability/achievement discrepancy definition of reading disability in ADHD and reading disability comorbidity studies, the contribution of low intelligence to the overlap between the two disorders was at least partially eliminated because reading had to be lower than expected given a child’s level of intellectual functioning. Without controlling for intelligence, the expected overlap between ADHD and reading disability will be greater and
must be controlled for some other way rather than using a discrepancy definition of reading
disability. Third, the new understanding of the proximal cause of reading disability suggests
that exploring the relationship between ADHD and early phonological processing skills may
be a promising direction for ADHD and reading disability comorbidity research.

**Developmental Course of Reading Difficulties**

Reading difficulties tend to be persistent, typically following individuals through the
school-age years and into adulthood (Joseph, 2002). Although reading difficulties cannot be
diagnosed until children learn to read, early manifestations of possible future reading
difficulties may include delays in saying first words and/or first sentences, atypical speech
patterns, or difficulty comprehending speech (Duane, 1991). During the preschool years,
children with reading difficulties generally lag behind peers in letter naming and rhyming
ability (Duane, 1991).

During the preschool years and at school entry, children are expected to develop skills
fundamental to reading. These skills include phonemic awareness, or the knowledge that
words are made up of sounds, and an understanding of the alphabetic principle, the concept
that sounds are represented by letters and that letters make up words. Children who do not
develop these skills early on will struggle trying to decode words and will have difficulty
developing automaticity in reading. Without automaticity, children cannot develop accuracy
and fluency in reading which is closely tied to comprehension. Due to limited memory
storage, if children cannot read quickly and accurately, it is difficult for children to
understand the meaning of what they read (Stanovich, 1986).

During childhood, reading difficulties may interfere with overall cognitive
development (Badian, 1999; Lyon, 1996). Slowed growth in vocabulary and language due to
the lack of exposure to print may lead to further difficulties with reading and listening comprehension (Badian, 1999). The more difficult reading becomes, the less motivated and interested the children are in reading. School-age children that do not read fluently enough to appreciate and take pleasure in reading do not engage in independent reading (American Federation of Teachers, 1999). This, in turn, hinders the development of reading as well. In addition, difficulty reading can lead to difficulties in various academic domains (American Federation of Teachers, 1999). This cycle is known as the “Matthew effect” (Stanovich, 1986).

During adolescence, poor readers are nearly 25% more likely to drop out of school. Reading difficulties not only lead to persistent poor academic achievement, but also to a reduction in subsequent IQ and in language ability (McGee, Prior, Williams, Smart, & Sanson, 2002). In addition, facing academic hardships due to reading problems can also lead to low self-esteem, embarrassment, anxiety, and frustration.

In adulthood, individuals’ with reading difficulties are inefficient spellers and slow readers. Many evidence the same phonological decoding deficits that were present in childhood (Wood & Felton, 1994). Individuals struggling with reading will more than likely have difficulty finding a secure employment and attaining personal autonomy (American Federation of Teachers, 1999; McGee et al., 2002). Current estimates are that twenty percent of the adult population in the nation is functionally illiterate (reading below the fourth-grade level) and a larger proportion of the population do not have sufficient literacy skills to perform in the workplace (U.S. Office of Technology Assessment, 1993 as cited in Moats, 1998).
In sum, the effects of reading difficulties are long-lasting and are often triggered by poor phonological skills. The following section will present information on problems associated with reading difficulties.

Associated Problems

Reading disorders are often associated with other conditions, such as externalizing disorders, internalizing disorders, other learning disabilities and language disabilities (American Psychiatric Association, 1994).

Students with reading problems frequently evidence externalizing behaviors or disorders. The relationship between reading difficulties and externalizing conditions becomes more evident during the school years (Williams & McGee, 1996). It is believed that students with academic difficulties may try to compensate for feelings of inadequacy by being hostile, aggressive, and delinquent (Richek, Schudt, Caldwell, Holt Jennings, & Lerner, 2002; Williams & McGee, 1996). In addition to aggressive behaviors, reading disabilities often co-occur with attentional difficulties (Hinshaw, 1992). Children with reading disabilities are more likely to lose interest and motivation in reading and become inattentive or act out. The presence of reading difficulties and attentional disorders are common and often intertwined. This makes it difficult to establish the causal relationship between these two conditions (Hinshaw, 1992).

It is also not uncommon for individuals with reading difficulties to have internalizing problems such as a low self-esteem, to be socially isolated, anxious, depressed, and experience frustration (Hinshaw, 1992; Lyon, 1996; Richek et al., 2002). Children with reading disabilities are often perceived by their classmates as shy, help-seeking, and bullied (Williams & McGee, 1996).
Children with other learning disabilities (mathematics and written expression) often have a reading disability as well (American Psychiatric Association, 1994). In addition, many students with reading difficulties have underlying language difficulties in written language, expressive and receptive language, and speech problems (Richek et al., 2002).

Reading difficulties are associated with a variety of behavioral, social-emotional, and learning disorders. Many of these conditions are viewed as secondary or underlying factors of RD. Having a better understanding of how these conditions evolve concurrently is important. The following section will focus on the co-occurrence of attentional difficulties and reading difficulties and its causal pathways.

Attention Deficit Hyperactivity Disorder and Reading Disability: Comorbidity and Causal Pathways

Using a somewhat liberal prevalence rate of 10% per disorder, the expected overlap between ADHD and reading disability by chance alone would be 1% (calculated by multiplying the probabilities of each disorder occurring independently together). However, even the most conservative estimates of comorbidity are several times this figure (8% to 45%) (Faraone et al., 1996; Purvis & Tannock, 2000; Schulte, et al., 1999; Semrud-Clikeman et al., 1992, as cited in Aaron et al., 2002; Lyon, 1996, as cited in Moats, 1998). This section will discuss ADHD and RD comorbidity rates reported in the literature and research relevant to the possible causal pathways between the two disorders. Much of this summary will draw from Hinshaw’s (1992) seminal review of the relationship between externalizing and learning disorders.
Factors Important in Investigating Comorbidity

Before discussing comorbidity estimates, a number of methodological issues that affect findings related to comorbidity will be discussed. These issues are important in understanding why ADHD/RD comorbidity rates differ markedly, but also are important in evaluating the conclusions that can be drawn from research studies about the likely pathways between the two disorders.

Epidemiological Versus Clinical Samples

Comorbidity estimates generally draw from two different types of samples, epidemiological and clinical. In epidemiological studies, a sample is drawn from the population at large (e.g., all children in a specified geographic area). In clinical studies, children who have been identified with a particular disorder, often at a university clinic or in a school system, are assessed to determine whether they also can be diagnosed with a second disorder. Comorbidity estimates based on the two different types of samples often differ greatly. In general, estimates based on clinical samples are much higher because children who exhibit two disorders are much more likely to be brought into clinics or referred for school services. Estimates based on epidemiological samples are more likely to represent the true rate of overlap between two disorders (Hinshaw, 1992).

Population Considered

Comorbidity rates between two disorders differ depending on what clinical population is of interest. For example, the prevalence of bipolar disorders in children with ADHD is relatively low (6-20%), but the prevalence of ADHD in children with bipolar disorder is quite high (98%, Mash & Barkley 1998). Studies tend to analyze overlaps among disorders in one specific direction and the overlap of disorder “x” with disorder “y” may be
greater than the overlap of disorder “y” with disorder “x”. Thus, it is important to know the
direction of the relationship on which a prevalence estimate is based. In the case of the
overlap between ADHD and reading disability, findings generally indicate that the
prevalence of a reading disability in children with ADHD, for example, is higher than the
prevalence of ADHD in children with a reading disability (Shaywitz et al., 1994).

Measures Used

Inattention and hyperactivity/impulsivity can be measured by behavioral
observations, task performance, or information gathered from teacher and/or parental rating
scales. The type of instrument used, the psychometric characteristics of the instrument, and
the informant if rating scales are used, can affect the accuracy of the results. Similarly, the
measures used to assess a child’s reading ability will affect the accuracy of the evaluation as
well.

Stringency of Cut Offs

ADHD and reading disability are thought to be the extremes of traits that are
normally distributed (Fergusson & Horwood, 1992). Therefore, for each particular disorder,
the choice of where to set the cut-off score that defines the disorder is somewhat arbitrary.
For example, some researchers have classified all children scoring below the 25th percentile
as reading disabled (Fletcher et al., 1998) while others have classified all children scoring
below the 10th percentile (Shaywitz et al., 1992, as cited in Beitchman & Young, 1997).
Likewise, definitions of ADHD for prevalence studies often employ behavior rating scales
and set cut-offs scores of 1.5 or 2 standard deviations above the mean on ratings of
Inattention and Hyperactivity as the means for classifying children as ADHD.
The stringency of the criteria for defining each disorder will affect the prevalence of the disorder. This, in turn, will affect the extent of overlap between the two disorders. For example, two disorders with prevalence rates of 25% will have an expected overlap considerably higher than the expected overlap of two disorders with 10% prevalence (6.25% versus 1%). Therefore, in examining comorbidity prevalence rates, the base rate of each disorder in a particular study must be considered.

Variations in Diagnostic Criteria.

As reflected in summaries of the diagnostic criteria for ADHD and reading disability presented earlier, the criteria used to diagnose each disorder have shifted over time. In addition, researchers have varied in the precision with which they have measured each domain, as well as the instruments that have been used.

For example, in assessing ADHD and its overlap with reading disability, some studies have categorized children as having ADHD, without making distinctions among children with predominantly attention difficulties, children with predominantly hyperactive/impulsive difficulties, or children with both (e.g., McGee, et al., 1986; Palfrey, Levine, Walker, Sullivan, 1985; Richman, Stevenson, & Graham, 1982). Other studies have been even less precise (e.g., Kellam, Branch, Agrawal, & Ensminger, 1975), grouping together defiance, impulsivity, hyperactivity, inattention, disruptiveness, aggression, and antisocial behaviors, labeling them as undercontrolled or externalizing behaviors, and reporting overlap between externalizing behaviors and reading disability (Hinshaw, 1992). As noted earlier, the more inclusive the criteria, the higher the overlap expected by chance alone, a fact that may explain some of the higher comorbidity rates reported in the literature (Schulte et al., 1999). In addition, several researchers have suggested that reading disability has a stronger relation
with inattention than with hyperactivity (Lonigan, et al., 1999; McGee, et al, 1985; Rabiner, et al., 2000). Thus, it would be important to classify children by ADHD subtypes when evaluating comorbidity rates.

In terms of variations in the diagnostic criteria for reading, comorbidity studies have varied on two important dimensions: (a) whether a low achievement or ability/achievement discrepancy definition of reading disability was used, and (b) how reading was measured. With regard to use of a low achievement or an ability/achievement discrepancy, use of an ability/achievement discrepancy in the diagnostic criteria for reading disability is used in order to exclude students with reading difficulties related to low intelligence. Given that lower intelligence is related to both ADHD and reading disability, the choice between these two definitions of reading disability affects comorbidity estimates. This issue will be discussed more extensively in the next section.

In terms of how reading is measured, as noted earlier, there is evidence that problems with word identification due to poor underlying phonological processing skills may be the core deficit in reading disability (Mody, 2003; Torgesen et al., 1999) and that readers with problems in both word identification and comprehension may be different than readers with only poor comprehension (Stanovich, 1986). Although most researchers have used measures of reading that did not assess word identification and reading comprehension skills separately (Rabiner et al. 2000; Rowe & Rowe, 1992), there is some evidence that these two subskills may be differentially related to ADHD (Shaywitz et al., 1994).

**Intelligence**

Students with ADHD score, on the average, approximately seven to fifteen points below their peers without ADHD (Barkley, 1998). Reading skill is correlated with
intelligence (Stanovich, 1986). Thus, without controlling for intelligence, the association between ADHD and reading disability may be due to the relationship of both disorders to intelligence. When using an ability/achievement discrepancy definition of reading disability, the relationship of both disorders to intelligence is controlled for. Thus, when ability/achievement discrepancy definitions of reading disability are used, comorbidity estimates are lower. If low achievement definitions of reading disability are used, another means of controlling for intelligence must be employed or comorbidity estimates will be higher.

Comorbidity Estimates

The previous sections have detailed the many factors that affect RD/ADHD comorbidity estimates. As one group of researchers pointed out, there are so many possible factors on which studies can vary that no two studies have employed the same methodology (Fletcher et al., 1998) in calculating RD/ADHD comorbidity rates. This variability may explain the wide range of comorbidity rates found in the literature. As noted earlier typical comorbidity estimates range from 8% to 45% (Faraone et al., 1996; Lyon, 1996, as cited in Moats, 1998; Purvis & Tannock, 2000; Schulte et al., 1999; Semrud-Clikeman et al., 1992, as cited in Aaron et al., 2002), but some researchers here reported comorbidity estimates up to 92% (Silver, 1980; as cited in Conte, 1998).

Given that clinical samples overestimate the true rate of comorbidity, in this section only epidemiological studies will be reviewed. Furthermore, only studies that separated attentional problems from other externalizing problems will be considered.

When these two criteria are applied, comorbidity estimates are available from only two studies, the Dunedin Multidisciplinary Child Development Study, conducted in New
Zealand (Anderson, Williams, McGee, and Silva, 1989; McGee et al., 1984), and the Connecticut Longitudinal Study (Shaywitz, et al., 1994; Shaywitz et al., 1988; Shaywitz & Shaywitz, 1990). Results from these studies are presented in Table 3.

McGee et al. (1984) reported on the overlap between ADHD and reading disability in children included in the Dunedin Multidisciplinary Child Development Study. This sample consisted of 792 children who entered the study at 3 years of age and were monitored every other year until they reached adolescence. Children were assessed using the Wechsler Intelligence Scale for Children- Revised (WISC-R, 1974), a measure of word identification, and the Rutter Child Scale A for parents and B for teachers, as well as other measures. The Rutter scales listed a variety of problems and the respondent rated how much each statement applied to the child in question. The hyperactivity measure on the parent and teacher scales consisted of items measuring restlessness, squirminess, and poor concentration/difficulty settling. Using cut-off scores from the Rutter Child Scale for teachers, 8.6% of the children were classified as ADHD, and 9.6% were classified as reading disabled. The authors reported that 28.6% of children with ADHD had RD. The prevalence of ADHD in the reading disabled group was not reported. In another publication reporting on the same sample at 11 years of age, Anderson et al. (1989) reported that 3.8% of the children were classified as ADHD and 62% of these children were reading two years below their peers. Although different definitions of RD were used in the two publications, one an IQ/achievement discrepancy and one a non-IQ discrepant low achievement definition, the results suggest that the rate of RD in children with ADHD is more than that expected by chance regardless of the definitional criteria used. The increase in comorbidity from the
McGee, Williams, and Silva (1984) publication to the Anderson et al. (1989) publication may be due to age or the different definitions of reading disability.

In another epidemiologic study, the Connecticut Longitudinal Study, a sample of 445 kindergarten children was followed longitudinally into adulthood. In elementary, children were classified as reading disabled if they had a significant discrepancy between intelligence and reading achievement or a reading standard score below 90 (Shaywitz et al., 1994; Shaywitz et al., 1988). Inattention and activity (mostly hyperactive/impulsive behaviors), along with other behaviors, were measured by teacher ratings on the Multigrade Inventory for Teachers (MIT). The researchers found a 7% prevalence of inattention and a 17.5% prevalence of RD in the sample in the early elementary grades (grade was not stated, but the sample appeared to be in second and third grade). Approximately 36.4% of children with inattention were also classified as RD and 15% of children classified as RD were also inattentive. Rates of overlap among the disorders, similar to those in the Dunedin Study were more than what would be predicted by chance alone.

The RD/ADHD comorbidity rates from the Dunedin Study and the Connecticut Longitudinal Study are based on different ways of defining reading disability and ADHD. However, the findings from the studies suggest that the overlap between reading disability and attention disorders is higher than would occur by chance alone. It also appears that the prevalence of ADHD in the RD population is greater than expected, yet less than the rate of RD in the ADHD population. Also, although ADHD and reading disabilities are associated with lower intelligence, even after controlling for intelligence, the association between RD and ADHD remains.
<table>
<thead>
<tr>
<th>Reference</th>
<th>Type</th>
<th>Age</th>
<th>Population Considered</th>
<th>ADHD Dx Criteria</th>
<th>RD Dx Criteria</th>
<th>Intelligence controlled?</th>
<th>Base Rates</th>
<th>Comorbidity Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dunedin Study (McGee et al., 1984)</td>
<td>Epidemiologic</td>
<td>7 years of age</td>
<td>RD in ADHD</td>
<td>Teacher &amp; parent ratings of attention and hyperactivity (not separated)</td>
<td>PIQ/word identification discrepancy</td>
<td>Yes</td>
<td>ADHD: 8.6%</td>
<td>28.6% RD in ADHD rate</td>
</tr>
<tr>
<td>Dunedin Study (Anderson et al., 1989)</td>
<td>Epidemiologic</td>
<td>11 years of age</td>
<td>RD in ADHD</td>
<td>Teacher &amp; parent ratings of attention &amp; hyperactivity (not separated)</td>
<td>Word identification 2 yrs behind peers</td>
<td>No</td>
<td>ADHD: 3.8%</td>
<td>62% RD in ADHD rate</td>
</tr>
<tr>
<td>Connecticut Longitudinal Study (Shaywitz et al., 1994; Shaywitz et al., 1988; Shaywitz et al., 1990)</td>
<td>Epidemiologic</td>
<td>Unspecified</td>
<td>RD in ADHD &amp; ADHD in RD</td>
<td>Teacher ratings of attention &amp; hyperactivity</td>
<td>FSIQ/WJ-Reading cluster discrepancy and low reading achievement</td>
<td>No</td>
<td>ADHD: 7%</td>
<td>36.5% RD in ADHD rate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>RD: 17.5%</td>
<td>15% ADHD in RD rate</td>
</tr>
</tbody>
</table>
The variability in ADHD and RD comorbidity rates found in the studies described above, as well as those found in studies using clinic samples points to the need for precise description of samples and measures, and further research in this area. Furthermore, the results from the Dunedin sample (Anderson, et al., 1989; McGee et al., 1984) indicate that the extent of overlap between the two disorders is likely to vary with age, suggesting that longitudinal studies of the overlap between ADHD and RD are important and might provide more understanding of what contributes to the overlap between the disorders.

In the next two sections four hypothetical causal models for the association between ADHD and RD are summarized. The subsequent section briefly describes results from longitudinal studies that have examined the relationship between ADHD and RD across the early school years.

**Causal Models**

In discussing the relationship between attention disorders and reading difficulties, Hinshaw (1992) presented four hypothetical causal pathways that might explain the association between the two disorders: (a) reading difficulties lead to attention disorders, (b) attention disorders lead to reading difficulties, (c) reading difficulties and attention disorders lead to each other (bidirectional model), and (d) a third variable (or set of variables) may result in difficulties with reading and attention. These four models are briefly described below.

With regard to the first model, that reading difficulties lead to attention disorders, some researchers have suggested that children with RD may become inattentive and overactive when they are unable to function successfully in school (McGee et al., 1986; McGee & Share, 1988). Such an explanation would require that reading difficulties be
present before attentional problems develop. If attention disorders are present at the same
time that a RD is diagnosed, then it is uncertain which disorder emerged first and causality
cannot be established.

Other researchers (Fergusson & Horwood, 1992; Segalowitz, Wagner, & Menna, 1992, as cited in Schulte et al., 1999) have suggested that the symptoms associated with attentional disorders limit the opportunities and practice required for students to become good readers. This second model requires that attention disorders predict subsequent reading difficulties, and that early attention problems be unrelated to poor readiness skills (Hinshaw, 1992).

With the third model, both disorders are thought to influence each other simultaneously. That is, attention disorders increase the difficulty in a child’s acquisition of reading skills, and poor reading skills increase a child’s difficulty attending, primarily in a school setting. This possibility has been suggested by Rowe and Rowe (1992). In this case, children showing either disorder early in their school careers would be at risk for developing the second disorder, and the overlap between domains would increase with age (Rowe & Rowe, 1992).

Finally, a fourth model is that a factor or set of factors, gives rise to both attention and reading disorders. The underlying factors could be intraindividual, such as temperament, intelligence, and language difficulties, or environmental, such as large family size and problematic homes. Because the third variable(s) needs to precede the relationship, both attention disorders and reading difficulties would be expected to become evident early in a child’s school career (Hinshaw, 1992).
Although there is some evidence supporting each of these four causal models (Schulte et al., 1999), in a comprehensive review of the research related to the relationship between externalizing disorders and academic underachievement, Hinshaw (1992) reported that studies consistently found that attention and reading difficulties overlapped early in a child’s schooling. He suggested that longitudinal studies examining children’s behavior and skills before reading instruction begins, and then following the children as they progressed through school, were key to understanding how the relationship between the two disorders arises. In addition, he stressed the need for such longitudinal studies to assess antecedent variables that might contribute to the association between the ADHD and academic difficulties. Among the antecedent variables suggested by Hinshaw were parental involvement, IQ, verbal ability, and neurodevelopmental delay.

In his review, Hinshaw (1992) presented a number of longitudinal studies that examined the link between externalizing disorders and academic difficulties, with a primary focus on reading. Although Hinshaw concluded that the link between externalizing disorders and poor reading was most often specific to inattention and hyperactivity (versus other externalizing disorders), only a small number of the studies he reviewed looked specifically at this relationship. The next section summarizes longitudinal studies examining early reading and its relationship with ADHD or problems with inattention and hyperactivity.

*Longitudinal Studies*

As noted in an earlier section, even the seemingly simple task of assessing the extent to which ADHD and RD co-occur presents a number of complex methodological issues. Not surprisingly, assessing how the two disorders develop and interrelate over time presents even more challenges. Again, the criteria used to define each disorder, whether inattention and
hyperactivity are assessed separately or together, and the extent to which the disorders’ association can be explained by each one’s association with lower cognitive ability emerge as important methodological issues. Complicating longitudinal studies of how the two disorders develop and interrelate is the fact that possible antecedents of the two disorders are also related to the development of intelligence, such as parental involvement and language skills (Hinshaw, 1992). As such, controlling for IQ in studies, without first assessing and controlling for possible antecedents may mask pathways between the environmental conditions and the development of the two disorders, because these environmental conditions also result in lowered general cognitive ability or deficient language skills.

The next two subsections summarize several longitudinal studies that assessed children before exposure to formal reading instruction and also assessed reading and inattention/hyperactivity. The first subsection describes studies that Hinshaw (1992) included in his review. This subsection is followed by a summary and discussion of studies published after his review.

*Studies Included in Hinshaw’s (1992) Review*

Hinshaw (1992) summarized many longitudinal studies concerned with externalizing disorders and achievement (primarily reading achievement). However, only two of these studies separated hyperactivity and inattention from other externalizing disorders and distinguished between reading disabilities identified on the basis of low achievement (non-IQ discrepant poor readers) and on the basis of reading achievement lower than expected based on one’s intellectual functioning (IQ discrepant poor readers). Both were large scale studies, one conducted in Australia (Jorm, Share, Maclean et al., 1986; Jorm, Share, Matthews et al., 1986) and one in New Zealand (McGee et al., 1986).
In the first of these studies to be described, Jorm and his colleagues followed a large sample of Australian children from kindergarten through second grade (Jorm, Share, Maclean et al., 1986; Jorm, Share, Matthews et al., 1986) assessing their language, behavior, and academic skills. At the end of second grade, 453 children were administered nonverbal intelligence and reading tests. On the basis of these second grade results, Jorm, Share, Matthews et al. (1986) classified 39 of the students as reading disabled. Of these, 25 were classified as RD on the basis of reading that was lower than expected given their nonverbal IQ (IQ discrepant poor readers), and 14 were classified as poor readers with reading achievement commensurate with their nonverbal IQ (non-IQ discrepant poor readers).

The behavioral characteristics of both RD groups, compared to those of non-reading impaired children, were then examined in kindergarten, first, and second grade. (Jorm, Share, Matthews et al., 1986). The authors found that the non-IQ discrepant poor readers showed behavior problems at school entry and in the first grade. IQ discrepant poor readers did not display these early behavior problems. The authors employed teacher rating scales that were broad-based (e.g., assessed behaviors related to a number of externalizing and internalizing disorders) and not designed to allow reliable assessment of the specific domains of hyperactivity and inattention separate from other types of behavior problems. However, when individual items and small combinations of items from the ratings scales were examined, it appeared upon school entry that children who would eventually be classified as non-IQ discrepant poor readers showed problems with both inattention and hyperactivity. Children who would eventually be classified as IQ discrepant readers did not.

In a related publication, Jorm, Share, Maclean et al. (1986) examined how the three groups of readers they created on the basis of children’s second grade reading status differed
on these tests of cognitive skills administered in kindergarten. Non-IQ discrepant readers scored lower than both non-reading impaired children and IQ-discrepant readers on tests assessing general language development (syntax, vocabulary, sentence memory) and other areas of development or general knowledge exposure (motor skills, ability to write and read own name). Both groups of poor readers differed from non-reading impaired children on measures that assessed children’s skills in areas that were more specific to reading (knowledge of letter names and sounds, phoneme segmentation, recognition and discrimination of letters).

Jorm, Share, Matthews et al. (1986) suggested that for non-IQ discrepant poor readers, attention problems predated children’s difficulty in reading, and that both poor reading and difficulties attending in class were related to a third variable. Given that IQ-discrepant poor readers did not have attentional difficulties, it appeared that the relationship between attention problems and reading difficulties might be explained by lower overall cognitive functioning or some variable related to poor performance on cognitive tests (e.g., disadvantaged background, poor language development). A notable aspect of this study is the finding that both groups who would eventually be classified as poor readers showed weak phonological skills prior to reading instruction. This finding predates the recent research in the RD touched upon earlier that strongly suggests that a specific weakness in processing the phonological aspects of language is an important precursor of reading disability (Torgesen & Wagner, 1998).

A second study, McGee et al. (1986), examined the overlap of hyperactivity/attentional problems and reading disorders in boys who were participating in the Dunedin Multidisciplinary Health and Development Study (mentioned earlier in relation
to prevalence rates). In this study, a sample of New Zealand children was followed from 3 to 11 years of age. McGee et al. divided the boys in the original sample of children into three groups: (a) those with IQ discrepant reading disabilities at both 9 years of age and 11 (n= 18), (b) those with non-IQ discrepant reading disabilities at both 9 years of age and 11 years of age (n= 22), and (c) all remaining boys (n = 436). The IQ discrepant poor readers had lower than expected scores on a word recognition test given their Performance IQ. The non-IQ discrepant poor readers scored two years below what would be expected based on their age on the same test of word recognition, but did not have scores that were discrepant from their Performance IQ. All remaining boys were placed in the non-reading impaired group.

The behavioral characteristics of both groups of poor readers were compared to those of non-impaired readers from 5 to 11 years of age using parent and teacher scales that assessed hyperactivity/inattention, aggressiveness, and worry-fearfulness. The parent and teacher scales consisted of 31 and 26 items, respectively, that grouped a variety of behavior problems into the three previously mentioned domains. At age 5, ratings of overall behavior problems by parents did not differ significantly among the three groups. However, at age 7, the IQ discrepant poor readers were more aggressive when compared to the non-IQ discrepant poor readers and the remaining boys. At age 9 and 11, no significant differences were found among the groups after controlling for behavior problems exhibited at previous ages. Thus, the results from the parent scales suggest that parents saw no differences among the three groups in terms of hyperactivity and inattention, but saw more aggression in IQ-discrepant poor readers that appeared after school entry. The aggression did not appear to worsen after 7 years of age.
Contrary to the results from parents, the teachers rated both the IQ discrepant poor readers and the non-IQ discrepant poor readers as exhibiting more aggression and hyperactivity/inattention at 5 years of age compared to the non-reading impaired boys. After controlling for teacher ratings at age 5, aggressiveness did not increase with age, but hyperactivity/inattention increased at both 7 and 9 years of age. A closer look at the data indicated that the hyperactivity/inattention increased for non-IQ discrepant poor readers between 5 and 7 years of age, while for the IQ discrepant poor readers hyperactivity/inattention increased between 7 and 9 years of age. Thus, in comparison to the rest of the sample, the non-IQ discrepant poor readers had a relative increase in hyperactivity/inattention between the ages of 5 and 7, while the IQ discrepant poor readers showed a similar increase between 7 and 9.

McGee et al. (1986) also examined the relationship between family adversity (e.g., low socioeconomic status, large family size, parental separation, single parent household, low mental ability, poor maternal mental health, reports of marriage counseling) and later reading ability. Results indicated that there was a significant relationship between reading difficulties and family adversity; yet controlling for family adversity did not affect the association between reading and behavior problems.

McGee et al. (1986) suggested that although parent and teacher ratings reported different things, both reported the presence of behavior problems in reading impaired children. Although parents did not report the presence of behavior problems at school entry, teachers reported that non-IQ discrepant reading impaired children as well as IQ-discrepant reading impaired children demonstrated symptoms of aggression as well as hyperactivity/inattention. This hyperactivity/inattention worsened over time, but at different
ages depending on the type of reading impairment (non-IQ discrepant or IQ discrepant).
However, the scales used to assess behavior did not measure the hyperactive or inattentive behaviors individually and sample size was very small.

Taken together, these two studies illustrate the methodological complexity of studying how ADHD and RD develop and how their relationship changes over time, and how difficult it is to find consistent patterns across studies. First, both studies used a categorical approach to defining ADHD and RD (although their definitions were not exact matches with the clinical definitions in use today). This approach resulted in only a small number of students from each sample identified as RD, even though both studies began with large samples. These small sample sizes decreased each study’s power to detect relationships and increased the chances that sampling error could account for some of the findings. Second, the Jorm study (Jorm, Share, Maclean et al., 1986; Jorm, Share, Matthews et al., 1986) used a small number of items to assess hyperactivity and inattention, although these two dimensions of ADHD were assessed separately. The McGee et al. (1986) study used more items, but did not separate out inattention and hyperactivity. The smaller number of items in the Jorm study is likely to have lowered the sensitivity of the study to detect early inattention and hyperactivity. The failure to separate the two dimensions in the McGee et al. study limits the ability of the study to find differences by dimension. Third, McGee et al.’s findings differed by whether the informant was the child’s teacher or parent, suggesting that who the informant is may influence results from studies.

Both Jorm (Jorm, Share, Maclean et al., 1986; Jorm, Share, Matthews et al., 1986) and McGee et al. (1986) found that teachers interacting with non-IQ discrepant poor readers before they began formal reading instruction rated these students as higher in
inattention/hyperactivity than non-disabled peers. However, teachers in the McGee et al. (1986) study also rated IQ discrepant poor readers higher in inattention and hyperactivity. The different findings between the two studies relative to IQ-discrepant poor readers may be due to a failure to find attention difficulties in the Jorm study because of the small number of participants or the small number of items used to assess inattention and hyperactivity. Jorm found that language problems predated reading problems, with the specificity of the language problems depending on whether the IQ discrepant or non-IQ discrepant group was considered. McGee et al. did not assess this likely precursor of reading problems. McGee et al. found that not only did children who eventually developed reading problems enter school more hyperactive and inattentive, but they also became more hyperactive and inattentive as they progressed through school.

As noted, the two studies summarized above were the only ones in Hinshaw’s (1992) review that assessed children before first grade and separated inattention/hyperactivity from other externalizing disorders. However, two other longitudinal studies cited by Hinshaw had findings that are relevant to assessing causal models for ADHD/RD comorbidity. Specifically, Richman (1982) assessed children from 3 years of age to 11 years of age and found that poor early language development and overall behavior problems were both related to later non-IQ discrepant reading problems, but did not predict IQ-discrepant reading problems. Richman’s (1982) finding again suggests that some or all of the observed overlap between ADHD and RD can be explained by both disorders’ association with low IQ. However, low cognitive ability was associated with poor language development at age three, suggesting the possibility that language difficulties may predate and perhaps account for the general cognitive deficits.
In another study from Hinshaw (1992), Palfrey et al. (1985) assessed children starting at birth until kindergarten and then again in second grade. Information on the children’s behavior, motor development, cognitive development, social-emotional adjustment, physical health, and neurological health was collected. Among the assessments was a general measure of hyperactivity/impulsivity/inattention that was comprised of items assessing poor concentration, distractibility, disorganization, impulsivity, and overactivity. Palfrey et al. (1985) grouped children into 4 different categories: (a) children that did not demonstrate any hyperactivity/impulsivity/attention problems, (b) children who had early hyperactivity/impulsivity/attention problems that persisted into kindergarten, (c) children who had early hyperactivity/impulsivity/attention problems that abated before kindergarten, and (d) children who did not demonstrate hyperactivity/impulsivity/attention problems early on, but developed them by kindergarten. In second grade, information on the child’s reading level, mathematics and reading achievement, hyperactivity/impulsivity/attention, academic competence, and behavior were collected.

Palfrey et al.’s (1985) results indicated that children who showed evidence of hyperactivity/impulsivity/attention problems at any point in time, contrary to children who did not have hyperactivity/impulsivity/attention problems, were more likely to have a lower general cognitive ability and lower verbal skills at 42 months of age and at kindergarten. In addition, children who had persistent hyperactivity/impulsivity/attention problems or whose hyperactivity/impulsivity/attention problems were evidenced in kindergarten demonstrated lower cognitive development and social emotional problems. In addition, children’s persistent hyperactivity/impulsivity/inattention was also associated with low reading levels, low mathematic achievement, as well as poor work skills, low overall competency, and a
higher tendency to receive special services in school in second grade. An analysis of the children’s home environment suggested that persistent hyperactivity/impulsivity/attention difficulties were associated with low maternal education, developmental lags, single parent households, signs of affective disturbance, and other maladaptive conditions.

Palfrey et al.’s findings again suggest that lower cognitive ability explains a major portion of the relationship between ADHD and RD, although home environment or poor language skills also appear to be possible precursors of lower cognitive ability and both disorders.

Current Longitudinal Studies

The studies reviewed by Hinshaw (1992) all suggest that the difficulties with inattention and hyperactivity predate children’s reading problems, although children who eventually develop reading disabilities also show lower cognitive ability, language and prereading skills prior to learning to read. Since Hinshaw’s review, several additional longitudinal studies have been published that provide additional information about early relationships between reading and behaviors related to ADHD. These studies will be briefly summarized in this section.

The most relevant research to this study presented here is the work by Rabiner et al. (2000) because many of the problems present in earlier longitudinal work were addressed in the Rabiner study. The authors controlled for IQ, assessed both reading and inattention/hyperactivity as continuous dimensions, assessed inattention and hyperactivity separately, and assessed parental involvement as a possible third variable accounting for the relationship between inattention/hyperactivity and reading. They also controlled for internalizing and externalizing problems other than inattention/hyperactivity.
In this study, Rabiner et al. (2000) examined the predictive relationship between early attention/hyperactivity problems and reading achievement by following 387 children from kindergarten through second grade, with a final assessment in fifth grade (211 of the 387 were represented in the last assessment point). In kindergarten, inattention was assessed using the inattention items and overactivity items from Achenbach’s (1991) Teacher Report Form. In first and second grade, both inattention and hyperactivity were assessed with the two scales measuring these dimensions from the ADHD Rating Scale (DuPaul et al., 1998). Teachers rated parents’ involvement in their children’s education in first and second grade.

All children were administered a shortened measure of intelligence in kindergarten and a measure of reading achievement in kindergarten, first and fifth grade. The reading achievement measures assessed letter-word identification in kindergarten, first, and fifth grade, and reading comprehension and letter-word identification in the fifth grade.

Rabiner et al. (2000) found that intelligence predicted reading achievement at each grade. Even after controlling for intelligence and other predictors, inattention was consistently related to reading achievement. Hyperactivity had a weaker and less consistent relationship with reading. Using path analysis, the authors found that inattention at each grade predicted inattention in subsequent grades, and kindergarten IQ and reading achievement in each grade predicted reading achievement in subsequent grades. Most relevant to the question of the pathways between ADHD and reading problems, kindergarten inattention predicted kindergarten reading achievement (ability to identify letters and simple words) independent of IQ. First grade inattentiveness was related to kindergarten reading achievement, suggesting that exiting kindergarten with low reading readiness skills was related to increased inattention in first grade. First grade inattentiveness was related to first
grade reading achievement. Fifth grade reading achievement was related to second grade inattention. The authors did not find that first grade reading was related to second grade inattentiveness. Parental involvement was not related to achievement, and inconsistently related to inattention, perhaps because of low power due to the way parental involvement was measured.

Rabiner et al. (2000) argued that the finding that attention problems predicted children’s reading achievement after controlling for IQ, prior reading achievement, and parental involvement suggested that inattention had an adverse and “often substantial” (p. 865) impact on reading achievement. There was some indication that poor reading skills increased inattention, but this effect was smaller than the impact of inattention on reading. Rabiner et al. noted that an independent assessment of language functioning as a control variable would have been desirable in the study, because of the relationship of language problems to ADHD and academic underachievement.

The findings of two other recent longitudinal studies provide additional data about the relationship of inattention/hyperactivity to reading. Velting and Whitehurst (1997) used structural equation modeling to look at the relationship of hyperactivity to prereading and reading skills in a low income sample attending Head Start preschools. Prereading skills were measured in preschool and kindergarten and reading skills in first grade. The authors found no relationship between inattention/hyperactivity and prereading skills in Headstart or kindergarten, but did find a relatively weak path between inattention/hyperactivity in first grade. However, the authors did not separate out inattention and hyperactivity and the majority of the items on their measure of inattention/hyperactivity, Conners’ (1969) Hyperactivity Index, were related to hyperactivity. Thus, the failure to find a link between
prereading skills in preschool and kindergarten could be explained by the Rabiner’s finding that it is inattention that is most strongly related to developing reading skills. One interesting point made by Velting and Whitehurst was that the failure to find a link between inattention/hyperactivity and prereading skills might have been explained by the lack of academic focus in Headstart programs and the kindergartens sampled in the study. If prereading skills are not taught in preschool and kindergarten, classroom inattention could not interfere with their acquisition. A strength of the Velting and Whitehurst study is that they assessed specific prereading skills including phonological processing and concepts of print. However, these areas were combined when testing their model of the relationship between inattention/hyperactivity and attention.

Finally, a recently published longitudinal study examined how family factors thought to be important in achievement were related to inattention. This NICHD Early Child Care Research Network (2003) study followed 1,002 children from birth until 54 months of age, when they were initially assessed, and then assessed for follow up comparisons in first grade. A variety of measures were administered in order to gain information on family environment, cognition, achievement, language, and social development, as well as attention and impulsivity.

Although reading was not assessed separate from other academic areas, and inattention and impulsivity were measured with a sustained attention task rather than by teacher ratings, this study is notable for its inclusion of measures of cognition and language, family variables, and its test of whether inattention mediates the relationship of family factors to achievement. Sustained attention and impulsivity partially mediated the relationship of family factors to achievement, and also mediated the relationship between family
environment and language. The impact of family factors on cognition (vocabulary, short-term memory, and auditory processing) was not mediated by sustained attention or impulsivity.

The three recent longitudinal studies presented in this section help put some of the findings from longitudinal studies included in Hinshaw’s (1992) review into context. Rabiner et al.’s (2000) study supports the earlier finding that inattention, rather than hyperactivity/impulsivity, is most consistently related to early reading skills. Both Rabiner et al.’s findings and those from the NICHD Early Child Care Network (2003) study suggest that even after controlling for IQ and language, inattention has an adverse impact on early reading skills and later achievement. The NICHD study also suggests that although inattention and impulsivity are related to family background factors, inattention operates directly on acquisition of prereading and reading skills. All of these studies treated attention and reading skills as continuous variables rather than studying groups with clinical diagnoses. This strategy is preferable to the studying clinical groups because it allows detection of early relationships, before either disorder has emerged and provides better power to detect effects. The Velting and Whitehurst study (1997) suggests that the relationship of inattention to reading is most likely to be found when formal instruction in reading begins, a possibility also discussed by others (Mantzicopoulos & Morrison, 1994). This suggests that inattention operates to influence reading achievement by interfering with children’s ability to benefit from instruction. However, for inattention to interfere with the acquisition of reading or prereading skills, children must be in situations where they are exposed to reading instruction.
Big Ideas in Beginning Reading

The previous section summarized research regarding the pathways that might link reading disabilities and attention disorders. Overall, the research indicates that reading and attention difficulties are likely to co-occur early in a child’s school career; that low language and cognitive skills may explain part, but not all of the relationship between attention and reading, and that the strongest pathway between the two disorders may be that inattention may interfere with acquisition of children’s prereading and reading skills.

In the past decade, a better understanding of the skills underlying early reading has emerged (National Reading Panel, 2000). For many years, reading researchers had not been successful in separating out causal and correlational variables associated with reading success and failure. However, longitudinal and intervention studies now have provided strong evidence that difficulty with phonological processing is a major impediment to children’s acquisition of reading (Torgesen, 2000; Wood & Felton, 1994). This finding has lead to a clearer articulation of the key skill areas in beginning reading. This new understanding of beginning reading has implications for examining pathways between reading and attention disorders because few studies have examined inattention and hyperactivity and their relationship to the specific early reading skills that have been directly linked to reading disabilities (Torgesen & Wagner, 1998). Because this new understanding of the key components of early reading forms the basis of the present study, this final section of the literature review will summarize key findings about early reading.

Specifically, five skill areas important to early reading will be briefly described. These areas were delineated by the Institute for the Development of Educational Achievement (IDEA, 2002-2003) and were based on findings of several studies including a
broad review of scientific evidence related to reading development (National Reading Panel [NRP], 2000). The NRP was a panel formed in response to a 1997 Congressional request to evaluate the available research-based knowledge in the area of reading, its process, and effective teaching strategies. The NRP concluded that certain skills and knowledge were essential components of reading and should be a part of early reading instruction: phonemic awareness, an understanding of the alphabetic principle (phonics), accuracy and fluency in word identification, vocabulary, and comprehension (IDEA, 2002-2003; NRP, 2000; Whitehurst & Lonigan, 1998). These skills are components of emergent literacy that develop during the preschool years and are related to subsequent reading achievement (Lyon et al., 1996; Whitehurst & Lonigan, 1998).

Phonemic Awareness

Phonemic awareness refers to an awareness of and ability to manipulate the sounds in words and the understanding that words and syllables are composed of sequences of phonemes (IDEA, 2002-2003; Juel & Leavell, 1988; NRP, 2000). Examples of phonemic awareness skills include the ability to group words with similar and dissimilar phonemes (e.g., “run” and “ran” start with similar phonemes or sounds, yet the two words start with a different sound than “mat”), hear the individual sounds of the word “run” (e.g., hear the sounds of /r/ /u/ /n/), segment a word as a sequence of phonemes (e.g., segment “run” into three different phonemes /r/ /u/ /n/), blend the sounds (e.g., /rrruuuunnnn/) into a word, and detect and manipulate phonemes or speech sounds within words (e.g., changing /r/ for /b/ in “run” results in the word “bun”).

Phonemic awareness is essential in matching speech to print and reading in an alphabetic writing system. Awareness of phonemes is a strong predictor of children’s early
success in reading (Juel & Leavell, 1988; NRP, 2000), and as Lyon (1995; as cited in IDEA, 2002-2003) has stated, the difficulty with phonemic awareness is the best predictor of reading difficulty in kindergarten and first grade. Phonemic awareness is important in the development of reading because it is the first step in children recognizing that letters represent sounds (alphabetic principle), which sets the stage for understanding the concept of print and reading (NRP, 2000). Phonemic awareness gives children some insight into sounding out words and reading new words. Thus, it is a skill fundamental to the development of future skills required to eventually develop reading. Phonemic awareness plays a causal role in the acquisition of pre-reading skills (IDEA, 2002-2003; Juel & Leavell, 1988; NRP, 2000).

Alphabetic Principle

In general, the alphabetic principle refers to the fact that sounds are linked to letters and that these sounds or phonemes are used to form words (Foorman, Francis, Fletcher, Schatschneider, & Mehta, 1998). Examples of knowledge and skills involving alphabetic principle are: knowledge that words are composed of letters, recognition that letters have a corresponding phoneme, ability to decipher a word according to the sequence of letter-sound correspondences (e.g., the word “run” is made up of the sounds /r/ /u/ /n/ that are represented by the letters “r” “u” “n”), ability to blend letter-sound correspondences to decode words, ability to identify and manipulate letter-sound correspondences, and capacity to read nonsense words accurately (e.g., “tup”).

Knowledge of the letter-sound correspondence is necessary in order to achieve word identification (NRP, 2000). Students who have a good grasp of the alphabetic principle at an early age appear to benefit from this skill by being able to effectively phonologically decode
and recode words (Foorman et al., 1998; Stanovich, 1986). It is essential that children have
the opportunity to practice phonologically decoding words in order to become accustomed to
different sound patterns and in order to learn to recognize words (IDEA, 2002-2003).
Foorman et al. (1998) and Bus and Van IJzendoorn (1999) indicate that instruction in both
phonological awareness and letter-sound correspondence appears to facilitate early reading.

Accuracy and Fluency

Fluency refers to the ability of readers to read words with little “cognitive or mental
effort” (Moats, 1998). In order for fluency or automaticity to occur, children have to master
word recognition skills and overlearn words (Moats, 1998). Once this is achieved, the
effortless ability to read frees mental resources in order to find meaning in the words
(Stanovich, 1986). Thus, the process of reading and comprehending material is based on the
reader’s ability to read quickly and accurately.

Children who have achieved fluency can recognize letter-sound associations quickly
and accurately, can identify common spelling patterns to increase effective decoding, can
apply a large amount of resources to blend phonemes and decode words, and can apply the
alphabetic principle to identify words either in isolation or connected text (NRP, 2000).
Developing accuracy and fluency in reading is important because children who are successful
readers have to learn to rely on the letters in the word and letter-sound associations to
identify words instead of using context or pictures. Once automaticity is established, freed
mental resources can aid in comprehending text (Stanovich, 1986).

Vocabulary

Vocabulary is defined by the capacity to understand and use words to obtain (receive)
and communicate (express) information (NRP, 2000). Beginning readers not only should
develop phonemic awareness, understand letter-sound association, and identify words quickly and accurately, but should also acquire an extensive and useful vocabulary. There are two types of vocabulary: expressive vocabulary, which requires an individual to generate a specific word for a particular meaning, and receptive vocabulary, which requires an individual to link a specific meaning with a given word (IDEA, 2002-2003).

In the early grades vocabulary is important because it helps children gain meaning from words and text and provides children with a way to produce or express a concept. In addition, children who enter school with a limited vocabulary, over time, show more discrepancy in reading than children who enter school with a rich vocabulary (Baker, Simmons, & Kame’enui, 1997; as cited in IDEA, 2002-2003). Thus, it is important for beginning readers to develop and extend their vocabulary. Developing vocabulary as well as enhancing the components of reading described above set the stage for reading comprehension.

**Comprehension**

Comprehension, as defined by IDEA (2002-2003), refers to the complex cognitive process involved in abstracting meaning from text. Comprehension is the ultimate goal of reading and requires the active interaction between the reader and the text (Durkin, 1973; as cited in IDEA, 2002-2003). The reader’s grasp of phonemic awareness, alphabetic principle, accuracy and fluency, and vocabulary, as well as prior knowledge contribute to the comprehension of the text. Children that are good decoders, can recognize words easily, have rich vocabulary, and can read quickly and accurately are better readers (NRP, 2000). The five big ideas of reading work together in a cyclic fashion.
As mentioned earlier, the most common cause for reading disabilities is a weakness in the ability to process phonological aspects of language (Mody, 2003; Torgesen et al., 1999). Children who lack phonological awareness or fail to understand or apply the alphabetic principle are at high risk for developing a reading disability because their difficulties reduce their opportunities to pair spoken and written words, impairing the development of automaticity in word recognition. Direct instruction in phonological awareness and the alphabetic principle reduces the risk of children developing a reading disability (Lyon et al., 2001).

This improved understanding of the roots of reading disability in difficulty hearing and manipulating the sounds in words (phonemic processing), and linking those sounds with written letters and words (the alphabetic principle) allows more refined research questions to be posed about the relationship between children’s prereading skills and classroom behaviors symptomatic of ADHD. Previous studies of the early links between ADHD and RD have typically assessed a mix of reading readiness tasks, rather than focused on the specific precursors of RD (Lonigan et al., 1999; Mantzicopoulos and Morrison, 1994; Velting and Whitehurst, 1997). However, the weight of evidence supporting the importance of phonemic processing and understanding of the alphabetic principle as key precursors of RD suggest that studies of RD/ADHD links should examine these skills specifically.
CHAPTER THREE: RESEARCH AIMS

Statement of the Problem

Based on the review of the literature, it is evident that ADHD and RD frequently co-occur. However, estimates of their comorbidity vary greatly from study to study (Hinshaw, 1992; Schulte et al., 1999). The wide range in comorbidity estimates is due partly to variations in methodology across studies, such as the type of sample (epidemiologic or clinical), the population considered, the measures used, the stringency of cut-offs, the variations in diagnostic criteria of RD and ADHD, and whether or not IQ was controlled when the relationship between the two disorders was examined.

The higher than expected overlap between these two domains can be explained by four possible models: (a) RD leads to the development of ADHD, (b) ADHD leads to the development of RD, (c) both disorders predispose children to develop the other disorder, and (d) a third variable is related to the development of both disorders. Although there is evidence that supports each of these models (Hinshaw, 1992; Schulte et al., 1999), several studies have found evidence that attention and reading difficulties co-occur in early schooling (Jorm, Share, Maclean et al., 1986; Jorm, Share, Matthews et al., 1986; Kellam et al., 1975; Lonigan et al. 1999; McGee et al., 1986; NICHD Early Child Care Research Network, 2003; Palfrey et al., 1985; Rabiner et al., 2000; Richman et al., 1982). This consistent finding suggests that a third variable may account for the development of both ADHD and RD, or that both disorders lead to each other. In order to gain a better understanding of how ADHD and RD co-occur, it is important to look at the relationship between these two domains in early childhood, before formal reading instruction begins.
Existing research does not provide a detailed picture of how the behavioral symptoms specific to the current diagnostic formulation of ADHD relate to specific prereading skills in young children. The majority of extant research does not separate the inattention and hyperactivity/impulsivity dimensions of ADHD, nor make distinctions among the specific early reading skills when investigating the relationship between the two disorders. By having a finer grained examination on how symptoms of inattention and hyperactivity/impulsivity overlap with early reading skills in young children, researchers may develop a more precise model of how these two domains are interrelated and why. In addition, researchers and practitioners may be able to identify and intervene early with children who are at-risk for developing reading difficulties or ADHD in later school years.

A major goal of the present study was to examine whether ADHD symptoms and early reading skills co-vary before formal reading instruction begins. A significant feature of the study was that the specific dimensions of ADHD, inattention and hyperactivity/impulsivity, were evaluated separately, as were two basic pre-reading skills that research (e.g., Torgesen, 1999) has suggested are key in the development of reading disabilities (phonemic awareness and mastery of the alphabetic principle). It was predicted that higher teacher ratings of behaviors associated with ADHD would be associated with poorer phonemic processing and skill in using the alphabetic principle to decode written text into its spoken equivalent. In addition, it was predicted that inattention would be more strongly related to early literacy skills than hyperactivity. The following research questions and hypotheses were proposed.
Research Questions and Hypotheses

Question 1. Are Teacher Ratings of Classroom Behavior Symptomatic of ADHD Related to Early Literacy Skills?

Hypothesis 1. Teachers’ ratings of children’s inattention in the classroom will be negatively related to children’s phonemic awareness skills.

Hypothesis 2. Teachers’ ratings of children’s hyperactivity/impulsivity in the classroom will be negatively related to children’s phonemic awareness skills.

Hypothesis 3. Teachers’ ratings of children’s inattention in the classroom will be negatively related to children’s mastery of the alphabetic principle.

Hypothesis 4. Teachers’ ratings of children’s hyperactivity/impulsivity in the classroom will be negatively related to children’s mastery of the alphabetic principle.

These hypotheses are supported by research addressing the relationship between behavior problems and early reading skills. Several studies have found that behaviors associated with ADHD during early schooling and elementary years are negatively related to the acquisition of reading skills (e.g., Jorm, Share, Matthews et al., 1986; Kellam et al., 1975; McGee et al., 1986; NICHD Early Child Care Research Network, 2003; Richman et al., 1982). Although few studies have investigated the overlap between the two domains before children learn to read, there is evidence suggesting that they are linked at an early age (Lonigan et al., 1999).
Question 2. When Controlling for Verbal Ability, are Teacher Ratings of Children’s Classroom Behavior Symptomatic of ADHD Related to Children’s Early Literacy Skills?

Hypothesis 5. When controlling for verbal ability, teacher ratings of children’s inattention in the classroom will be negatively related to children’s phonemic awareness skills.

Hypothesis 6. When controlling for verbal ability, teachers’ ratings of children’s hyperactivity/impulsivity in the classroom will be negatively related to children’s phonemic awareness skills.

Hypothesis 7. When controlling for verbal ability, teachers’ ratings of children’s inattention in the classroom will be negatively related to children’s mastery of the alphabetic principle.

Hypothesis 8. When controlling for verbal ability, teachers’ ratings of children’s hyperactivity/impulsivity in the classroom will be negatively related to children’s mastery of the alphabetic principle.

Vocabulary has been found to be one of the best predictors of verbal ability and overall cognitive ability (Bornstein & Hayes, 1998; as cited in Brownell, 2000). Cognitive ability, in particular verbal ability, has been found to be negatively associated with both ADHD and RD, such that RD and ADHD comorbidity may be at least partially explained by both disorders’ association with limited cognitive or verbal ability.

Thus, in order to have a true understanding of how inattention and hyperactivity/impulsivity are related to components of early reading, it essential to control for cognitive ability. After controlling for cognitive ability, previous research (McGee et al., 1986; Richman et al., 1982) still suggests that ADHD and RD co-occur, although the relationship is likely to be less robust.
Question 3. Are Symptoms of Inattention and Hyperactivity/Impulsivity Differentially Related to Early Literacy Skills?

Hypothesis 9. Teachers’ ratings of children’s inattention in the classroom will account for a significant and unique portion of the shared variance between ADHD symptoms and children’s phonemic awareness, over and above the variance accounted for by teachers’ ratings of children hyperactivity.

Hypothesis 10. Teachers’ ratings of children’s inattention in the classroom will account for a significant and unique portion of the shared variance between ADHD symptoms and children’s mastery of the alphabetic principle, over and above the variance accounted for by teachers’ ratings of children hyperactivity.

Support for these hypotheses comes from studies of children in early school years, as well studies with older children. Rabiner et al. (2000) studied a sample of children from kindergarten to fifth grade and found that attention problems predicted reading achievement even after controlling for prior reading achievement, IQ, and behavior problems, while hyperactivity did not. Gaub and Carlson (1977) and Merrell and Tymms (2001) further support this disparate relationship between the two dimensions of ADHD and reading difficulties.

The findings from this study will contribute to a better understanding of the overlap between ADHD and RD. If early reading skills and ADHD symptoms overlap this could lend support to models of comorbidity between RD and ADHD that focus on third variables or the impact of ADHD on acquisition of early cognitive skills that further affect the acquisition of reading skills in later grades. If inattention is more strongly related to reading problems than hyperactivity/impulsivity and subsequent research shows this relationship is
causal, then the findings from the present study suggest that interventions to prevent reading difficulties in children with ADHD should focus on inattention.
CHAPTER FOUR: METHOD

The present study investigated the relationship between inattention and hyperactivity/impulsivity and prereading skills in kindergarten children. Extant data from a longitudinal study conducted to examine the relationship between ADHD and RD throughout early school years were used.

Participants

Parental permission to complete measures of early reading skills, vocabulary, and inattention and hyperactivity/impulsivity as part of a longitudinal study was requested for all children in a total of five kindergarten classrooms located in four elementary schools in a single school district in North Carolina. All four schools were magnet schools, located in areas with high minority populations. Each school had specialized programs designed to draw suburban families to the urban schools, as part of the district’s strategy for maintaining ethnic and socioeconomic balance across schools.

Parental permissions were granted for a total of 74 kindergarten children in the five classrooms, with classroom participation rates ranging from 50 to 91%. The children’s mean age was 69 months (standard deviation 4.1) when calculated in December.

Table 4 provides the demographic characteristics of the sample.
## Table 4

### Demographic Characteristics of the Sample

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>41</td>
<td>55.4</td>
</tr>
<tr>
<td>Male</td>
<td>33</td>
<td>44.6</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>49</td>
<td>66.2</td>
</tr>
<tr>
<td>African American</td>
<td>18</td>
<td>24.3</td>
</tr>
<tr>
<td>Asian</td>
<td>3</td>
<td>4.1</td>
</tr>
<tr>
<td>Other/Mixed ethnicity</td>
<td>4</td>
<td>5.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>74</td>
<td></td>
</tr>
</tbody>
</table>

**Materials**

*Dynamic Indicators of Basic Early Literacy Skills (DIBELS)*

The DIBELS (Good & Kaminski, 2002) is an individually administered measure used to assess a student’s emergent literacy skills or pre-reading skills. The DIBELS subtests were originally designed as extensions of curriculum based measurement (CBM) reading probes (Elliot, Lee, & Tollefson, 2001). CBM probes are brief (one to five minute) assessments of basic skills that are sensitive to small changes in a student’s skill level. They can be used to assess student skill mastery in order to plan instruction, monitor academic progress, or make classification and placement decisions (Good & Kaminski, 2002).

The DIBELS subtests used in the present study were the Phoneme Segmentation Fluency (PSF) and the Nonsense Word Fluency (NWF) subtests. These subtests assess three specific early reading skills: phonemic awareness, knowledge of the alphabetic principle, and
accuracy and fluency in decoding. These emergent literacy skills have been identified as essential components of early reading (Moats, 2003) and are strong predictors of children’s acquisition of reading in early grades (Elliot, Lee, & Tollefson, 2001; Kaminski & Good, 1996; VenDerHeyden, Witt, Naquin, & Noell, 2001). Multiple forms of each subtest are available and the measures are typically administered two to three times during kindergarten. Each of the subtests is described below.

**DIBELS Phonemic Segmentation Fluency (PSF)**

The DIBELS PSF assesses one aspect of phonological awareness, the examinee’s ability to segment words into their separate phonemes. For this subtest, the examiner reads a word with three or four phonemes and asks the student to segment the word into the individual phonemes. For example, the examiner may say, “pat,” and the examinee should respond with the sounds “/p/ /a/ /t/.” Several words are presented to the examinee.

To score this subtest, the examiner counts the total number of correct phonemes provided by the examinee in one minute. The DIBELS PSF subtest takes between one and two minutes to administer.

There are 20 multiple alternate forms of DIBELS PSF. Alternate-form reliability in May of kindergarten was .79 (Good, Kaminski, & Smith, 2002).

Various studies provide information on the validity of this subtest. Concurrent validity of DIBELS PSF with the Readiness Cluster of the Woodcock-Johnson Psycho-Educational Battery-Revised (WJ-R; 1989) in spring of kindergarten was .54 (Good et al., 2002), and .60 with the Stanford Diagnostic Reading Test (Elliot et al., 2001). Hintze, Ryan, and Stoner’s (2003) study indicated that the DIBELS PSF correlated moderately with the Comprehensive Test of Phonological Processing (CTOPP) subtests assessing phonological
awareness, such as Elision (.47), Blending Words (.63), Sound Matching (.25), and the Phonological Awareness Composite (.53). In addition, in a predictive validity study, the DIBELS PSF, administered in spring of kindergarten, correlated .68 with WJ-R Total Reading Cluster Score (1989) and .62 with the DIBELS oral reading fluency subtest, when these measures were administered in spring of first grade (Good et al., 2002).

**DIBELS Nonsense Word Fluency (NWF)**

The DIBELS NWF is a measure of children’s mastery and fluency in using the alphabetic principle to translate written letters into sounds. It taps into a student’s ability to understand sound-symbol associations and blend letters into words (Good & Kaminski, 2002). To administer this subtest, the examiner presents to the student a list of VC (a word pattern in which a vowel is followed by consonant) and CVC (a word pattern in which a consonant is followed by a vowel and a consonant) nonsense words (e.g. “ol” or “taj”). The examinee has one minute to pronounce as many words or sound-symbol associations as possible.

To score this subtest, the examiner tallies the total number of sound-symbol associations the examinee produces correctly within the one minute time frame. The administration of this subtest usually takes approximately two minutes.

DIBELS NWF has 20 alternate forms. As stated in (Good & Kaminski, 2002) the alternate-form reliability for DIBELS NWF in January of first grade was .83. The concurrent validity of the DIBELS NWF with the Readiness Cluster of the WJ-R (1989) for kindergartners tested in January was .36, and .59 for first-graders tested in February (Good et al., 2003; as cited in Good et al., 2002). Good, Wallin, Simmons, Kameenui, & Kaminski (2002) reported that the DIBELS NWF, administered in January of first grade, correlated .82
with the DIBELS oral reading fluency subtest administered in May of first grade. They also reported that the NWF subtest correlated .60 with the DIBELS oral reading fluency subtest administered in May of second grade and .66 with the WJ-R Total Reading Cluster score (1989).

These two kindergarten DIBELS measures provide valuable information on examinees’ emergent literacy skills (Moats, 2003). Overall, the studies on the DIBELS provide adequate evidence for the reliability and validity of the two DIBELS measures.

**ADHD Rating Scale- IV: School Version**

The ADHD Rating Scale-IV: School Version (ADHD-SV, DuPaul et al., 1998) is an 18-item behavior questionnaire that measures teacher’s ratings of developmentally inappropriate levels of inattention and impulsivity/hyperactivity in children. This scale is based on the DSM-IV’s diagnostic criteria for ADHD and items on this scale match the symptoms listed in the diagnostic criteria. The instrument has two subscales and produces three scores: Inattention, Hyperactivity-Impulsivity, and Total Scale Score.

When completing the scale, teachers are asked to provide demographic information on the child they are rating and to indicate the frequency they have observed of each ADHD symptom listed in the target child over the previous 6 months. Frequency is described on a 4-point Likert scale: “never or rarely,” “sometimes,” “often,” or “very often.”

Scoring the ADHD-SV consists of calculating the Inattention subscale raw score by adding the scores on the odd-numbered items, and calculating the Hyperactive-Impulsive subscale raw score by adding the even-numbered items. A Total Scale raw score is obtained by summing the Inattention and Hyperactivity-Impulsivity raw scores. These raw scores can
be converted into percentile scores using norm tables supplied in the test manual based on a national sample of approximately 2,000 children between the ages of 4 to 20.

Studies of the psychometric properties of the ADHD-SV are summarized in the test manual (DuPaul et al., 1998). The authors reported internal consistency reliabilities of .96 for Inattention, .88 for Hyperactivity-Impulsivity, and .94 for Total score. Test-retest reliability coefficient, from ratings obtained 4 weeks apart, were .89 for Inattention, .88 for Hyperactivity-Impulsivity, and .90 for Total score.

Information on the concurrent validity of the ADHD-SV subscales in relation to other measures of behaviors symptomatic of ADHD is also reported in the test manual (DuPaul et al, 1998). The ADHD-SV Inattention subscale correlated with the Conners Teacher Rating Scale (CTRS) Daydream-Attention subscale (.85), the CTRS Hyperactivity subscale (.73), and CTRS Hyperactivity Index (.76). The ADHD-SV Hyperactivity-Impulsivity subscale correlated with the CTRS Hyperactivity subscale (.79), and the CTRS Hyperactivity-Index (.76). Weaker correlations were found between the ADHD-SV Hyperactivity-Impulsivity scores and behaviors related to ADHD observed in the classroom, such as daydreaming-attention, anxiety-passiveness, and time off-task and fidgeting. In terms of discriminant validity, the items on the Inattention scale on the ADHD-SV were more highly related to other measures of inattention than those of hyperactivity. Similarly, the items on the Hyperactivity-Impulsivity subscale were more highly correlated with other measures of hyperactivity than of inattention.

The manual also reported the results of exploratory and confirmatory factor analyses used to assess the structure of the ADHD-SV (DuPaul et al., 1998). The factor analyses supported the existence of two factors representing the two dimensions of ADHD,
hyperactivity and inattention. These factors were correlated at a moderately high level (.70), suggesting the two factors are closely related.

Overall, the psychometric characteristics of the ADHD-SV reported in the manual were adequate. The internal consistency and test-reliability were high. In addition, the ADHD subscale scores had significant correlations with other measures frequently used when evaluating the presence of ADHD in children. Teacher ratings on this scale were able to distinguish between different subtypes of ADHD (Inattention and Combined) and could moderately predict the diagnosis of ADHD in both clinical and school settings (DuPaul et al., 1998).

Expressive One-Word Picture Vocabulary Test (EOWPVT)

The EOWPVT (Brownell, 2000) provides a measure of an individual’s English speaking vocabulary. Individuals are asked to name objects, actions, and concepts pictured in illustrations using a set of 170 colored illustrations that depict words of increasing difficulty. This measure is individually administered and designed for individuals between the ages of 2 years, 0 months and 18 years, 11 months.

The EOWPVT administration usually takes about 10 to 15 minutes. The administration consists of showing an individual pictures and asking them to provide the word that names each picture or the objects in a picture. Responses are then recorded. Prior to administering the test, the administrator must calculate the child’s chronological age in order to identify the item number at which testing should begin. The individual’s score is determined by establishing a basal of eight consecutive correct responses and a ceiling of six consecutive incorrect responses.
Scoring the EOWPVT usually takes about 5 minutes and consists of calculating the number of correct responses up to the last item in the ceiling. In addition, all items below the basal are considered correct. These raw scores can be converted to standard scores, percentile ranks, and age equivalents.

The EOWPVT’s psychometric properties were obtained from the test manual (Brownell, 2000). The internal consistency reliabilities, based on the correlation between scores on odd-numbered and even-numbered items, range from .96 to .99 according to age group. Test-retest reliability, assessed over approximately 20 days, ranges from .88 to .97. Inter-rater reliability calculated across the dimensions of scoring, response evaluation, and administration, ranged from 93 to 100 percent.

The concurrent validity of the EOWPVT with several other vocabulary tests employing expressive and receptive task formats (such as Expressive Vocabulary Test; Peabody Picture Vocabulary Test-Revised; Test of Language Development, Primary-Third Edition: Picture Vocabulary, Relational Vocabulary, Oral Vocabulary; WISC-III; California Achievement Test- Fifth Edition) ranged from .67 to .90.

Overall, the EOWPVT has acceptable psychometric properties. The EOWPVT has a uniform content, is stable over time, and can be used consistently by different examiners. In addition the EOWPVT’s test items are a good measure of expressive vocabulary and correlate highly with other measures assessing the same domain.

Procedure

Prior to the beginning of the assessments, all examiners were trained on the DIBELS subtests. Examiners were required to meet the all the test administration criteria contained in
competency checklists provided for each subtest in the DIBELS manual (Good & Kaminski, 2003).

After obtaining informed parental consent, faculty and graduate students who were part of the project individually tested kindergartners in sessions lasting from 10 to 30 minutes, at three different times during the academic year. In the first testing wave, which took place in December, students completed two DIBELS subtests (that were not a focus of the present study), as well as the EOWPVT and a brief rapid naming task (also not a focus of the present study). The tests were administered in one or two sessions depending on the child’s attention span and speed of responding. The second wave of assessment, which took place in late March and early April, consisted of four DIBELS subtests, the two subtests of interest in the present study (PST and NWF) and two additional subtests. The third wave of testing, which took place in May, consisted of same four DIBELS subtests administered in the second assessment wave.

A small number of students (n = 13) whose parents had returned the permissions slips after the first wave of assessment or had been absent during the assessment wave were administered the EOWPVT and rapid naming task during the second wave assessment. One child who had been absent during the initial testing completed the EOWPVT in May.

In December, kindergarten teachers were given a folder with ADHD-SV response forms and a second teacher rating scale (not a focus of this study) for each child in their class who was participating in the study. Teachers completed the rating scales and notified project staff when their ratings had been completed.
CHAPTER FIVE: RESULTS

This chapter presents the data analysis procedures and results for the research questions and hypotheses discussed in Chapter 3. Data analysis was carried out in two stages. First, descriptive statistics such as means, standard deviations, analyses of variance and correlations were computed to obtain general information about the variables included in the analyses and to determine if the data obtained were appropriate for the statistical analyses planned. Second, the analyses to address the primary hypotheses were conducted. The procedures and results of these two stages of data analysis are described below.

Results of Descriptive Analyses

Score Distributions and Outliers

To examine the extent to which each variable was normally distributed, basic descriptive statistics and graphic depictions of the score distributions for each variable were generated and then reviewed, using the procedures outlined in Tabachnick and Fidell (1996). Table 5 provides the mean, standard deviation, obtained range, possible range, skewness, and kurtosis for each variable. Normal quantile plots, and expected and detrended normal probability plots of each variable were also generated and examined.

Review of the descriptive statistics and graphs indicated that the distributions for two of the five variables for the primary analyses displayed satisfactory approximations of the normal distribution and had no outliers. These variables were the EOWVT (Vocabulary) and the PSF.

The distribution for the NWF scores was slightly positively skewed. However, the normal quantile plot indicated that the majority of the data points stayed within the confidence interval for a normal distribution. Therefore, no transformations of NWF were
considered. The distribution for the NWF had three outliers, defined as data points falling more than 1.5 interquartile range units from the closest value in the interquartile range for the variable (Sall, Lehman, & Creighton, 2001). In this case, these three points were 1.5 interquartile range units above the next closest value, indicating that three students were much faster decoders of nonsense words than the remainder of the students. Deleting these scores because of their extreme values was considered. However, Tabachnick and Fidell (1996) stated that when outliers are a part of the expected distribution for a variable, caution should be used in deleting them. Therefore, the scores were included with a rationale that it is not unusual for some children in kindergarten to have mastered the alphabetic principle so well that they are rapid and fluid decoders of CVC nonsense words.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum Score</th>
<th>Maximum Score</th>
<th>Possible Range</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocabulary</td>
<td>105.7</td>
<td>18.5</td>
<td>67</td>
<td>145</td>
<td>55-145</td>
<td>0.36</td>
<td>-0.28</td>
</tr>
<tr>
<td>PSF</td>
<td>37.0</td>
<td>12.3</td>
<td>7</td>
<td>59</td>
<td>0-**</td>
<td>-0.54</td>
<td>-0.38</td>
</tr>
<tr>
<td>NWF</td>
<td>50.6</td>
<td>28.8</td>
<td>5</td>
<td>133</td>
<td>0-145</td>
<td>1.03*</td>
<td>0.85</td>
</tr>
<tr>
<td>Inattention (raw score)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>7.2</td>
<td>6.8</td>
<td>0</td>
<td>27</td>
<td>0-27</td>
<td>0.69</td>
<td>0.11</td>
</tr>
<tr>
<td>Female</td>
<td>4.8</td>
<td>5.6</td>
<td>0</td>
<td>27</td>
<td>0-27</td>
<td>1.87*</td>
<td>5.80*</td>
</tr>
<tr>
<td>All</td>
<td>6.4</td>
<td>6.4</td>
<td>0</td>
<td>27</td>
<td>0-27</td>
<td>1.13*</td>
<td>1.40</td>
</tr>
<tr>
<td>Hyperactivity/Impulsivity (raw score)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>5.2</td>
<td>7.3</td>
<td>0</td>
<td>27</td>
<td>0-27</td>
<td>1.71*</td>
<td>2.03</td>
</tr>
<tr>
<td>Female</td>
<td>3.8</td>
<td>5.8</td>
<td>0</td>
<td>27</td>
<td>0-27</td>
<td>2.41*</td>
<td>6.81*</td>
</tr>
<tr>
<td>All</td>
<td>4.5</td>
<td>6.6</td>
<td>0</td>
<td>27</td>
<td>0-27</td>
<td>1.97*</td>
<td>3.43*</td>
</tr>
<tr>
<td>Inattention (z-score)</td>
<td>-1.16</td>
<td>3.96</td>
<td></td>
<td></td>
<td></td>
<td>1.26*</td>
<td>2.68*</td>
</tr>
<tr>
<td>Hyperactivity/Impulsivity (z-score)</td>
<td>-0.72</td>
<td>4.00</td>
<td></td>
<td></td>
<td></td>
<td>2.02*</td>
<td>4.00*</td>
</tr>
</tbody>
</table>

* Statistically significant at $p < .001$.  
** No ceiling on this measure.
The distributions for the raw scores on the Inattention and Hyperactivity/Impulsivity subscales of the ADHD Rating Scales also deviated markedly from the normal distribution. Both distributions were very negatively skewed, with a large number of scores falling in the range of 0 to 10, indicating that many children displayed few or no hyperactive/impulsive or inattentive behaviors. In retrospect, this result was not surprising, given that the both scales assess symptoms of a disorder that is displayed in less than 10% of the population. The kurtosis value for the Hyperactivity/Impulsivity scale was significant as well. The distributions of both the Inattention and the Hyperactivity/Impulsivity scores each had two outliers indicating students who had much higher levels of Inattention and Hyperactivity/Impulsivity than other students. These scores were included in the data set because the primary interest of the study was the relationship between symptoms of ADHD and early literacy skills. Therefore, including extreme data points suggestive of the presence of ADHD symptoms was viewed as crucial to this study.

Although logarithmic transformation of the ADHD variables was considered in an effort to make the scores more closely approximate a normal distribution prior to conducting the primary analyses, this strategy was ultimately rejected. Variable transformations did not markedly change the observed correlations between variables or the significance tests for the correlation values. The scores could not be satisfactorily transformed because the primary problem was that the instrument was insensitive to differences among children in inattention and hyperactivity/impulsivity when those differences were within normal limits on these dimensions. With so many scores falling in such a narrow range at the lower end of each of the scales, there was no way to use a mathematical transformation to force the data into a more normal distribution.
An additional problem with these two scales was that it is common to find gender differences in symptoms of hyperactivity/inattention and impulsivity, and for that reason most scales use gender-based norms. Although gender-based norms are available for the ADHD Rating Scale, they are only provided as percentile ranks, which are ordinal scores. Therefore, to adjust children’s scores for expected gender differences in teachers’ ratings of these behaviors, the raw scores were transformed to gender-based z scores for analysis, using the mean and standard deviation by gender for the present sample. These transformed scores are also presented in Table 5.

**Demographic Differences**

If demographic differences in the sample were systematically related to the primary variables of interest, then failing to include them in the planned regression analysis could result in variance in the criterion being attributed to the predictors rather than these demographic variables. For example, if girls have strong early literacy skills and are less hyperactive, then one explanation for a significant relationship between hyperactivity and early literacy skills might be that boys are more likely to have reading problems and be overactive. To explore the need for control variables in the planned analyses, one-way analyses of variance were used to test for differences by gender, classroom, and ethnicity in each of the primary variables. A criterion alpha level of .10 was set for these preliminary analyses to assure that differences would be detected if they were present.

The results indicated a mean difference by gender for one primary variable, PSF \[F(1,71) = 3.68, p <.10\]. Significant mean differences by classroom were found in four variables, NWF \[F(4,68) = 3.37, p <.10\] , Inattention \[F(4,69) = 2.28, p <.10\] , Hyperactivity/Impulsivity \[F(4,69) = 3.33, p <.10\] , and Vocabulary \[F(4,68) = 2.24, p
To examine mean differences in the primary variables by ethnic group, the sample was divided into three groups; white, black, and other. Given that the “other” group was small (n=9), ethnic differences were examined by comparing black and white students only. Mean differences by ethnicity were found in the five variables, PSF \([F(1,62) = 3.78, p < .10]\), NWF \([F(1,62) = 5.80, p < .10]\), Inattention \([F(1,63) = 10.77, p < .10]\), Hyperactivity/Impulsivity \([F(1,63) = 3.17, p < .10]\), and Vocabulary \([F(1,62) = 17.37, p < .10]\). Based on these findings, all regression analyses used to test the study hypotheses included gender, classroom, and ethnicity as control variables.

**Correlations Among Primary Variables**

A correlation matrix of the primary variables of interest was constructed (see Table 6). As indicated below, correlations between variables were low, with the exception of the strong relationship between the subscales assessing the two dimensions of ADHD, hyperactivity/impulsivity and inattention \((r=.73)\). Neither of the correlations between the PSF, the measure of phonemic awareness, and the ADHD Rating Scale subscales was significant.

<table>
<thead>
<tr>
<th>Correlations of Primary Variables</th>
<th>Vocabulary</th>
<th>Inattention z-scores</th>
<th>Hyperactivity/Impulsivity z-scores</th>
<th>PSF</th>
<th>NWF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocabulary</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inattention z-scores</td>
<td>-0.15</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyperactivity/Impulsivity z-scores</td>
<td>-0.12</td>
<td>0.73*</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSF</td>
<td>0.25*</td>
<td>-0.03</td>
<td>0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NWF</td>
<td>0.26*</td>
<td>-0.22*</td>
<td>-0.14</td>
<td>0.34*</td>
<td>-</td>
</tr>
</tbody>
</table>

* \((p<.05)\), one tailed test
Results for Questions and Related Hypotheses

Results for Question 1: Are Teacher Ratings of Classroom Behavior Symptomatic of ADHD Negatively Related to Early Literacy Skills?

Based on earlier literature, two hypotheses were posed to address this question. Hypothesis 1 predicted that teachers’ ratings of children’s inattention would be related to children’s phonemic awareness skills, as measured by the DIBELS’ Phonemic Segmentation subtest. Hypothesis 2 predicted that teachers’ ratings of children’s inattention would be related to children’s mastery of the alphabetic principle, as measured by the DIBELS’ Nonsense Word Fluency subtest. To test these hypotheses, two-step multiple regression models were tested. In each analysis, the control variables (gender, classroom, and ethnicity) were dummy coded and regressed as a block on the early literacy variable in the first step of the analysis. In the second step, the variable of interest, either teacher ratings of hyperactivity/impulsivity or teacher ratings of inattention, was entered. If the variable of interest resulted in a significant increment in R² and the sign of the standardized beta weight indicated that the relationship was in the predicted direction, the hypothesis was confirmed.

Tables 7-10 present the results of the analyses. Teachers’ ratings of inattention or hyperactivity/impulsivity failed to predict children’s PSF scores (Hypotheses 1 and 2). Teachers’ ratings of inattention did predict children’s NWF scores (Hypothesis 3), but teachers’ ratings of hyperactivity did not (Hypothesis 4).

As a group, these results address Question 1. One dimension of ADHD, Inattention, was found to be related to one early literacy skill, speed and accuracy in decoding nonsense words. No evidence was found that behaviors related to the ADHD dimension of Hyperactivity/Impulsivity were related to early literacy.
**Table 7**

Prediction of PSF by Inattention (Hypothesis 1)

<table>
<thead>
<tr>
<th>Model</th>
<th>Variable</th>
<th>Beta(^1)</th>
<th>t</th>
<th>p-value</th>
<th>Model (R^2)</th>
<th>Model p-value</th>
<th>Increment in (R^2)</th>
<th>Increment in (R^2) p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Constant</td>
<td></td>
<td>.91</td>
<td>.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Classroom (^b)</td>
<td>.243</td>
<td>1.20</td>
<td>.236</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Gender</td>
<td>.216</td>
<td>1.82</td>
<td>.074</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Ethnic</td>
<td>.182</td>
<td>1.17</td>
<td>.248</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Hyperactivity/</td>
<td>.013</td>
<td>.09</td>
<td>.929</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^{a.}\) Standardized beta and significance values are from final analysis

\(^{b.}\) Contrast variables were Classroom 5 for Classroom, Female for Gender, and Black for Ethnicity

**Table 8**

Prediction of PSF by Hyperactivity/Impulsivity (Hypothesis 2)

<table>
<thead>
<tr>
<th>Model</th>
<th>Variable</th>
<th>Beta(^1)</th>
<th>t</th>
<th>p-value</th>
<th>Model (R^2)</th>
<th>Model p-value</th>
<th>Increment in (R^2)</th>
<th>Increment in (R^2) p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Constant</td>
<td></td>
<td>.93</td>
<td>.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Classroom (^b)</td>
<td>.248</td>
<td>1.24</td>
<td>.219</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Gender</td>
<td>.215</td>
<td>1.82</td>
<td>.074</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Ethnic</td>
<td>.213</td>
<td>1.47</td>
<td>.146</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Hyperactivity/</td>
<td>.122</td>
<td>.93</td>
<td>.359</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^{a.}\) Standardized beta and significance values are from final analysis

\(^{b.}\) Contrast variables were Classroom 5 for Classroom, Female for Gender, and Black for Ethnicity
Table 9

Prediction of NWF by Inattention (Hypothesis 3)

<table>
<thead>
<tr>
<th>Model</th>
<th>Variable</th>
<th>Beta</th>
<th>t</th>
<th>p-value</th>
<th>Model R²</th>
<th>Model p-value</th>
<th>Increment in R²</th>
<th>Increment in R² p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Constant</td>
<td>3.73</td>
<td>.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Classroom b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>.307</td>
<td>1.67</td>
<td>.101</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>.143</td>
<td>.77</td>
<td>.445</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>.036</td>
<td>.22</td>
<td>.826</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>-.263</td>
<td>-1.53</td>
<td>.132</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gender</td>
<td>-.016</td>
<td>-.15</td>
<td>.880</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethnic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>White</td>
<td>.056</td>
<td>.39</td>
<td>.696</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>.119</td>
<td>.89</td>
<td>.378</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inattention</td>
<td>-.312</td>
<td>-2.43</td>
<td>.018</td>
<td></td>
<td></td>
<td>.22</td>
<td>.023</td>
</tr>
</tbody>
</table>

- a. Standardized beta and significance values are from final analysis
- b. Contrast variables were Classroom 5 for Classroom, Female for Gender, and Black for Ethnicity
- c. Relevant test for the hypothesis was statistically significant

Table 10

Prediction of NWF by Hyperactivity/Impulsivity (Hypothesis 4)

<table>
<thead>
<tr>
<th>Model</th>
<th>Variable</th>
<th>Beta</th>
<th>t</th>
<th>p-value</th>
<th>Model R²</th>
<th>Model p-value</th>
<th>Increment in R²</th>
<th>Increment in R² p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Constant</td>
<td>3.33</td>
<td>.001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Classroom b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>.238</td>
<td>1.27</td>
<td>.210</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>.132</td>
<td>.68</td>
<td>.502</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>.052</td>
<td>.31</td>
<td>.759</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>-.222</td>
<td>-1.26</td>
<td>.213</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gender</td>
<td>-.026</td>
<td>-.234</td>
<td>.816</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethnic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>White</td>
<td>.162</td>
<td>1.18</td>
<td>.242</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>.215</td>
<td>1.65</td>
<td>.103</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hyperactivity/</td>
<td>-.155</td>
<td>-1.25</td>
<td></td>
<td></td>
<td></td>
<td>.22</td>
<td>.023</td>
</tr>
<tr>
<td></td>
<td>Impulsivity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- a. Standardized beta and significance values are from final analysis
- b. Contrast variables were Classroom 5 for Classroom, Female for Gender, and Black for Ethnicity

Results for Question 2: When Controlling for Verbal Ability, are Teacher
Ratings of Children’s Classroom Behavior Symptomatic of ADHD Negatively Related to Children’s Phonemic Awareness Skills?

When relationships between ADHD dimensions and reading skills are found, one concern is that the relationship might be explained by the correlation of each construct with verbal ability rather than by a unique association between the two constructs. Hypotheses 5 through 8 addressed this issue by examining the relationship between ADHD dimensions and phonemic awareness skills while controlling for verbal ability.

Hypothesis 5 and 6 concerned the relationship between phonemic awareness as assessed by the PSF and Inattention (Hypothesis 5) and Hyperactivity/Impulsivity (Hypothesis 6) while controlling for verbal ability. Given that no relationship was found between the PSF and behaviors related to either dimension of ADHD without controlling for verbal ability (Hypotheses 1 and 2), the statistical analyses for Hypotheses 5 and 6 were not performed.

Hypothesis 7 concerned the relationship between Inattention and mastery of the alphabetic principle, as measured by NWF. Given that Inattention predicted NWF scores in the first analysis (Hypothesis 3), this hypothesis was tested using a similar strategy to the one used for the hypotheses related to Question 1. Specifically, a three step multiple regression analysis was run. In the first step, the control variables were used to predict children’s NWF scores. In the second step, the vocabulary measure was added. In the third and final step, Inattention was added. A significant increment in $R^2$ with the addition of Inattention with a standardized beta weight in the predicted direction was the criterion for confirming the hypothesis. As is evident from Table 11, this hypothesis was confirmed. Overall, verbal
ability did not account for a significant part of the variance in NWF and the relationship between Inattention and NWF remained significant even while controlling for verbal ability.

Table 11

<table>
<thead>
<tr>
<th>Model</th>
<th>Variable</th>
<th>Beta 1</th>
<th>t</th>
<th>p-value</th>
<th>Model</th>
<th>Model</th>
<th>Increment in R²</th>
<th>Increment in R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Constant</td>
<td>.150</td>
<td>1.50</td>
<td>.139</td>
<td>Model</td>
<td>.150</td>
<td>.139</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Classroom</td>
<td>.281</td>
<td>1.49</td>
<td>.140</td>
<td>.115</td>
<td>.60</td>
<td>.550</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>.019</td>
<td>.12</td>
<td>.907</td>
<td></td>
<td>.050</td>
<td>.27</td>
<td>.791</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Gender</td>
<td>-.115</td>
<td>1.49</td>
<td>.140</td>
<td>-.019</td>
<td>.12</td>
<td>.907</td>
<td></td>
</tr>
<tr>
<td></td>
<td>White</td>
<td>.020</td>
<td>.14</td>
<td>.892</td>
<td>.107</td>
<td>.79</td>
<td>.430</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>.020</td>
<td>.14</td>
<td>.892</td>
<td>.107</td>
<td>.79</td>
<td>.430</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Vocabulary</td>
<td>.094</td>
<td>.76</td>
<td>.452</td>
<td>.23</td>
<td>.029</td>
<td>.01</td>
<td>.335</td>
</tr>
<tr>
<td>3</td>
<td>Inattention</td>
<td>-.302</td>
<td>-2.33</td>
<td>.023c</td>
<td>-.302</td>
<td>-2.33</td>
<td>-.023c</td>
<td>.29</td>
</tr>
</tbody>
</table>

a. Standardized beta and significance values are from final analysis
b. Contrast variables were Classroom 5 for Classroom, Female for Gender, and Black for Ethnicity
c. Relevant test for the hypothesis was statistically significant

Hypothesis 8 concerned the relationship between phonemic awareness and hyperactivity/impulsivity. Because no relationship between the hyperactivity/impulsivity and the PSF was found in the multiple regression analysis that did not control for verbal skills (Hypothesis 4), no analysis was needed to determine that the hypothesis was not supported.

Similar to the results for Question 1, the results relevant to Question 2 indicate that one dimension of ADHD, inattention, is related to one early literacy skill. The observed
relationship between inattention and children’s mastery of the alphabetic principle as assessed through the NWF subtest cannot be explained by the relationship of each variable with children’s overall verbal ability.

Results for Question 3: Are Symptoms of Inattention and Hyperactivity/Impulsivity Differentially Related to Phonemic Awareness Skills?

Hypothesis 9 and 10 predicted that teacher’s ratings of inattention in the classroom would account for a significant and unique portion of the shared variance between ADHD symptoms and early literacy skills, over and above the variance accounted for by teacher’s ratings of children’s hyperactivity/impulsivity. In other words, it was hypothesized that after taking into account hyperactive/impulsive behaviors, inattention would still explain a significant amount of variance in PSF (Hypothesis 9) and NWF (Hypothesis 10). Given that teachers’ ratings of children’s inattention in the classroom did not predict children’s PSF scores, no analysis for this Hypothesis 9 was conducted. For Hypothesis 10, a three step multiple regression analysis was conducted. First, the control variables of gender, ethnicity, and classroom were used to predict children’s NWF scores. Second, hyperactivity was entered as a single variable. Third, inattention was added to the regression equation. As indicated in Table 12, Hypothesis 10 was confirmed. Adding inattention to the regression equation resulted in a significant increment in $R^2$, indicating Inattention accounts for a unique portion of the variance in NWF.
Table 12

Increase in Prediction of NWF with Inattention (Hypothesis 10)

<table>
<thead>
<tr>
<th>Model</th>
<th>Variable</th>
<th>Beta¹</th>
<th>t</th>
<th>p-value</th>
<th>Model R²</th>
<th>Model p-value</th>
<th>Increment in R²</th>
<th>Increment in R² p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Constant Classroom b</td>
<td>3.75</td>
<td>.000</td>
<td>.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Classroom</td>
<td>.329</td>
<td>1.75</td>
<td>.085</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Gender</td>
<td>.123</td>
<td>.65</td>
<td>.517</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Ethnic White</td>
<td>.047</td>
<td>.33</td>
<td>.745</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Ethnic Other</td>
<td>.100</td>
<td>.73</td>
<td>.469</td>
<td></td>
<td></td>
<td></td>
<td>.22 .023</td>
</tr>
<tr>
<td>2</td>
<td>Hyperactivity/Impulsivity</td>
<td>.122</td>
<td>.69</td>
<td>.491</td>
<td></td>
<td></td>
<td>.23 .023</td>
<td>.02 .217</td>
</tr>
<tr>
<td>3</td>
<td>Inattention</td>
<td>-.406</td>
<td>-2.17</td>
<td>.034²</td>
<td></td>
<td></td>
<td>.29 .008</td>
<td>.05 .034²</td>
</tr>
</tbody>
</table>

a. Standardized beta and significance values are from final analysis
b. Contrast variables were Classroom 5 for Classroom, Female for Gender, and Black for Ethnicity
c. Relevant test for the hypothesis was statistically significant

Of the hypotheses presented in this study, there were three confirmed hypotheses and seven disconfirmed hypotheses. The hypotheses confirmed showed a consistent pattern. All were concerned with the relationship of inattention and NWF.
CHAPTER SIX: DISCUSSION

Although research has been conducted to investigate the co-occurrence of ADHD and RD, few studies have focused on evaluating the relationship between these two domains before formal reading instruction begins (Hinshaw, 1992; Purvis & Tannock, 2000). Having an understanding of how prereading skills and symptoms of ADHD are related in early schooling can contribute to a better understanding of the comorbidity of ADHD and RD. Looking at behaviors associated with the two specific dimensions of ADHD and their relationship with individual early literacy skills has the potential to provide important information concerning how the observed relationship between ADHD and RD arises.

To that end, the primary purpose of this study was to evaluate whether ADHD symptoms and early reading skills overlap. Unlike most previous studies (Jorm, Share, Maclean et al., 1986; Jorm, Share, Matthews et al., 1986; McGee et al., 1986; NICHD Early Child Care Research Network 2003; Palfrey et al., 1985), the present study examined the two dimensions of ADHD separately, controlled for children’s verbal ability, and assessed early literacy with tasks that tapped key precursors to reading disabilities (Torgesen & Wagner, 1998). Seventy-four kindergarten children from five different kindergarten classrooms and their respective teachers completed measures of early literacy, inattention and hyperactive/impulsive behaviors, and verbal ability. Ten hypotheses concerning the nature of the relationship between two individual early literacy skills and the two dimensions of ADHD were tested.

Results from this study indicated that teachers’ ratings of children’s inattention in the classroom were negatively related to only one of the two early literacy skills examined, mastery of the alphabetic principle. This relationship continued to be significant when
controlling for children’s verbal ability. In addition, inattention was a unique and significant predictor of children’s mastery of the alphabetic principle, above and beyond that explained by hyperactivity/impulsivity. However, the present study failed to find a relationship between the second dimension of ADHD, hyperactivity/impulsivity, and mastery of the alphabetic principle, and failed to find a relationship between either dimension of ADHD and phonemic awareness.

The following sections discuss the study results and their implications. First, the results of the present study are placed in the context of previous research and possible reasons for the failure to confirm several of hypotheses are discussed. Second, the strong relationship observed between classroom assignment and children’s scores on the NWF is detailed, and possible implications of this finding for understanding conflicting results from previous studies are presented. Third, the limitations of the present study are discussed. Finally, the last two sections provide implications for practice and directions for future research.

Inattention, Hyperactivity/Impulsivity, and Early Literacy

*Inattention and the Alphabetic Principle*

Results from the present study indicated that teacher’s ratings of children’s inattention in the classroom were negatively related to children’s mastery of the alphabetic principle. This result is consistent with the findings of previous studies linking attention problems and reading difficulties in early schooling (Jorm, Share, Maclean et al., 1986; Jorm, Share, Matthews et al., 1986; Kellam et al., 1975; Lonigan et al. 1999; McGee et al., 1986; NICHD Early Child Care Research Network, 2003; Palfrey et al., 1985; Rabiner et al., 2000; Richman et al., 1982). It extends the existing literature by demonstrating that inattention is
negatively related to the acquisition of a key early literacy skill, mastery of the alphabetic principle. Previous studies (e.g., Jorm, Share, Maclean et al., 1986; Jorm, Share, Matthews et al., 1986; Rabiner et al., 2000) have often used test batteries to assess early literacy that combined tests of correlates of reading skill (e.g., rapid letter naming) with tests of skills that current research (Lyon et al., 1996; Mody, 2003; Purvis & Tannock, 2000; Torgesen, 2000; Whitehurst & Lonigan, 1998; Wood & Felton, 1994) has shown are causally related to reading acquisition. Demonstrating that there is a link between inattention and difficulty acquiring a skill that is strongly implicated in later development of reading disabilities is consistent with three explanations of ADHD/RD comorbidity in which ADHD gives rise to later reading disabilities, in which ADHD and RD lead to each other, or in which a third variable leads to both of these disorders. It is inconsistent with an explanation of ADHD/RD comorbidity where reading disabilities lead to ADHD (Hinshaw, 1992). Of course, experimental studies are necessary to demonstrate causation, but the pattern of results in the present study better fits some explanations of ADHD/RD comorbidity than others.

The results of the present study indicated that the relationship between inattention and mastery of the alphabetic principle could not be explained by the relationship of each domain with general verbal ability, as measured by children’s oral vocabulary. This finding is consistent with the research of McGee et al. (1986) and Richman et al. (1982), who found that after controlling for cognitive ability, ADHD and RD still co-occurred. This finding also is consistent with explanation of ADHD/RD comorbidity where ADHD-related behaviors interfere with the acquisition of reading skills.
Hyperactivity and the Alphabetic Principle

The present study failed to observe a relationship between hyperactivity/impulsivity and children’s mastery of the alphabetic principle, as assessed by the NWF task. There are a number of possible reasons for the failure to find a negative relationship between NWF and the ADHD dimension of Hyperactivity. First, it may be that inattention is uniquely related to reading difficulties. This possibility has been suggested by Gaub and Carlson (1977), Lonigan et al. (1999), Merrell and Tymms (2001), and Rabiner et al. (2000). Although limited studies have analyzed the relationship between early literacy skills and specific dimensions of ADHD, findings have demonstrated that inattention more so than hyperactivity/impulsivity is related to reading difficulties. In Rabiner et al. (2000), for example, inattention was a strong and consistent predictor of reading skills from kindergarten through fifth grade. Hyperactivity/impulsivity, contrary to inattention, was a much weaker and less consistent of a predictor.

If inattention is uniquely related to early reading skill development, then it may be that the relationship between hyperactivity/impulsivity and reading skill arises later in development. This pattern would explain the failure to find a relationship between hyperactivity/impulsivity and early literacy skill in the present study when other researchers have found a relationship between hyperactivity/impulsivity and later reading skill (Hinshaw, 1992; McGee et al., 1986; Palfrey et al.’s, 1985; Richman, 1982). For example, Velting and Whitehurst’s (1997) findings indicated that the relationship between inattention and hyperactivity/impulsivity with literacy skills didn’t appear until first grade. One hypothetical causal model for this relationship is that students who encounter academic difficulties may try to counteract feelings of inadequacy and failure by becoming overactive (Hinshaw, 1992).
That is, children who face difficulties in reading may lose interest in reading and then act out when they don’t function successfully in school (McGee et al., 1986; McGee & Share, 1988). Williams and McGee (1996) suggested that the relationship between reading difficulties and externalizing conditions, such as overactivity, would manifest itself when children were older. Thus, it may be that children’s hyperactivity/impulsivity may be the result of children’s “fight or flight” reaction to difficult reading tasks in later schooling. If this is the case, it suggests that, unlike inattention, hyperactivity may be a response to reading difficulty rather than a cause of it.

A second possibility is that hyperactivity is negatively related to early literacy skill development, but that the problems with the measure of hyperactivity/impulsivity in the present study made it difficult to detect this relationship. The ADHD-SV is designed to detect the presence of ADHD symptoms. All items are negatively worded and teachers indicate only whether the problematic behavior is present and to what extent. This type of scale does not discriminate between children who are highly engaged and compliant and those who show normal levels of inattentiveness and hyperactivity. As a result, many of the children’s scores on this measure in the present study were zeroes, therefore creating a floor effect on both scales. This problem may have masked the relationship between the NWF and the ADHD dimension of hyperactivity/impulsivity. Although this problem would have also made it difficult to find a relationship between inattention and the NWF, the distribution for the Inattention scale on the ADHD-SV was less skewed than the distribution for the Hyperactivity/Impulsivity scale and past research has indicated the relationship between reading and inattention is stronger, making it easier to find an effect for this dimension of ADHD, even with measurement problems.
Given that most children in the classrooms did not present symptoms of hyperactivity/impulsivity, a scale that assessed the level of engagement instead of the amount of disengagement would have been more appropriate. In a regular classroom setting, this type of scale would likely generate scores with a more normal distribution, with children’s behaviors ranging from very frequently compliant and on-task to very frequently off-task and unengaged. Using a scale with more variation would have allowed a more powerful test of the hypotheses.

*Inattention, Hyperactivity/Impulsivity, and Phonemic Awareness*

Given studies that support the relationship between early literacy skills and attentional difficulties (Jorm, Share, Maclean et al., 1986; Jorm, Share, Matthews et al., 1986; Kellam et al., 1975; Lonigan et al. 1999; McGee et al., 1986; NICHD Early Child Care Research Network, 2003; Palfrey et al., 1985; Rabiner et al., 2000; Richman et al., 1982), it is surprising that a negative relationship between either dimension of ADHD and phonemic awareness was not observed. It may be possible that phonemic awareness is related to one or both dimensions of ADHD, but not related to the particular phonemic awareness task used in this study. A second possibility is that, unlike other early literacy skills, phonemic awareness is not related to either dimension of ADHD. These possibilities are discussed below.

One of the possible reasons why the present study failed to find a relationship between the two ADHD dimensions and phonemic awareness could be that although phonemic awareness is related to ADHD, the particular phonemic awareness skill (word segmentation) assessed on the DIBELS did not have a strong relationship with either ADHD dimension. Other phonemic awareness tasks more closely related to reading may have been more strongly related to either or both dimensions of ADHD. As support for this possibility,
one can examine the correlations for reading achievement and the various phonemic awareness tasks on the Comprehensive Test of Phonological Processing (CTOPP), as reported in the test’s manual (Wagner, Torgesen, & Rashotte, 1999.) The elision task on this test (which entails omitting a sound) was more highly correlated with reading than the phonemic segmentation task included on that test.

A second possibility is that although phonemic segmentation is related to inattention and hyperactivity/impulsivity, the DIBELS PSF task was not a good measure of phonemic segmentation skill. The alternate-form reliability of this instrument as indicated by Good, Kaminski, and Smith (2002) is moderate to good (.79). However, the correlation of the PSF scores across the two administrations of the task in the present study was only .62. It is possible that the PSF task’s modest capacity to measure children’s phonemic segmentation across time may have attenuated the correlations between the two ADHD dimensions and phonemic segmentation, leading to a failure to observe a relationship between this task and behaviors related to the two dimensions of ADHD.

Finally, the nature or presentation of the PSF may also have affected its relationship to inattention and hyperactivity/impulsivity. The PSF task requires less coordination across modalities than the NWF task. The PSF requires that a child listen to verbal stimuli from the examiner and then respond in a verbal fashion. Thus, the task demands the use of one code system because the items and their responses are both in a verbal format. Also, the PSF task entails one-on-one interaction between the child and the examiner. The NWF task, on the other hand, demands that a child decode visual stimuli and produce a verbal response, therefore requiring a change in code systems or an intermodal transfer of information. Given the characteristics of children with attention problems, engaging in a task that is unimodal
and which involves one-on-one interactions may be less challenging than a task which requires a change in code systems (Barkley, 1998). Thus, fundamental differences between the PSF and NWF task may explain why inattention was negatively related to children’s mastery of the alphabetic principle, as assessed by NWF, but no such relationship was observed in the case of phonemic awareness, as assessed by PSF.

In this study, gender, ethnicity, and classroom were used as control variables. Of these control variables, children’s classroom assignment accounted for the most variance in an outcome variable. The following section will discuss the effect of including children’s classroom as a control variable, speculate why this variable was so important, and how this finding might be helpful in interpreting conflicting findings in the literature.

Classroom Effects on Early Literacy Skills:
An Explanation for Conflicting Findings?

Preliminary analyses demonstrated that there were gender, ethnicity, and classroom differences in either the predictor or outcome variables in the present study. Although most of these differences were small, classroom assignment was a strong predictor of NWF. When classroom assignment alone was used to predict NWF, it accounted for 16.6% of the observed variance in NWF.

Although the variable “classroom” accounted for a significant proportion of variance in NWF in the present study, it is unclear what this variable represents. Without random assignment of students to classrooms, the relationship between NWF and classroom assignment might be explained by differences among classrooms in student characteristics such as entry skill level, socioeconomic status, or intelligence. Alternately, the relationship between classroom and NWF might be explained by differences in classroom practices...
related to early literacy. If teachers vary in the extent to which they focus on letter-sound relationships or their effectiveness in teaching this knowledge, this variation would account for the relationship observed between children’s classroom assignment and NWF score (see Table 13).

Controlling for this difference would then make a finer-tuned test of the relationship between inattention and NWF possible. If children are not exposed to early literacy skills in the classroom, then these skills are likely to be low. When evaluating whether there is a relationship between early literacy skills and attention difficulties, the relationship between the two domains would be masked if many children’s scores on the literacy tasks were lowered by lack of instruction instead of attention problems. If the level of exposure to early literacy skills in the five kindergarten classrooms included in this study varied, then controlling for classroom effects would allow the relationship between inattention and mastery of the alphabetic principle to emerge by suppressing the variance due to instruction.

Table 13.

*Mean NWF Scores and Ratings of Inattention by Teacher/Classroom*

<table>
<thead>
<tr>
<th>Teacher/Classroom</th>
<th>NWF Mean</th>
<th>NWF Standard Deviation</th>
<th>Inattention Mean (z-score)</th>
<th>Inattention Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>63.74</td>
<td>26.95</td>
<td>.28</td>
<td>.85</td>
</tr>
<tr>
<td>2</td>
<td>52.33</td>
<td>29.27</td>
<td>.29</td>
<td>1.07</td>
</tr>
<tr>
<td>3</td>
<td>54.79</td>
<td>32.37</td>
<td>-.44</td>
<td>.81</td>
</tr>
<tr>
<td>4</td>
<td>30.27</td>
<td>13.59</td>
<td>-.42</td>
<td>.74</td>
</tr>
<tr>
<td>5</td>
<td>32.75</td>
<td>46.00</td>
<td>.06</td>
<td>1.44</td>
</tr>
</tbody>
</table>
There is some support in the literature for this possibility. Lonigan et al. (1999) assessed the relationship between behavior difficulties and early literacy skills in two preschool settings, one with an academic orientation serving children of middle income parents and one more child-directed serving children of low income families. Given the differences in children and academic focus across settings, the authors did not combine the two groups of children in their analyses. Although attention difficulties were associated with emergent literacy skills in both groups, the relationship was stronger in the sample from the academically-oriented preschool. In addition, some of the specific early literacy skills that were related to inattention varied between the groups. The authors suggested that the differences between groups in the strength of the relationship of inattention to early literacy skills may have been due to differences in exposure and instruction of early literacy skills. The results of Lonigan et al., as well as the results of the present study, suggest that differences in exposure to early literacy skills across settings make it challenging to examine the relationship between symptoms associated with ADHD and early literacy skills without careful assessment of classroom curriculum.

It also appears that teachers varied systematically in their ratings of children’s inattention (see Table 13). Thus, controlling for classroom may have had an impact on the predictor as well as the outcome variables in tests of the relationship between inattention and mastery of the alphabetic principle.

The possibility that the type or content of teachers’ instruction or their behavioral expectations may affect whether inattention and early literacy are related is an intriguing proposition. Unfortunately, neither the present study nor Lonigan et al. (1999) are good tests of this proposition because neither assessed amount or type of classroom instruction, or
teachers’ behavioral expectations. However, if these factors do affect the relationship, it might explain the conflicting findings in the literature. Previous studies that have evaluated the relationship between attentional difficulties and early reading skills have generally failed to explicitly take into account amount of classroom instruction in literacy skills or teachers’ behavioral expectations in their studies.

In sum, it is unclear why mean differences by classroom in NWF scores were observed. However, the present results, along with the results of Lonigan et al. (1999), suggest that future research should include classroom observations of literacy instruction and teacher management style, as well as controls for demographic variables. Additional directions for future research will be presented following a discussion of the limitations of the present study.

Study Limitations

As is evident from the discussion above, one of the limitations of this present study is that although the children’s classroom was of significant importance in predicting children’s mastery of the alphabetic principle, it is unclear what factor or set of factors comprised this variable. Having additional measures of classroom variables and student characteristics would have allowed a better understanding of how these variables were related to ADHD symptoms and early literacy skills, and how these two domains are related to each other.

A second limitation of this study is the way that inattentive and hyperactive/impulsive behaviors were measured. Teachers completed a behavior rating scale in December and the early literacy skill subtests were administered in end of March/beginning of April and May. If children’s behavior changed as a result of maturity or teacher intervention after December, then the behavior ratings would be inaccurate, attenuating the correlation between ADHD
behaviors and literacy skills assessed in the spring. In addition, given that there were
differences across classrooms in the ratings of children’s hyperactive/impulsive behaviors,
having more than one rater per classroom (for example teacher and teacher’s aide) complete
a rating scale for each child would have provided more input and more reliable measures of
the ADHD behaviors. The use of an objective observer also would have prevented any
teacher biases from influencing the ratings. In addition, a performance-based measure of
inattention and impulsivity, such as a sustained attention task, might have been a more
sensitive measure of these types of problems in children.

Another problem with the ADHD measure was its use of only negatively-worded
items. Given that most of the students did not engage in ADHD behaviors, the measure had a
floor effect, creating an atypical distribution, with skewness and kurtosis. A measure with
both positively and negatively worded items may have been more appropriate for this study.

A third limitation is the way in which phonemic awareness skills were assessed.
There are other tasks that assess phonemic awareness that may have allowed a relationship
between this skill and the two dimensions of ADHD to be observed. Perhaps if a test of a
more difficult phonemic awareness skill (e.g., elision) had been used, the predicted
relationships would have been found. Given the issues raised about the impact of looking at
the paper versus the examiner, and the intermodal versus unimodal nature of the NWF and
PSF tasks, perhaps if the phonemic segmentation task had used a picture and asked the child
to say the word associated with the picture and then segment it, the predicted relationships
between phonemic segmentation and either dimension of ADHD would have been observed.
However, the primary limitation of this study is its correlational design. This design makes it impossible to infer a causal relationship between the ADHD dimensions and early literacy skills.

In sum, the nature of the ADHD-SV and PSF scales may have affected the results of the study. In addition, further exploration of variables confounded within classroom may generate a better understanding of how early literacy skills and attentional difficulties are related. A different methodology may have led to a better ability to deduce cause and effect relationships among the domains of interest. The following sections will discuss the study’s implications for practice and future directions for research.

Implications for Practice

The results of this study enhance our understanding of the early association between dimensions of ADHD and early literacy skills. First, the finding that variables associated with classroom assignment are related early literacy skill scores suggests that school psychologists should interpret DIBELS and other early literacy in the context of the type of classroom experiences children have had. Although it was impossible to ascertain why classroom assignment was related to children’s NWF scores, this finding suggests that school psychologists should not assume that all children have had the same literacy experiences. It may be most valid to assess whether a child has a problem with mastering early literacy skills after an initial DIBELS assessment and individualized intervention. Using an instrument such as the DIBELS in conjunction with an early reading intervention with at-risk children can facilitate progress monitoring that is sensitive to the effects of targeted interventions. A response to intervention strategy may be the most useful strategy for differentiating children who are low in early reading acquisition skills due to lack of instruction from those whose
low skills are more likely to be caused by cognitive deficits that make learning to read more difficult (Vellutino et al., 2006). Such a distinction can also be helpful in understanding how the relationship between ADHD and RD arises.

Second, inattention was related to early literacy skill. Although the present study design does not allow causal inferences, this finding does suggest that children with inattention are at heightened risk for reading problems and their reading development should be monitored closely. If these children show signs of lagging early reading skills, implementing early literacy skill interventions designed for children with specific attention difficulties and following the children’s progress may benefit the children and also allow educators and scientists to gain a better understanding of the relationship among domains.

Future Directions for Research

Several changes in the design of this study could be implemented for future research. First, although the sample was larger than some of the early studies of ADHD/reading comorbidity, a larger sample size may aid in generating more conclusive results. Second, enhancing the diversity of the study sample in terms of ethnicity would result in a better understanding of the differences in ADHD dimensions and early literacy skills across ethnicities. Third, having multiple raters assessing children’s behavior on the ADHD dimensions, and adding a laboratory-based measure of attention may provide more insight into the relation between early attention difficulties and prereading skills. Fourth, using a longitudinal design could provide more information about how ADHD and RD relate to each other across time, and which of the four hypothetical causal models (Hinshaw, 1992) is most valid.
In the present study, analyses indicated that once the children’s classroom, gender, and ethnicity were taken into account, inattention and children’s mastery of the alphabetic principle were consistently related. Thus, future studies should consider or control for these variables and other effects or factors that could potentially impact children’s literacy skill acquisition or behavior. Only 28% of the variance in children’s mastery of the alphabetic principle was explained by children’s classroom, gender, and ethnicity and children’s inattention. These variables did not account for a significant portion of the variance in the second early literacy skills examined. Future studies should incorporate a wide range of child and classroom variables into the design to explain a larger portion of the variance in children’s reading skills.

In summary, this study demonstrated that one dimension of ADHD, inattention, was consistently related to a key early literacy skill that must be acquired for skilled reading (Torgesen, 2000). This finding suggests that the relationship between ADHD and reading arises early and that those seeking to understand and eventually intervene in the development of these two disorders will be most likely to achieve their goals by focusing on a better understanding of the precursors of the two disorders. The use of multiple classrooms in the present study suggested an explanation for previous conflicting results in the literature and indicated that controlling for amount and type of instruction in reading that children have encountered may be an important addition to future ADHD/RD research.
References


