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Identification of Specific Learning Disability Profiles: Consideration of Patterns across Cognitive, Academic, Socio-Emotional, and Executive Variables

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IDENTIFICATION OF SPECIFIC LEARNING DISABILITY PROFILES: CONSIDERATION OF PATTERNS ACROSS COGNITIVE, ACADEMIC, SOCIO-EMOTIONAL, AND EXECUTIVE VARIABLES

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Dissertation Approval

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requirements for the degree of Doctor of Psychology, has been examined and is

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Abstract

During recent years, there has been a growing urgency and a heightened demand for increased accountability for all students to demonstrate academic success in school, as required by the No Child Left Behind Act (NCLB; 2002). An integral part of helping students to meet success in school includes providing them with a free and appropriate education; this also includes those students who have educational disabilities, through the provision of specially designed instruction and supports. In the past, SLD had been studied as a homogenous classification (Rourke, 1999). However, as more recent research has evolved, it has become clearer that students classified with SLD exhibit different patterns of performance (strengths and weaknesses), suggesting that they actually compose a heterogeneous group (Rourke, 1999). The current study was designed to determine and describe meaningful SLD profiles through the examination of patterns of strengths and of weaknesses across cognitive, academic, socio-emotional, and executive variables, using standard scores in a school-aged population of students identified with SLD. In this sample of data drawn from a population of students classified with SLD (n = 40), bivariate correlations and multivariate analyses of variance were performed. Students with SLD were organized into three groups by the presence of a reading-based SLD, a math-based SLD, or a mixed reading/math-based SLD. Results demonstrated significant, positive correlations between cognitive and academic variables, whereas little significance was noted between cognitive and socio-emotional or executive variables. Significant differences were found between the SLD groups (Reading SLD group, Math SLD group, and Combined Reading/Math SLD group), for cognitive and academic variables; however, no significance was found for socio-emotional or executive variables.

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Chapter I

Introduction

During recent years there has been a growing urgency and a heightened accountability for all students to demonstrate academic success in school, as required by the No Child Left Behind Act (NCLB; 2002). An integral part of helping students to meet success in school includes providing them with a free and appropriate education; this also includes those students who have educational disabilities, through the provision of specially designed instruction and supports. Considering the fact that ten to fifteen percent of all school-aged children are classified with specific learning disabilities (SLD) (Hendricksen, Keulers, Feron, Wassenberg, Jolles, & Vles, 2007), it becomes crucial to specify, appropriately, the nature of the student's learning disability and to link assessment findings with individualized intervention. Of greatest concern are those children who suffer from SLD, because they represent over one-half of classified students in the United States (Zirkel & Thomas, 2010). At this time, the construct of SLD is rather heterogeneous, consisting of a mixture of students receiving special education due to a variety of reading, math, or language related disorders. However, this is also a time when we know much more about how a child learns because of advances in neuroimaging techniques that have revealed changes to the brain as a result of intervention (see Shaywitz, 2005).

In the past, SLD had been studied as a homogenous classification (Rourke, 1999), with a focus on a common pattern of significant discrepancies between ability and achievement among classified students. However, as more recent research has evolved, it has become clearer that students classified with SLD exhibit different patterns of performance (strengths and weaknesses), suggesting that they actually compose a heterogeneous group (Rourke, 1999), even when displaying the same general academic areas of weakness. For example, neuroscience in the

area of education has discovered that all struggling readers do not suffer from the same cognitive processing problem, even when all of them demonstrate the same behavioral difficulties (i.e., reading problems). The National Reading Panel (2001) has identified five areas of balanced literacy, which include phonemic awareness, phonics, fluency, vocabulary, and comprehension. Students may struggle in one or more of these areas, which often can be related to deficiencies in cognitive processes. This has been illustrated through educational neuroscience, which has helped identify parts of the brain that either activate or fail to activate during different types of reading tasks. For example, Shaywitz (2005) demonstrated that students with Dyslexia utilize their brains differently in reading. She discovered that they use less efficient pathways by relying on right parietal, dorsal, and frontal regions to compensate for a deficient ventral pathway (Shaywitz, 2005). Further, she found that intervention increased activity in the word form area (fusiform gyrus), evidencing the fact that appropriate intervention changes brain structure (Shaywitz, 2005).

As a result of this recently discovered heterogeneity in SLD, research has rapidly begun to demonstrate that in addition to cognitive and academic deficits, many students also experience difficulty with socio-emotional adjustment and executive dysfunction (Greenham, 1999; Hain, 2008; Helland & Asbjornsen, 2000; McCloskey, 2009; Rourke, 2008). Therefore, it has been suggested that SLD frequently occurs in conjunction with psychopathology and executive dysfunction (Crews & D'Amato, 2009; Forrest, 2004; Hain, Hale, & Kendorski, 2008; Hendriksen et al., 2007; Nussbaum & Bigler, 1986; Nussbaum, Bigler, & Koch, 1986; Nussbaum, Bigler, Koch, & Ingram, 1988; Rourke, 1999; Rourke, 2005) that are often overlooked. In particular, comorbid socio-emotional disorders may be found in 40% of the SLD population (Taggart, Cousins, & Milner, 2007). When considering students with classifications

of serious emotional disturbances, psychologists have recognized that up to 75% also have overlapping SLD (Rock, Fessler, & Church, 1997). The majority of these students, especially those demonstrating psychopathology, also demonstrate executive dysfunction; this has become overwhelmingly apparent in recent years, after school psychologists have begun to place a greater emphasis on investigating executive function capacities during conduction of psychoeducational evaluations of students (Buttner & Hasselhorn, 2011; McCloseky et al., 2008).

Such findings have fueled a long-standing debate regarding whether or not psychosocial and executive problems should be more prominent in definitions of SLD (Kavale & Forness, 1996; Greenham, 1999; Wong, 1996). In the past, little attention has been paid to such comorbidity in students who display evidence both of SLD and of another classification, such as an emotional disturbance. Although this may be a consequence of the language used in the federal definition, which targets differentiation of disabilities without recognizing that systems may overlap (Rock et al.,1997), it confounds effective assessment and intervention because students often demonstrate comorbidity with other disorders, but typically only academic (and sometimes cognitive) deficits of SLD are identified (Hain, 2008). To assist in understanding the effects of comorbidity on other areas of deficit on SLD, researchers have begun to identify subtypes of SLD through examination of unique patterns of performance (strength and weaknesses) across multiple domains (i.e., cognitive, academic, socio-emotional, and executive domains) (see Crews & D'Amato, 2009; Hain et al., 2008; Mayes & Calhoun, 2004; Mayes & Calhoun, 2006; Rourke, 1999; Rourke, 2005).

Even as these recent advances in SLD research (i.e., comorbidity of deficits in SLD; possibility of SLD subtypes) have developed, current laws and policies have not yet adapted to

accommodate them. The fundamental definition of what constitutes SLD remains the same with the revision of IDEIA 2004, with no mention of a possibility of SLD subtypes. Yet in considering the amount of evidence demonstrating the existence of differential SLD subtypes based on patterns of performance, there appears to be an urgency to investigate the impact of all variables on children's learning (Forrest, 2004; Hain, 2008; Mayes & Calhoun, 2004; Mayes & Calhoun, 2006). Collapsing students with any type of learning difficulty into one group is problematic because it ignores students' differing patterns of strengths and deficits among variables assessed, and it does not allow for the possibility that students may experience similar academic deficits that might be caused by very different learning profiles. Furthermore, a homogenous classification ignores the possibility that subtypes of SLD are likely connected to different patterns of socio-emotional adjustment and executive dysfunction (Hain, 2008). Without consideration of such comorbidity across variables, the recognition of which advances in assessment have made possible through the use of neuropsychological methods, identification of students for special education services and development of Individualized Educational Plans (IEPs) cannot be accurate or appropriate.

Models have evolved which enable practitioners to evaluate multiple domains of functioning of students. Lurian theory (1966, 1973) introduced the use of qualitative observations of errors and informal hypothesis testing to allow for an individualized approach to assessing individuals (Miller, 2007). Later, Kaplan (2009) introduced the Boston Process Approach to neuropsychological assessment, allowing for a flexible battery approach to answer referral questions; this included an aim to understand the qualitative nature of behavior assessed by clinical psychometric instruments through assessment of the pattern of impaired functions. This approach can involve standardized tests or a set of tasks specially designed for each student

(Milberg, Heppen, & Kaplan, 2009), and has popularized a model in which all areas of functioning can be examined. These approaches, along with more recent models of determining strengths and weaknesses, which will be discussed further on in this dissertation, have provided methods of assessment of students that investigate all variables on children's learning, and enable practitioners to differentiate subtypes of SLD in order to provide more individualized and appropriate interventions. It has long been argued that if distinct subtypes of learning disabilities could be determined, intervention that is precise and specific to the individual subtype could be designed, resulting in a better outcome (D'Amato, Dean, & Rhodes, 1998; Fletcher, et al., 1997; Lyon, 1991). Of further importance is that with the existence of SLD subtypes, simple Response to Intervention (RTI) or discrepancy model approaches, to be described further on in this dissertation, will not suffice in determining the presence of a SLD for eligibility purposes regarding special education. There is a need for both national and state legislatures to make revisions to allow classification procedures to be consistent with recent SLD research findings in order that educators may be better able to provide appropriate interventions to students in need.

Purpose of the Study

The current study is designed to determine and describe meaningful SLD profiles through the examination of patterns of strengths and weaknesses across cognitive, academic, socio-emotional, and executive variables, using standard scores in a school-aged population of students identified with SLD. The current study will explore possible SLD profiles through bivariate correlations and MANOVA's of the WJ III Test of Cognitive Abilities standard subtest scores, WJ III Test of Achievement standard scores, socio-emotional functioning scores attained from BASC-2 parent ratings, and executive function capacity scores measured through BRIEF parent ratings. The study is designed to investigate research questions rather than research hypotheses;

however, the results could aid in understanding how students with different areas of cognitive, socio-emotional, and executive strengths and weaknesses may experience different types of learning problems, leading to a holistic and individualistic approach to intervention. The research questions are as follows:

Research Questions

1. Do meaningful profiles of children with SLD exist, and if so, what are the patterns across cognitive, academic, socio-emotional, and executive variables?
    a. Which relationships are significant?
    b. What is the direction of these relationships?
    c. What is the strength and magnitude of these relationships?
2. If meaningful profiles of children with SLD do not exist, can the students with SLD be further differentiated based on their academic areas of deficiency (i.e., reading, math, or a mixed reading/math)?
    a. Are there significant differences between the SLD groups across the cognitive, academic, socio-emotional, and executive variables?

Chapter II

Literature Review

Eligibility Procedures in Determining SLD

The definition of SLD has been historically controversial and has lacked consistency, allowing distinct eligibility criteria to be used between states. Although IDEIA 2004 modified procedures for determining SLD in students, the legal definition of SLD continues to remain the same. IDEIA 2004 defines a specific learning disability in Title 20 United States Code Section 1401(30) [cited as 20 USC 1401930)] as follows:

(30) Specific Learning Disability.

(A) In General. The term 'specific learning disability' means a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which may manifest itself in the imperfect ability to listen, think speak, read, write, spell, or to do mathematical calculations.

(B) Disorders Included. Term includes conditions such as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia (34 C.F.R. 300.8). Additionally, through IDEIA 2004, after it is determined that the student has a disability, it must be decided whether the child needs specially designed instruction. It must also be determined whether there is an educational impact, meaning that the student does not achieve adequately for his/her age and does not meet state-approved grade-level standards in one or more of the following areas, when provided with learning experiences and instruction appropriate for the child's age or state-approved grade-level standards: Oral expression, listening comprehension, written expression, basic reading skills, reading fluency skills, reading comprehension, mathematics calculation, mathematics problem solving [see 34 CFR 300.309(a)(1)]. It needs to

be ruled out that the results are not primarily the result of a visual, hearing, or motor disability, mental retardation, emotional disturbance; cultural factors, environmental or economic disadvantage, or limited English proficiency. Data need to prove that prior to, or as a part of, the referral process, the child was provided appropriate instruction in regular education settings delivered by qualified personnel.

IDEIA (2004) currently allows a choice from three different models in determining SLD classification of students. These three options consist of an ability-achievement discrepancy model, a Response to Intervention (RTI) model, or a third method (derived of other alternative, research-based procedures). However, difficulty arises because there are inconsistencies between state regulations. A recent study (Berkeley, Bender, Peaster, & Saunders, 2009) reported that 15 states had adopted an RTI model; however, only two of them allowed the use of only this model for SLD classification. Twelve states prohibit the use of an ability-achievement discrepancy model; four states allow a combination of RTI and a discrepancy model, and 20 states allow the third, research-based alternative method (Zirkel & Thomas, 2010). With the variation of classification methods that states have adopted, consistent criteria for classifying SLD in students becomes confounded, and students who meet criteria in one particular state may not be eligible in a different state.

Ability-Achievement Discrepancy Model. The most popular method of SLD classification in the past has been the use of an ability-achievement discrepancy, partially because it addresses psychological processes, which evidence has shown are associated with different types of SLD (Stuebing, Fletcher, Branum-Martin, & Francis, 2012). However, although this model includes evaluation of psychological processes, it deemphasizes the inspection of patterns of cognitive strengths and weaknesses in relation to achievement

weaknesses, focusing instead on a Full Scale Intelligence Quotient standard score. The method does not allot much attention to levels of functioning in areas other than ability and achievement, such as socio-emotional levels or executive function capacities; it hyper-focuses on quantitative discrepancies found between standard scores, without allowing for an ecological examination of the child (Buttner & Hasselhorn, 2011; Hain, 2008). It has also been considered a "wait to fail" model because students do not receive intervention until they are performing significantly below expected levels, ignoring the importance and effectiveness of early intervention services (Buttner & Hasslehorn, 2011). Other concerns with this method include over-classification of students with high cognitive abilities and average achievement levels, as well as under-classification of students with low scores on cognitive measures and below average achievement levels (Buttner & Hasslehorn, 2011; Hale, 2008). In its most recent version, IDEIA 2004 continues to allow this method to be used; however, it states that classification procedures for SLD no longer require the use of a severe discrepancy between intellectual ability and achievement for determining whether or not a child has a specific learning disability. Instead, procedures now also permit the use of a process that is based on the child's response to scientific, research-based interventions or the use of other alternative research-based procedures (Title 20 of Section 1414, subsection b(6); [cited as 20 USC 1414(b)(6)]).

Response to Intervention (RTI) Model. The response to intervention, also called RTI, RtI, RTII, RTI^2, and SRBI in various states, is a multi-tiered approach designed to help struggling learners; in this method, students' progress is closely monitored at each stage of intervention to determine the need for further research-based instruction and/or intervention in general education, special education, or both (see RTI Action Network). It can be used as a method to provide research-based intervention while progress monitoring students' levels of

achievement, but it has also become a means of classification for students in some states, because tier three involves long-term programming for students who fail to respond to tier two interventions (see RTI Action Network). Classification decisions are made on ipsative rather than normative assessment of academic performance (Fletcher et al., 2006). Although RTI has demonstrated tremendous success as a prevention model by enabling students to receive early intervention, it has been criticized for use as a classification method because it does not allow for assessment of the basic psychological processes to examine possible deficiencies that often play a role in students' difficulties with achieving at expected academic levels (Hale, 2008). The model is ignorant of the possibility that a multitude of reasons could be responsible for students' lack of responses to an intervention, such as cognitive or process weaknesses, attention difficulties, executive dysfunction, or psychopathology, all of which could significantly interfere with the students' abilities to access the intervention. Often, many students who do not respond to a tier two intervention have true learning disabilities; however, there are also those students who have different problems interfering with their abilities to respond to the intervention, and these problems may mask academic deficits. Providing these students with more intensive levels of academic intervention to remediate the skill deficit will be ineffective, if those underlying areas of concern not also addressed.

A problem with these first two classification methods arises because neither the ability-achievement discrepancy nor RTI models allow for school psychologists to examine an ecological perspective of the child through consideration of comorbid deficits; this may be done through examination of psychological process strengths and weaknesses, academic levels, socio-emotional functioning, and executive function capacities in relation to each other when making the determination of whether or not a child meets criterion for SLD eligibility. The RTI model

does not allow examiners to assess the basic psychological processes that could be areas of weakness for students, regardless of the fact that such deficits can have enormous implications on, or even be responsible, for a student's academic difficulties in the classroom (Hain et al., 2009; Hale et al., 2010). This was publicly stated through an Expert Panel White Paper (Hale et al., 2010), a position paper of the Learning Disabilities Association of America (LDA, 2006), and a paper prepared by the National Joint Committee on Learning Disabilities (NJCLD, 2010). Furthermore, the National Joint Committee on Learning Disabilities (2005) in the United States had already suggested by this time, that practitioners should conduct a comprehensive evaluation of a child's difficulties using multiple sources, including data from standardized and norm-referenced measures, in addition to responsiveness to intervention, at least within the third tier, if not sooner. Similarly, OSERS (Office of Special Education and Rehabilitative Services) prepared a memo in January of 2011 reporting that RTI cannot be used to delay or deny an evaluation for eligibility under the IDEIA. Because of these problems, the third method of classification has gained popularity; however, this method is not currently allowed in every state.

A Third Alternative Method. Many authors in the field of psychology have argued for the utilization of a neuropsychological approach in the assessment and understanding of children's learning problems to assist in the development of appropriate educational programs for children (D'Amato & Hartlage, 2008; Fiorello, Hale, & Snyder, 2006; Flanagan, Fiorello, & Ortiz, 2010; Hain, 2008; James & Selz, 1997; Naglieri, 2001; Rhodes, D'Amato, & Rothlisberg, 2008; Sattler & D'Amato, 2002; Teeter, Ellison, & Semrud-Clikeman, 2007; Work & Heesook, 2005). Such a model can not only address the concept of comorbid deficits in students, but it can also allow for the subtyping of SLD across variables. This third method allows for the use of a model that includes a cognitive and neuropsychological orientation in the interpretation of

assessment results, examination of cognitive and process strengths and weaknesses in relation to academics, and an ecological formulation of the whole child when making classification decisions for SLD (Hale et al., 2010).

There are some models currently available that can be used following this third alternative procedure classification method for determining SLD according to IDEIA 2004. Some contemporary models have been proposed: Hale et al. (2004) suggested the Concordance-Discordance Method (C-DM), Naglieri and Das (1997) introduced the Discrepancy/Consistency Method (D/CM), and Flanagan, Ortiz, and Alfonso (2007) popularized the Cross Battery Assessment (XBA) approach. Additional methods include the Operational Definition of SLD (Flanagan et al., 2002, 2006) and Hypothesis-Testing Cattell-Horn-Carroll (HT-CHC; 2010). One model that has gained popularity is Hale's and Fiorello's (2004) C-DM, which relies on a Lurian process-oriented approach, and includes Cognitive Hypothesis Testing (CHT). This is done through examining whether or not concordance exists between the deficient achievement area and deficient cognitive processes that are related to that assumed area of academic weakness. Discordance is next examined between the deficient achievement area and cognitive processing strength. When a significant difference exists between the cognitive strength and the achievement weakness (discordance), and there is not a significant difference between the cognitive weakness and the achievement deficit (concordance), then SLD in that deficient achievement area is identified (Hale & Fiorello, 2004). CHT suggests that if a global deficit is observed in a child's assessment results, hypotheses should be made regarding the deficit, and then tested further for specific deficits (Miller, 2007).

When using Naglieri's and Das' (1997) Discrepancy/Consistency Method (D/CM) model, the examiner looks for substantial differences among a student's basic psychological

processes, meaning that the lowest score is significantly below average. There needs to be a significant difference between average or better processing scores and achievement. Additionally, there needs to be consistency between poor processing scores and academic deficits (Naglieri, 2011). This method, which was developed for use with the Cognitive Assessment System (CAS; Naglieri & Das, 1997), looks for greater within-child variability than expected (Flanagan, Fiorello, & Ortiz, 2010). A different approach is the Operational Definition of SLD, (Flanagan et al., 2002, 2006). This method includes three levels of evaluation that attempt to identify normative strengths and weaknesses in academic and cognitive abilities and processes, and also to understand the relationships among them. The authors report that exclusionary or rule-out factors, defined in the IDEIA, are systematically evaluated to separate children with SLD from those whose performance is due to noncognitive factors (i.e., behavior problems, sensorimotor difficulties, cultural and linguistic differences) and students who have more pervasive cognitive and academic problems that are not believed to be attributable primarily to a SLD (i.e., intellectual disability [ID]) (Flanagan, Fiorello, & Oritz, 2010). A newer approach called Hypothesis-Testing Cattell-Horn-Carroll (HT-CHC; 2010) is based on an integration of previous models developed by Flanagan and colleagues (2002) and Hale and Fiorello (2004). The HT-CHC model includes a four-tier, RTI model and utilizes CHC Theory and hypothesis testing within the tiered framework. Finally, a cross-battery approach (XBA) has been introduced by Flanagan, Ortiz, and Alfonso (2007) to allow practitioners to examine cognitive abilities above and beyond the scope of what is possible from a single intelligence battery. This theory is used as a way to examine evidence for SLD determination that is meant to be used as a part of a larger collection of data obtained within a problem-solving context (Flanagan, Ortiz, & Alfonso, 2011), rather than as a sole classification method for determining

SLD.

As a way of combining the values of RTI and cognitive/neurocognitive assessment, Hale (2006) suggests the Balanced Practice Model, in which children receive RTI with progress monitoring during Tier 1, and a more individualized problem-solving RTI approach at Tier 2, both of which can be accomplished in the general education setting (Fiorello et al., 2009; Hale, 2006; Hale et al., 2006). However, prior to the typical RTI model's SLD determination and Tier 3 intervention, Hale (2006) suggests that at this point, children should receive a comprehensive evaluation in all areas of suspected disability, including examination of the basic psychological processes that underlie SLD (Hain, 2008; Hale, 2008). An aggregation of both the ability-achievement discrepancy and the RTI approaches would be in compliance with IDEIA (2004).

Specific Learning Disabilities: Evidence of Heterogeneity

In addition to the noted inconsistencies and difficulties with the definition and classification procedures of students with SLD, learning disabilities continue to be described as one of the most confusing and disorganized categories in the area of child psychology; this observation has been attributed to Coplin and Morgan (2001) as a result of the attempt to study children with SLD as a homogeneous population. This popular belief regarding the population of students with SLD to be homogeneous types of learners dates back to the earliest researchers (Benton, 1975; Rourke, 1978; Rourke, 1999). It was found consistently that people with innate learning disabilities were quite similar to those who had suffered brain damage, and studies therefore focused on comparing these populations with typical populations (Rourke, 1999). But as studies evolved, it became more apparent that differences existed between this population with SLD (i.e., findings that some students with SLD were more deficient in auditory versus visual memory), leading to the realization that the group may not be as homogeneous as once imagined

(Rourke, 1999). For example, Whitehurst and Fischel (1994) found that children with receptive language deficits, which are common in several types of SLD, appear to be more likely to demonstrate psychopathological behavior than those with expressive deficits. In a different study, Myklebust (1967) observed noticeable differences in patterns of performance among students with SLD, especially noticing that some who struggled to read presented with cognitive profiles quite different from those who had other areas of academic difficulty. Other researchers had indicated that three main categories of learning disabilities were reported, including those with verbal deficits, nonverbal deficits, and automatic processing difficulties (Hurley & Levinson, 2002). Verbal disabilities included poor oral language, difficulty with auditory short-term memory, and phonological difficulties (Hurley & Levinson, 2002). These students were described as having strong visual-perceptual skills but weak receptive and expressive language skills, poor verbal reasoning, and weak auditory memory (Hurley & Levinson, 2002). Nonverbal learning disabilities were noted to involve difficulties with visual-spatial analysis, visualization, nonverbal reasoning and problem solving, and organization, although they demonstrate strengths with oral language and verbal skills (Hurley & Levinson, 2002). They additionally struggled to attend to facial expression, body language, and other visual cues that are involved in social situations, as well as to reading comprehension, arithmetic, creative writing, and basic graphomotor skills (Hurley & Levinson, 2002). Isatsanis, Fuerst, and Rourke (1997) suggested a possibility that subtypes of SLD and subtypes of psychosocial functioning might be related in a causal manner to specific patterns of neuropsychological strengths and deficits. Researchers explained that psychosocial disturbance is thought to originate as a direct expression of the same pattern of neuropsychological strengths and weaknesses that underlies the academic learning difficulties of the child with SLD (Isatsanis, Fuerst, & Rourke, 1997). Nussbaum and Bigler

(1986), and then Nussbaum et al. (1986) provided evidence for three subtypes of SLD after examining neuropsychological and behavior profiles of classified students. The first subtype demonstrated severe and generalized impairments, the second presented with a moderate degree of impairment with more significant verbal deficits, and the third showed the least number of deficits, although somewhat greater impairment was noted with their visuo-spatial/motor functioning (Nussbaum & Bigler, 1986; Nussbaum et al., 1986). Rock, Fessler, and Church (1997) described a conceptual model that delineated six critical areas of functioning that might be impaired in students with SLD; these areas were concomitant with an emotional/behavioral disorder, including cognitive processing, social emotional adjustment, behavioral functioning, academic performance, language functioning, and executive functioning. They described the fact that there is overlap and interaction among deficits within the domains, resulting in different patterns of performance among these students (Rock et al., 1997). The model was developed with the purpose of providing a framework for assessing children in order to design interventions in all relevant areas (Rock et al., 1997). Following these studies, it became clear that the same type of intervention was not unanimously successful among all students who presented with SLD (Johnson & Myklebust, 1967; Mattis, French, & Rapin, 1975; Rourke, 1999), which provided even more support for possible subtypes of SLD requiring different types of academic interventions.

Emergence of Subclassification of SLD. As emerging evidence of varying patterns of strengths and weaknesses in students with SLD became apparent, researchers began to organize the data into specific subtypes, with the aim to separate groups of individuals with similar performances across the variables being considered (Coplin & Morgan, 2001; D'Amato et al., 1998; Feifer & Della Toffalo, 2007; Hain, 2008; Hain, Hale, & Kendorski, 2008; Hendriksen et

al., 2007; McKinney & Speece, 1986; Morris et al., 1998; Nussbaum & Bigler, 1986; Nussbaum et al., 1986; Rourke, 1999; Rourke, 2005; Rourke & Darren, 1992; Speece et al., 1985). The identification of subtypes is important in order to allow interventions to be better allocated to meet the specific needs that each group has in common. Early studies evidenced that both the right hemisphere of the brain, which is specialized for holistic integration of visual-spatial stimuli, and the left hemisphere, which is specialized for sequential integration of primarily linguistic stimuli, are necessary for learning. When students experience dysfunction in one of the hemispheres, it creates an imbalance that emerges through student performance in the classroom (Coplin & Morgan, 2001). The different patterns of performance that result from deficits that emerge from hemispheric dysfunction can be organized into neuropsychological subtypes of learning disabilities (Coplin & Morgan, 2001).

SLD and neurocognitive/academic variables: Patterns of performance. Through a thorough examination of the multiple factors that go into academic skills (reading, writing, mathematics), Feifer and Della Toffalo (2007) concluded that there are common themes throughout SLD; however, these are marked by heterogeneity. They developed their own unique subtypes of reading disabilities, explaining that Dyslexia can be separated into Dysphonetic Dyslexia, Surface Dyslexia (Visual Word-Form Dyslexia), and Mixed Dyslexia, and reporting that all subtypes are neurobiological in nature (Feifer & Della Toffalo, 2007). The researchers determined that Dysphonetic Dyslexia includes an inability to use phonology to bridge letters and sounds, with greatest effort being placed on visual and orthographic cues to identify printed words (Feifer & Della Toffalo, 2007). Specific deficits were noted in the areas of phonological awareness and phonological processing. In Surface Dyslexia, students can sound out words but struggle to recognize sight words automatically, with a severe deficit noted in fluency and word

accuracy (Feifer & Della Toffalo, 2007). The Mixed Dyslexia type is the most severe; students do not have a key to "unlock the functional code of literacy" (Feifer & Della Toffalo, 2007, p. 823). Deficits tend to be noted in the areas of phonological processing, rapid naming, verbal memory, and reading fluency (Feifer & Della Toffalo, 2007). Feifer (2007) added a fourth reading disorder subtype, which involves deficits in the area of reading comprehension, noting that these students have solid basic reading skills. These students tend to have specific weaknesses in the areas of executive functioning, working memory, and language foundation skills (Feifer & Della Toffalo, 2007). A different study suggested a breakdown of students into one of three subtypes regarding reading disabilities: those who have a phonological-deficit, a rapid-naming deficit, or both depressed phonological processing and rapid naming (King, Giess, & Lombardino, 2007).

Students who have reading disabilities appear to have a generalized deficit in working memory (Siegel & Ryan, 1989). Although children with an arithmetic disability do not have a generalized language deficit, they do appear to have a specific working memory deficit relative to processing numerical information (Siegel & Ryan, 1989). Crews and D'Amato (2009) examined subtypes of reading disabilities in children using the NEPSY Language and Memory and Learning Domains, finding an emergence of three clusters. They discovered a No Language or Memory Deficit Subtype, a Global Language and Memory Deficit Subtype, and a Global Memory Deficit Subtype, suggesting that memory-related processes, including more than merely phonologically related processes, might play a role in reading difficulties (Crews & D'Amato, 2009). In a previous study, D'Amato, Dean, & Rhodes (1998) had discovered subtypes of SLD in children with learning disabilities using neuropsychological, intellectual, and achievement measures. Four clusters had emerged, which were categorized as Verbal-Sequential-Arithmetic

Deficits, Motor Speed and Cognitive Flexibility Deficits, Mixed Language/Perceptual Deficits, and No Deficit Subtype (Crews & D'Amato, 1998).

Hendriksen et al. (2007) described three SLD subtypes, which consisted of Attention with or without Motor Function Disabilities (AMD), Verbal Learning Disabilities (VLD), and Non-Verbal Learning Disabilities (NVLD). In their study consisting of a sample of 495 school-aged children, LD and AMD were the most frequent diagnoses, with NVLD having been diagnosed less frequently (Hendriksen et al., 2007). Each of the subtypes discovered was categorized by different and unique patterns of performance regarding behavioral and neuropsychological functioning. They found that the VLD group demonstrated the least amount of behavioral problems, whereas the AMD group showed more externalizing problem than other subtypes (Hendriksen et al., 2007). The AMD group had a lower level of sequential processing and a less consistent speed of working on a task requiring sustained attention, and the LD subtype had lower scores on reading subtests (Hendriksen et al., 2007). The LD group had higher scores on visual motor integration than other subtypes, Hendriksen et al., 2007). The NVLD subtype demonstrated more internalizing problems, compared with other subtypes when rated by teachers, and they also showed lower simultaneous processing and arithmetic scores (Hendriksen et al., 2007).

Rosselli, Matute, Pinto, and Ardila (2006) examined mathematical skills and memory abilities of two subgroups of children with developmental dyscalculia (DD; one group with DD only and a second group with DD and reading disorders; RDD). The researchers found that children with DD and children with RDD all showed a similar pattern of mathematical impairment and demonstrated significantly lower scores than the control group on working memory tasks (Rosselli et al., 2006). However, the RDD group had significantly lower scores

than the control group in visual learning and semantic memory (Rosselli et al., 2006). Overall, they concluded that working memory tests seemed to be the best predictors of mathematical test scores, therefore suggesting that children with specific disabilities in mathematics may present with this major cognitive defect (Rosselli et al., 2006); this was somewhat contradictory to the results presented by Siegel and Ryan (1989). All of these studies successfully examined neurocognitive and academic variables in relation to SLD, but even more studies began to emerge that additionally considered psychosocial/behavioral impacts on SLD.

SLD and psychopathology: Evidence of comorbidity and patterns of performance.

In general, some studies have reported that children with classifications of SLD experience high levels of socio-emotional difficulties (Buttner & Hasselhorn, 2011), whereas others indicated that children who experience socio-emotional problems have a greater tendency to have brain-based disorders (Hale and Fiorello, 2004). Subsequently, although there is adequate evidence supporting an association between SLD and socio-emotional disturbance, there is currently no agreement regarding the degree and directions of this relationship (Isatsanis, Fuerst, & Rourke, 1997). Results from studies have shown that socio-emotional difficulties are often evidenced as secondary manifestations of a primary learning disability (Isatsanis, Fuerst, & Rourke, 1997), even though they may be truly comorbid. Hale and Fiorello (2004) describe how educators have a tendency to “compartmentalize the interrelated domains of cognition and behavior, although doing so rarely reflects the complexity of children” (p. 244). They report that this happens at times because of a level of discomfort on the part of the school psychologist; however, they stress that making proper identifications can lead to preventative early intervention (Hale & Fiorello, 2004).

According to the Surgeon General of the United States (U.S. Public Health Service, 2000), one in five children exhibits symptoms of a DSM-IV disorder, with five percent suffering severe impairment from an emotional disorder. Literature has overwhelmingly suggested that students with SLD display more behavioral problems, less competent social skills, and a greater likelihood to demonstrate socio-emotional difficulties than their nondisabled peers (Bryan, 1991; Hale & Fiorello, 2004; Isatsanis, Fuerst, & Rourke, 1997). Dyscalculia and dyslexia have been shown to be comorbid with ADHD at a rate of 26% and 33%, respectively, with 17% of students with dyscalculia also demonstrating significant deficits in reading (Mayes & Calhoun, 2006; Shaywitz & Shaywitz, 1988). Regarding social skills, it has been reported that although the majority of students with SLD are accepted by peers and are socially competent, they do demonstrate more social problems than students without SLD (Greenham, 1999). This has been demonstrated by studies showing that children with SLD are more likely to be rejected (i.e., rejected, meaning mentioned by peers as someone they do not like), and are less likely to be popular (i.e., popular described by peers as someone they like) (Conderman, 1995; Greenham, 1999; Nabuzoka & Smith, 1993; Ochoa & Palmer, 1991; Wiener, 1987). It has also been noted that children with SLD are more likely to be neglected (i.e., not named as liked or as disliked) than are students without the classification (Greenham, 1999; Stone & La Greca, 1994). Findings have suggested that students with SLD primarily misinterpret nonverbal clues, but they also misinterpret verbal cues more often than do their non-SLD peers (Bryan, 1981; Greehnam, 1999; Kavale & Forness, 1996; Pearl, 1986; Perlmutter, 1986).

Internalizing problems, such as depression and anxiety, tend to be somewhat higher for individuals with SLD than for non-SLD controls, although according to one study, scores fell within the normal range for both groups (Greenham, 1999). Externalizing problems, especially

aggression, delinquency, and hyperactivity, were noted to be higher in an SLD population, but again, scores were not at significant clinical levels (Greenham, 1999). As mentioned previously, Hendriksen, et al., (2007) described three SLD subtypes, which consisted of Attention with or without Motor Function Disabilities (AMD), Verbal Learning Disabilities (VLD), and Non-Verbal Learning Disabilities (NVLD). This study considered socio-emotional variables in addition to cognitive and academic factors; findings indicated that the VLD group demonstrated the fewest number of behavioral problems, whereas the AMD group showed more externalizing problem than other subtypes (Hendriksen et al., 2007). The NVLD subtype demonstrated more internalizing problems compared with other subtypes when rated by teachers, and they also showed lower simultaneous processing and arithmetic scores (Hendriksen et al., 2007). Isatsanis, Fuerst, and Rourke (1997) found clear relationships between academic achievement patterns and personality subtypes, reporting that of students classified with SLD, severity and type of socio-emotional functioning (Internalizing Problems, Externalizing Problems, or Normal), were found to be related to performance on cognitive and academic achievement measures. Particularly, students with SLD who also demonstrated Internalizing Problems scored significantly higher on verbal comprehension measures of cognitive tests than the other two groups (Isatsanis, Fuerst, & Rourke, 1997). Some evidence has been reported suggesting that individuals with nonverbal learning disabilities (NLD) are at much greater risk for personality disturbance and behavior problems than students with other subtypes of SLD (Greenham, 1999).

Research has demonstrated that the socio-emotional adjustment of individuals who have reading disabilities is within the same range as non-SLD controls (Greenham, 1999), whereas other studies have found that children with language and reading disorders are more likely to experience withdrawal, anxiety, fear, and depression (Hale & Fiorello, 2004). Prior, Smart,

Sanson, and Oberklaid (1999) reported, specifically, that children with a single SLD (e.g., reading) are more likely to experience internalizing behavior problems, whereas children with multiple SLD's (e.g., reading, math, and writing) are more likely to demonstrate disruptive behavior disorders. Cross-sectional research has noted possible developmental differences between students with verbal and nonverbal SLD, with the nonverbal SLD group demonstrating more pathological behavior over time (Hale & Fiorello, 2004), but others have found patterns to be consistent between the groups (Fuerst & Rourke, 1995). Hale and Fiorello (2004) further reported that assuming the dysfunction occurs within the left-hemisphere, some children with reading or language-based SLD might also have difficulty with affect and social perception. Similarly, Rourke and Fuerst (1991) found that a large portion of students in their sample, who experienced SLD and who scored better on the Performance measure than on the Verbal measure of the WISC-IV, also demonstrated psychopathology, especially internalizing disorders, such as depression, anxiety, withdrawal, and somatic complaints.

In his studies, Rourke (1989) identified two subtypes of SLD; one he referred to as those with a Basic Phonological Processing Disorder (BPPD), and the other he described as those with Nonverbal Learning Disabilities (NLD; Rourke, 1989). He reported that students with BPPD are those who demonstrate "poor psycholinguistic skills in conjunction with well-developed spatial-organizational, tactile-perceptual, psychomotor, and nonverbal problem-solving skills" (Rourke, 1999, p. 36). He suggested that they struggle with reading and spelling, but exhibit much stronger, although still impaired, math skills (Rourke, 1999). He explained the fact that the NLD group demonstrates "outstanding problems in visual-spatial organizational, tactile-perceptual, psychomotor, and nonverbal problem-solving skills", adding that they are strong with their "psycholinguistic skills such as rote verbal learning, regular phoneme-grapheme matching,

amount of verbal output, and verbal classification" (Rourke, 1999, p. 36). Rourke (2005) reported that the students with NLD are extremely prone to severe socio-emotional dysfunction throughout their development, whereas those with BPPD are not.

Expanding on Rourke's (1999; 2005) findings, Palombo (2006) suggested a need for more attention to be placed on the socio-emotional dimension of functioning; this led to him finding his own subtypes of NLD, including a group that demonstrated problems with complex nonverbal reasoning and processing (subtype I), a group with subtype I criteria plus problems with attention and executive functions (subtype II), a group with subtype I criteria plus impaired social cognition (subtype III), and a group with subtype II criteria plus impaired social cognition (subtype IV). In one of his more recent studies, Rourke (2000) described a pattern of arithmetic deficits in NLDs, which included lower WISC Performance than Verbal scores, right-hemisphere dysfunction, and psychopathology. Disorders such as NLD, which are presumed to be related to right hemisphere/white matter dysfunction, including disorders such as Williams Syndrome (Leyfer, Woodruff-Borden, & Mervis, 2009; Marenco et al., 2007), Turner Syndrome (Holzapfel et al., 2007; Lasker, Mazzocco, & Zee, 2007) and Asperger Disorder (Hale et al., 2006; McAlonan et al., 2009), tend also to present with significant math disability and psychopathology, consistent with Rourke's (2000) NLD theory (Hale, Hain, Murphy, et al., in press). Although Rourke's (2000) findings have been generally accepted, some have challenged them because not all NLD and math SLD subtypes display NLD profiles (Hale et al., in press). Further, right hemisphere/white matter dysfunction also interferes with implicit, higher-order language in addition to "nonverbal" problems (Bryan & Hale, 2001), suggesting that the "nonverbal" label may be an undersimplification. The right hemisphere has a larger proportion of white matter, specializing in integration of complex stimuli and novel problem-solving

(Goldberg, 2001; Hale & Fiorello, 2004; Rourke, 2008), both of which are necessary during social exchange (Hale, Hain, Murphy, et al., in press).

In one particular study, various subtypes of cognitive and academic SLD were examined across a multitude of variables, including neurocognitive, academic, and socio-emotional factors, resulting in the identification of Visual/Spatial, Fluid Reasoning, Crystallized/Language, Processing Speed, Executive/Working Memory, and High Functioning/Inattentive subtypes (Hain, Hale, & Kendorski, 2008). Each subtype demonstrated unique patterns of performance across the factors assessed, with common themes emerging.

Visual/spatial subtype. The researchers found a Visual/Spatial subtype, which they summarized as a group, including students who demonstrated overall deficiencies in visual and spatial processing, visual analysis and synthesis, understanding of part-whole relationships, and global processing (Hain, Hale, & Kendorski, 2008), suggesting right posterior dysfunction. Specifically, students demonstrated cognitive deficits in the areas of visual/spatial processing, sensory integration, sensory/motor coordination, and attention allocation. Academic deficits of this Visual/Spatial subtype included the areas of math calculation and math reasoning. There were also socio-emotional concerns common across this subtype, including attention problems, learning problems, school problems, and attention to self and environment (Hain, Hale, & Kendorski, 2008).

Fluid reasoning subtype. A second subtype, named a Fluid Reasoning Subtype was found; it involved overall impaired fluid novel problem-solving and categorical inductive reasoning; this also most likely resulted from right hemisphere dysfunction, although more anterior areas might be related to the attention difficulties and executive dysfunction (Hain, Hale, & Kendorski, 2008). Specific cognitive deficits were reported in the areas of fluid reasoning,

discordant/divergent thought, novel problem solving, and mental flexibility. Academic deficits that emerged across this second subtype were in the areas of math reasoning and reading comprehension. Particular socio-emotional concerns of this subtype were noted to be externalizing problems, depression/somatic complaints/withdrawal, attention, learning, school problems, and atypicality (Hain, Hale, & Kendorski, 2008).

Crystallized/Language subtype. A third subtype with common deficits, named the Crystallized /Language subtype, emerged from this study; this subtype is determined by an overall theme of deficits with concordant/convergent thought, receptive and expressive language difficulties, and high levels of psychopathology, comparable to the Verbal Learning Disability (VLD) subtypes indicated by other researchers (Hain, Hale, & Kendorski, 2008). This subtype most likely involves the left hemisphere, grey matter dysfunction, including specific cognitive deficits in the areas of crystallized ability, receptive/expressive language, auditory working memory, long-term memory, and symbolic relationships. The academic deficits endorsed were in the areas of word reading, reading comprehension, math calculation, math reasoning, spelling, and written expression. Particular socio-emotional concerns consisted of aggression, conduct problems, deficits, inattention/hyperactivity, learning and school problems, and atypicality (Hain, Hale, & Kendorski, 2008).

Processing Speed Subtype. A fourth subtype, named the Processing Speed Subtype, is marked by appropriate Verbal Comprehension and Perceptual Reasoning and Working Memory scores, but involves a significant deficit in the area of Processing Speed (Hain, Hale, & Kendorski, 2008). The authors hypothesized that this subtype could result from anterior cingulate/cingulate frontal-subcortical circuit dysfunction (Hain, Hale, & Kendorski, 2008); it consisted of cognitive deficits in the areas of visual sensory memory, visual-symbolic learning,

rote clerical tasks, processing speed, psychomotor skill, decision making, quick, efficient performance. Academic deficits found were in the areas of reading comprehension and written expression. Socio-emotional concerns included depression, withdrawal, attention, learning, school problems, and atypicality (Hain, Hale, & Kendorski, 2008).

Executive/Working memory subtype. A different subtype that emerged from the study was the Executive/Working Memory Subtype, which included overall deficits in auditory-verbal working memory and visual-motor psychomotor speed as well as severe socio-emotional deficits (Hain, Hale, & Kendorski, 2008). The deficits are most likely related to frontal-subcortical circuit dysfunction (Hain, Hale, & Kendorski, 2008). Specific cognitive deficits were indicated in the areas of working memory, processing speed, mental flexibility and manipulation, hypothesis testing, memory encoding and retrieval, and self-monitoring and evaluation. Academic deficits were reported to be in the areas of decoding, word reading, math calculation, and written expression. Socio-emotional concerns included attention/hyperactivity, aggression, conduct problems, depression, withdrawal, atypicality, somatic complaints, and learning and school problems (Hain, Hale, & Kendorski, 2008).

High functioning inattentive subtype. The final subtype was the High Functioning Inattentive Profile, which appeared to be the overall highest functioning subgroup (Hain, Hale, & Kendorski, 2008). A mild deficit with basic encoding of auditory information into short-term memory was noted, and is indicative of anterior dysfunction relating to attention (Hain, Hale, & Kendorski, 2008). This subtype included specific cognitive deficits such as crystallized ability, processing speed, visual spatial processing, concordant/convergent thought, discordant/divergent thought, auditory attention, working memory, and sequencing. Academic deficits that were endorsed included the areas of word reading, reading comprehension, calculation, math

reasoning, spelling, and written expression. Finally, socio-emotional concerns were noted to be hyperactivity, attention, and impulse control (Hain, Hale, & Kendorski, 2008). The emergence of these subtypes delineates common patterns of performance across neurocognitive, academic, and socio-emotional variables, particularly pertaining to the frontal/subcortical circuit, right hemisphere, or left hemisphere dysfunction (Hain, 2008).

Biological basis of psychopathology in SLD. Dysfunction in the frontal and temporal lobes have most commonly been connected to psychopathology (Hale & Fiorello, 2004), but left versus right hemisphere distinctions have also been made. Some studies have demonstrated that right hemisphere brain dysfunction has been linked to psychopathology, especially anxiety, depressive states, and mania (Hain, 2008), whereas other studies (Ehrlichman, 1987) indicated that the right hemisphere is specialized for negative emotions, but the left hemisphere is specialized for positive emotion. Similarly, Hale and Fiorello (2004) indicated that if the left hemisphere is underactive, negative affect, including avoidance behaviors may occur, but if the right is underactive, then positive affect and approach behaviors may occur. Further, Hale, Rosenberg, Hoeppner, and Gaither (1997) reported preliminary findings that suggest a group with right frontal dysfunction has more inattentive and disinhibited ADHD-type symptoms, whereas a group with right posterior dysfunction displays inattention and symptoms similar to Rourke's description of NLD syndrome.

Executive dysfunction and SLD: Evidence of comorbidity and patterns of performance. Although most studies regarding SLD subtypes have not tapped into executive function capacities, it has been documented that the majority of students with socio-emotional difficulties tend often to exhibit comorbid executive dysfunction (Buttner & Hasselhorn, 2011). Executive functions have been described by McCloskey, Perkins, and Van Divner (2009) as

"directive capacities of the human brain" (p. 13), relating to the higher order control processes that guide behavior in an environment that is continuously changing (Robinson, Goddard, Dritschel, Wisley, & Howlin, 2009). These are a variety of higher-order mental capacities "that cue the use of other mental capacities such as reasoning, language, and visuospatial representation" and develop gradually over time (McCloskey et al., 2009, p. 15). Executive functions work in combination with cognitive processes in the processing of information and can produce a different SLD picture for affected children (Hain, 2008; McCloskey et al., 2009).

Executive function deficits have been indicated to be important factors in many childhood disorders, as well as in many psychiatric disorders (see DSM-IV-TR, 2008; Hanna-Pladdy, 2007). Depression has been linked to decreased left frontal arousal with reductions in approach behavior; anxiety, however, has been linked with increased right anterior arousal, resulting in withdrawal behaviors (Davidson & Henriques, 2000). Specifically, the dorsolateral and orbital cortical structures of the prefrontal cortex have been linked to many disorders, such as Attention Deficit Hyperactivity Disorder (ADHD) and Obsessive-Compulsive Disorder (OCD). Studies have demonstrated that the dorsal prefrontal cortex and frontal lobe white matter are involved in the emergence of a change in personality when lesions are made to these areas (Koziol & Budding, 2009; Hanna-Pladdy, 2007). Students with EF dysfunction often demonstrate behavioral, emotional, social, and academic difficulties (Hain, 2008; Whitaker, Detzer, Hanna-Pladdy, 2007; Isquith, Christian, & Casella, 2004). In considering children with SLD, there appears to be a higher rate of behaviors associated with executive function deficits when compared with those children whose deficits have no formal classification.

Children who display executive function difficulties often manifest multiple problem behaviors in school (Garruto & Rattan, 2009). Executive functions overlap with both emotional

development and academic achievement, with deficits often adversely impacting student performance (Garuruto & Rattan, 2009). For example, researchers have found that attention often accounts for differences among poor readers (Helland & Asbjornsen, 2000; Crews & D'Amato, 2009), indicating that executive function deficits certainly interfere with academic performance. Many psychopathologies and socio-emotional difficulties can be traced to executive dysfunction, stemming from dysfunction of the prefrontal-subcortical circuits, with different circuit patterns leading to different forms of psychopathology (Hale et al., 2009). This creates a difficult task in attempting to discriminate between deficits in socio-emotional skills versus deficits in executive functioning capacities; however, in truth, they are most likely intertwined (see Koziol & Budding, 2009 for review of the role of subcortical structures).

SLD in the area of written expression are most commonly seen in students with executive dysfunction, although they also occur in the areas of reading and math (Berninger et al., 2009; Hale & Fiorello, 2004). In a study of students with dyslexia, Helland and Asbjornsen (2000) found that these students demonstrated significant impairment on tasks measuring executive functions, but different patterns of impairment emerged according to the subgrouping. They found that the subgroups were equally impaired on the Dichotic Listening Test, but differed on the Stroop and Wisconsin Tests (Helland & Asbjornsen, 2000), concluding that executive problems exist in dyslexia, depending on receptive language skills. The executive functions that were of focus in this study were the sustain function (vigilance or the capacity to maintain alertness over time, involving the limbic system and midbrain), the focus/execute function (ability to select relevant stimuli from a variety to complete tasks, involving the prefrontal cortex), and the shift function (the ability to change the focus of executive functions in a flexible and adaptive manner, involving the midbrain and the prefrontal cortex) (Helland & Asbjorsen,

2000). There is also evidence of selective attention to visual and auditory information being used to successfully identify children with SLD (Greenham, Stelmack, & van der Vlugt, 2003). Poor readers and children with SLD demonstrate greater difficulty focusing their attention on task-relevant information than do normally achieving children (Richards, Samuels, Turnure, & Ysseldyke, 1990) or children with attention deficit disorders (Tarnowski, Prinz, & Nay, 1986). In a study, Greenham, Stelmack, and van der Vlugt (2003) investigated the role of attention in the processing of pictures and words for a group of unclassified children and for groups of SLD subtypes that were so determined by deficient performance on tests measuring reading and spelling (Group RS) and arithmetic (Group A). They found that that the word-naming deficiency for Group RS was a due to a specific linguistic deficit that develops at a later stage of processing rather than being due to a selective attention deficit (Greenham, Stelmack, &van der Vlugt, 2003). In contrast, Group A demonstrated a selective attention deficit, for that develops at an early stage of visuo-spatial processing. Van der Schoot, Licht, Horsley, and Sergeant (2000) conducted a study in which children with a guessing subtype of dyslexia, operationally defined as a group of students who read quickly but inaccurately, were compared with children with a spelling subtype of dyslexia, operationally defined as a group who reads slowly but accurately; the study focused on three aspects of executive functions, including response inhibition, susceptibility to interference from irrelevant information, and planning. The researchers found that guessers were impaired in their ability to inhibit inappropriate responding on tasks used to assess EF, suggesting a possibility that the specific reading disorder of guessers may be linked to the same executive deficits which underlie ADHD (van der Schoot et al., 2000).

Biological basis of executive dysfunction in SLD. Executive functions have been linked to different parts of the frontal lobes of the brain, particularly the pre-frontal cortex and its

connections with subcortical structures involving catecholamine transmission (Robinson, et al., 2009). At least five frontal-subcortical circuits, as well as the frontal lobe, basal ganglia, and thalamus demonstrate reciprocal relationships, which are responsible for executive functions as well as social/behavioral functioning (see Licheter & Cummings, 2001; Koziol & Budding, 2009). These five circuits include the motor circuit (involving the premotor, supplementary motor and primary motor cortex functions), the oculomotor circuit (responsible for frontal eye field, prefrontal, and parietal cortex functions), the dorsolateral prefrontal cortex (responsible for executive function), the orbital prefrontal circuit (responsible emotional self-regulation), and the anterior cingulate circuit (responsible for online monitoring and decision-making).

Although the frontal lobe (basal ganglia and cortex) divisions play an integral part in frontal convexity that mediate motor functions rather than playing a large role in cognitive functions, the prefrontal cortex (PFC) is important in mediating cognitive control of higher order functions (Koziol & Budding, 2009). According to one specific model (Koziol and Budding, 2009), the PFC is divided into three areas, which include the dorsolateral prefrontal cortex (DLPFC), the orbitofrontal cortex (OFC), and the anterior cingulate or medial frontal cortex (MFC) (Koziol & Budding, 2009). Koziol and Budding (2009) proposed that the circuits are different, yet parallel structures that loop each other. They indicated that lack of activity in these circuits can result in specific cognitive, academic, and behavioral deficits (Hanna-Pladdy, 2007; Koziol & Budding, 2009).

Koziol and Budding (2009) reported that the dorsolateral prefrontal circuit (DLPFC) is responsible for cognitive executive functions, which involve the functions measured by most neuropsychological tests (i.e., sustained attention, inhibition, working memory). Lack of activity in this area often results in problems with attention, working memory, planning, and organization

(Koziol & Budding, 2009). Deficits also may be noted in speech fluency and learning and memory (Koziol & Budding, 2009). Koziol and Budding (2009) indicated that the orbitofrontal circuit (OFC) includes lateral and medial divisions, and further noted that the medial division involves circuits that play a role in personality functioning. Damage to this lateral division can result in disinhibition, impulsivity, irritability, and emotional lability (Koziol & Budding, 2009). It often results in socially inappropriate behavior (Koziol & Budding, 2009).

The medial frontal circuit (MFC) originates in the anterior cingulate, and it is characterized by apathy (Koziol & Budding, 2009). People with damage to this area appear indifferent and lack motivation and interest. There are no neuropsychological tests that measure this circuitry well; Koziol and Budding (2009) reported that lack of knowledge about this area can cause practitioners to misattribute difficulties with motivation as being due to emotional factors rather than to lack of activity in the MFC. Finally, there is a motor circuit; lack of activity in this area results in symptoms of movement disorders (Koziol & Budding, 2009). Overall, there is no one frontal lobe syndrome, as demonstrated by the circuits, and lesions might result in divergent cognitive and behavioral deficits (Koziol & Budding, 2009). When a person presents with deficits, it is common for more than one circuit to be involved, resulting in presentation of a mixture of behaviors (including cognitive, affective, and motivational factors) across circuits (Koziol & Budding, 2009). This is demonstrated in developmental and psychiatric disorders, such as ADHD, obsessive-compulsive disorder, autism, and depression, in that the neurological and behavioral difficulties presented, originating in the frontostriatal system, indicate the involvement of multiple circuitries (Koziol & Budding, 2009).

The basal ganglia are important in making actions become automatic. As behaviors become more automatic, higher-level processes become available for conscious thinking to take

place. Before becoming automatic, executive control of higher-order thinking occurs only during the initial phases of procedural learning tasks. After learning has occurred, and the behaviors become more automatic, the cortico-striatal and cortico-cerebellar systems become involved in the processes (Koziol & Budding, 2009). The inferotemporal and parietal loops of the basil ganglia assist with making hypotheses and decisions about problem solving (Koziol & Budding, 2009). The system is also involved in implicit and procedural learning, allowing students to perform desired behaviors or to get rewards (Koziol & Budding, 2009). Therefore, it is rewarding and in the best interests of student for their behavior to become automatic. Additionally, the basil ganglia and prefrontal cortex include the highest concentrations of dopamine, which drives reward-seeking behavior (Koziol & Budding, 2009). Koziol and Budding (2009) hypothesized that when disorders affect the frontostriatal system, a large continuum of learning differences can be observed in response to positive and negative reinforcement.

Because the basil ganglia is involved in the intention of both motor and cognitive functions, the cerebellum relates to manipulating body parts in the same way in which it is involved in the manipulation of ideas (Koziol & Budding, 2009). Disturbances in the cerebellar cognitive affective system in children have resulted in executive dysfunction, including impaired planning, set-shifting, verbal fluency, abstract reasoning, and working memory (Koziol & Budding, 2009). Visuo-spatial deficits have also been identified, as have personality changes, including flat affect, disinhibition, and inappropriate behavior, in some populations with disturbances of this system (Koziol & Budding, 2009).

Overall, it appears that students with SLD display varying patterns of performance (assets and deficits) in their neurocognitive, academic, psychosocial, and executive function skills that

can be subtyped to assist with more accurate classification and more individualized and appropriate interventions. Comorbidity and common areas of deficit exist in students with SLD across these different variables.

Implications of SLD Subgroups for Intervention

Neuropsychological assets and deficits that underlie SLD are thought to be the same deficits underlying the socio-emotional and executive deficits (Buttner & Hasselhorn, 2011; Hain, 2008; Rourke, 1994). This is imperative because if SLD subgroups are formed from a neuropsychological perspective, with all areas of functioning examined, more specific and individualized interventions can be designed. There are generally two methods in which to intervene relative to academic skills; these include remediation of a skill (usually more successful in early grade levels) or an accommodation/compensation tactic, which involves using the child's neuropsychological strengths to acquire academic skills (Coplin & Morgan, 2001). An approach in which the child's neuropsychological strengths are used to acquire academic skills can be successful because the "functional system capable of the most efficient means of information processing" is being used to compensate for areas of weakness (Coplin & Morgan, 2001, p. 617). For example, Coplin and Morgan (2001) indicate that children with left hemisphere strengths benefit from an analytic-sequential method that involves auditory-linguistic abilities, whereas children with right hemisphere strengths benefit from a simultaneous, visuo-spatial processing method.

The identification of subtypes of SLD is important to allow interventions to be better allocated to meet the specific needs that each subgroup has in common. Studies have demonstrated that interventions tailored to child needs not only lead to enhancement of learning and psychosocial deficits, but they also result in changes in brain structure and function (Hale, et

al., in press; Pliszka, Lancaster, Liotti, & Semrud-Clikeman, 2006; Richards et al., 2007; Simos et al., 2007). Without consideration of such comorbidity across variables, identification of students for special education services and development of Individualized Educational Plans (IEP's) addressing areas of specific deficits may not be accurate. If all areas are not assessed in the process of determining eligibility, then proper, focused, and individualized services cannot be delivered. Although some researchers have considered all areas of functions in their derivation of subgroups of SLD, many others have conducted studies that were too narrow, demonstrating that there is still a need for more studies that focus on variables across cognitive, academic, socio-emotional, and executive function capacities (Coplin & Morgan, 2001; Feifer & Della Toffalo, 2007; Hain, 2008; Hain, Hale, & Kendorski, 2008; Morris et al., 1998; Rourke, 1999; Rourke, 2005; Rourke & Darren, 1992). Also of importance is that with the existence of SLD subtypes, simple RTI or discrepancy model approaches may not suffice for determining the presence of a SLD for eligibility purposes regarding Special Education.

Overall, meaningful subtypes of SLD need to be identified according to patterns of performance across cognitive, academic, socio-emotional, and executive variables. In the past, SLD has been studied as a homogenous entity (Rourke, 1999), focusing on a common pattern of significant discrepancies between ability and achievement among classified students, but as more recent research has evolved, it has become more evident that there are very different patterns of performance (abilities and deficits) exhibited by children classified with SLD, suggesting that they actually compose a heterogeneous group (Rourke, 1999). In addition to the cognitive and achievement factors involved in SLD, many students also experience difficulty with socio-emotional adjustment and executive dysfunction (Hain, 2008; Helland & Asbjornsen, 2000; McCloskey, 2009; Rourke, 2008). To assist in understanding the effects of comorbidity with

other areas of difficulty on SLD, researchers have begun to develop subtypes of SLD through identification of unique patterns of performance (strength and weaknesses) across multiple domains (i.e., cognitive, academic, socio-emotional, and executive functioning) (Crews & D'Amato, 2009; Hain, et al., 2008; Rourke, 1999; Rourke, 2005). Comorbidity and common areas of deficit exist in students with SLD across these different variables.

Chapter 3

Method

Participants

Data for three students were obtained through responses to data requests from certified school psychologists in the suburbs surrounding the Philadelphia, Pennsylvania area. The remaining, and majority of the participant data, was drawn from a convenience sample of 800 school-aged children who had been evaluated in the school or in private practice settings by a certified school psychologist/licensed psychologist in the surrounding Pittsburgh, Pennsylvania area. All students included in the study were classified with SLD in one of the following areas: reading, math, or reading and math. Students with SLD in written expression were not included in this study. Approximately 5% (37 students) of the convenience sample of 800 children met criteria for inclusion in this study, resulting in a final sample of 40 students. Data were not included for the other 95% of participants in the convenience sample, because student files did not contain current WJ III Cognitive scores, WJ III Achievement scores, BASC-2 parent rating scores, and BRIEF parent rating scores completed simultaneously in the same evaluation, or students were not classified with SLD. The anonymous archival data, which did not include any identifying information of students, was provided in an excel spreadsheet from a certified school psychologist/licensed psychologist in private practice. Detailed information regarding the socioeconomic status of the children whose demographics and test scores were collected was available, although most data were drawn from a homogeneous, middle class population. Please refer to Table 1 for demographic information.

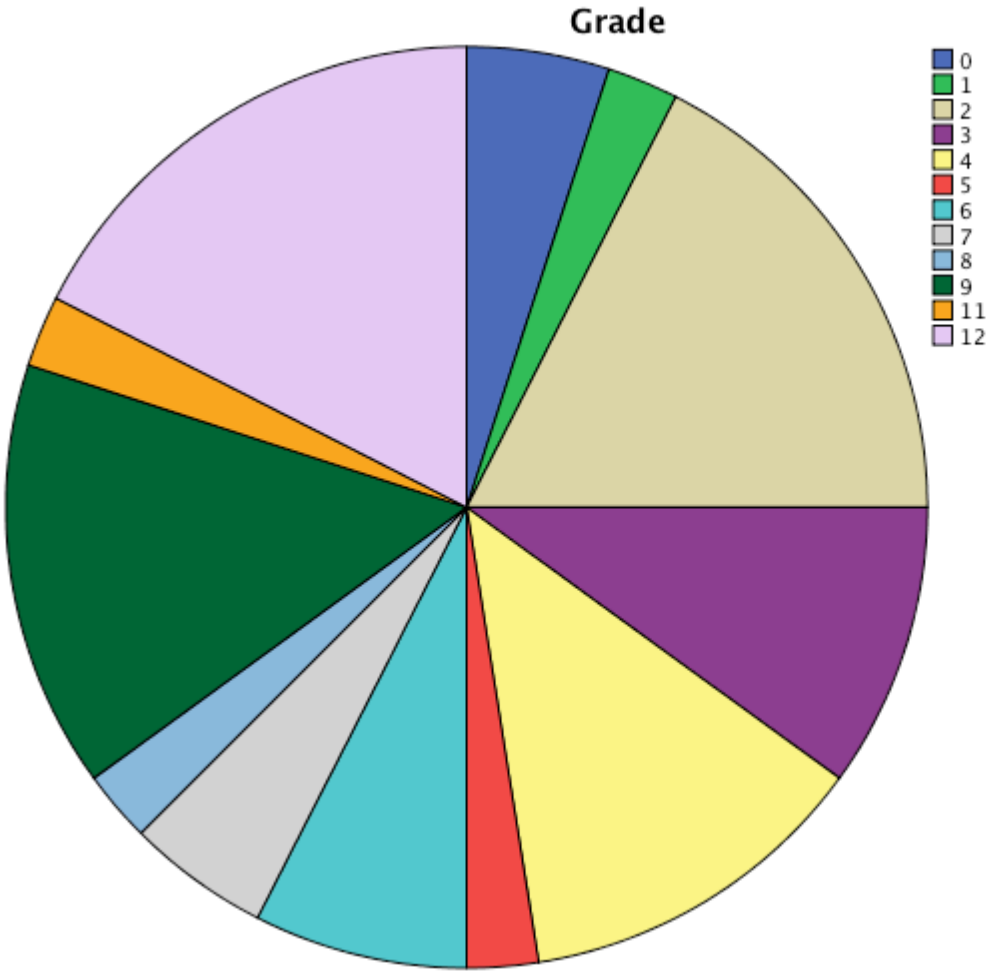
Table 1

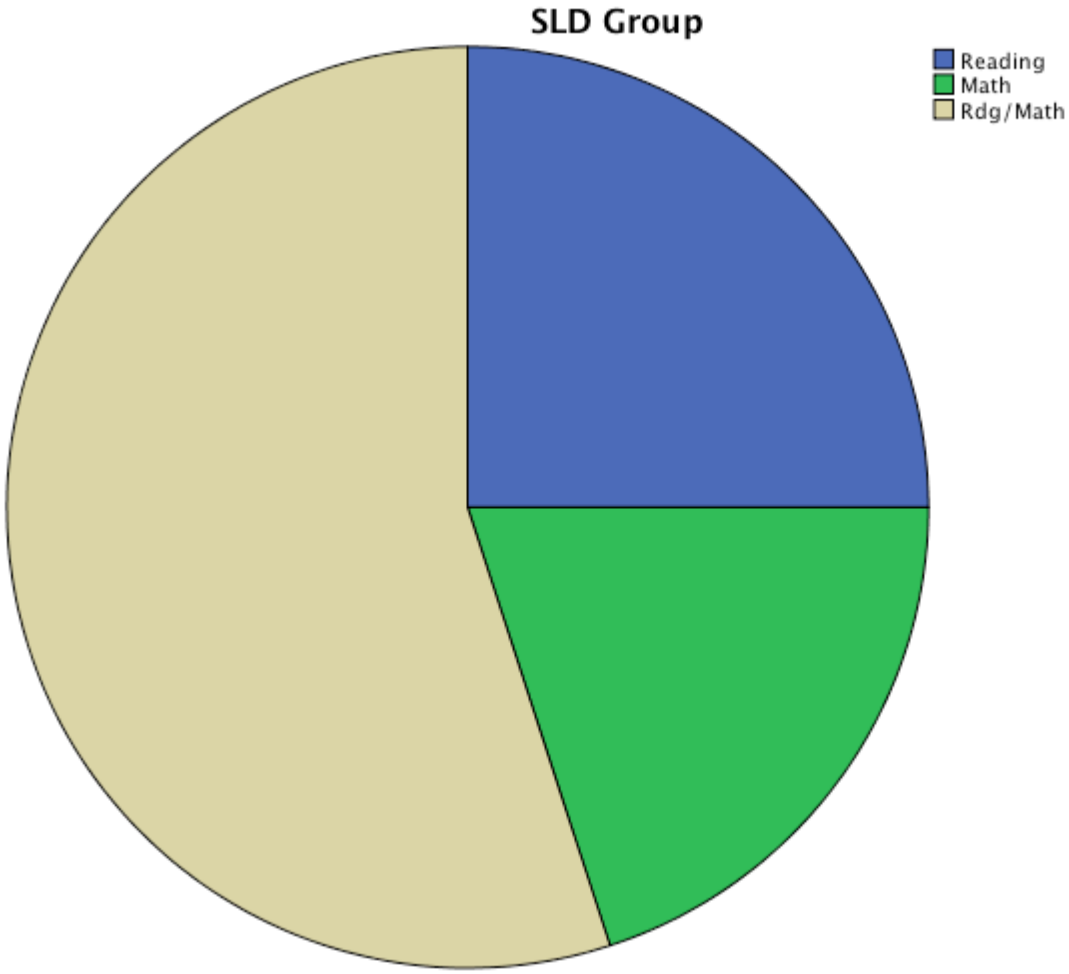
Basic Demographic Characteristics of Sample

	n	%
Gender		
Males	27	68
Females	13	32
Grade		
Kindergarten	2	5
First	1	2.5
Second	7	17.5
Third	4	10
Fourth	5	12.5
Fifth	1	2.5
Sixth	3	7.5
Seventh	2	5
Eighth	1	2.5
Ninth	6	15
Tenth	0	0
Eleventh	1	2.5
Twelfth	7	17.5

SLD Type

Reading	10	25
Math	8	20
Reading/Math Combined	22	5





Measures

The *WJ III Tests of Cognitive Abilities (WJ COG)* (2001; Woodcock, McGrew, & Mather) and the *WJ III Tests of Achievement (WJ ACH)* (2001; Woodcock, McGrew, & Mather) are cognitive and achievement assessment tools utilized with individuals between the ages of two years and 90 years. Together, the two instruments compose the WJ III series, which provide a comprehensive set of individually administered, norm-referenced tests for measuring intellectual abilities and academic achievement. Normative data are based on a single sample that was administered for both the cognitive and achievement tests. The normative sample included more than 8,000 individuals between the ages of two to 90 years old. On both WJ III assessment

batteries, standard scores are derived; these have a mean of 100 and a standard deviation of 15. For the WJ III series, scores of 69 and below are considered to fall within the very low range, scores from 70 to 89 fall within the low range; scores from 80 to 80 fall within the low average range; scores from 90 to 110 fall within the average range; scores from 111 to 120 are high average; scores from 121 to 130 are considered to be superior, and scores of 131 and above are reported to be very superior.

The WJ III COG includes 20 tests, each measuring a different aspect of cognitive ability. There is a standard and extended battery. The tests can be combined to form clusters that can be used for interpretive purposes. In addition to the General Intellectual Ability (overall intellectual ability), the factor scores that can be obtained include Verbal Ability, Thinking Ability, and Cognitive Efficiency. The Verbal Ability scale includes Verbal Comprehension subtests, which are measures of language development that include comprehension of words, as well as comprehension of relationships among words. The Thinking Ability scale assesses four distinct abilities (long-term retrieval, visual-spatial thinking, auditory processing, and fluid reasoning). The Cognitive Efficiency scale assesses the abilities required to process information automatically, including processing speed and short-term memory. CHC factors that can be assessed include Comprehension-Knowledge (Gc), Long-Term Retrieval (Glr), Visual-Spatial Thinking (Gv), Auditory Processing (Ga), Fluid Reasoning (Gf), Processing Speed (Gs), and Short-Term Memory (Gsm). Clinical clusters include Phonemic Awareness, Working Memory, Broad Attention, Cognitive Fluency, and Executive Processes. Examiners can use the WJ III COG to determine and explain present levels of functioning of an individual, including finding their strengths and weaknesses, determining the nature or extent of an impairment, and providing information to aid in classification and diagnosis. Only the first seven core subtests (Verbal

Comprehension, Visual-Auditory Learning, Spatial Relations, Sound Blending, Concept Formation, Visual Matching, Numbers Reversed) were included in the present study. These seven subtests score for the following scales: General Intellectual Ability, Verbal Ability, Thinking Ability, and Cognitive Efficiency. No additional factor, cluster, or scale scores were obtained.

Achievement scores were also examined in the areas of reading and math in the archival data sample. Achievement scores derived from the *Woodcock Johnson-III Tests of Achievement (WJ III ACH)* (2001; Woodcock, McGrew, & Mather). There are 22 tests that are divided into standard and extended batteries. The curricular areas that can be assessed include Reading (basic reading skill, reading fluency, reading comprehension); Oral Language (oral expression, listening comprehension); Mathematics (math calculation skills, math fluency, math reasoning); Written Language (basic writing skills, writing fluency, written expression), and Academic Knowledge. Only subtest scores from the archival sample were included in the present study. The subtest scores utilized for the area of reading included the following: Letter-Word Identification, Reading Fluency, Passage Comprehension, and Word Attack. In the area of math, the following subtest scores were obtained: Calculation, Math Fluency, and Applied Problems.

Additionally, the *Behavior Assessment System for Children – Second Edition Parent Rating Scales* (BASC-2; Reynolds & Kamphaus, 2004) were utilized; these are standardized broadband socio-emotional behavior rating scales completed by the parents of students. This measure, which was designed to assist in differential diagnosis of emotional and behavioral disorders, evaluates both positive and negative indicators of psychosocial functioning (Kamphaus, Reynolds, Hatcher, & Kim, 2004). Responses are compared with a normative sample of the student's same-age peers and reported in the form of t-scores. Within the Clinical

Scales section, high t-scores reflect areas of concern, whereas areas with low t-scores are considered not to be of concern. Scores above 70 are considered clinically significant and suggest a high level of maladjustment. These areas are likely in need of immediate attention and intervention. Scores of 60 to 69 are considered at-risk and indicate areas that are a significant problem but may not be severe enough to require formal treatment, or they are indicative of a potentially developing problem that needs careful monitoring. Within the Adaptive Section, high t-scores reflect areas of strength, but low scores reflect areas of concern. It is to be noted that this is the opposite of the Clinical Scales. Scores above 70 indicate that the student has very high skills in that area; scores from 60-69 are considered high skills, and scores ranging from 41-59 are considered to be average. T-scores ranging from 30-40 are at-risk for lack of skills and scores less than 30 are clinically significant.

The 15 different areas utilized in this study included t-scores for the following Clinical and Adaptive scales: Hyperactivity, Aggression, Conduct Problems, Anxiety, Depression, Somatization, Attention Problems, Atypicality, Withdrawal, Adaptability, Social Skills, Leadership, Activities of Daily Living, and Functional Communication. In addition, the Internalizing Problems, Externalizing Problems, Behavioral Symptoms Index and Adaptive Skills composites were examined.

Finally, scores from the Parent forms of the *Behavior Rating Inventory of Executive Function Parent Rating Scales (BRIEF)* (Gioia, Isquith, Guy, & Kenworthy, 1996, 1998, 2000) were utilized to examine executive function capacities of students in the sample. It was designed for children ranging from five to 18 years of age, and is derived of 86 items within eight clinical scales. The clinical scales on this measure include the following: Inhibit Shift, Emotional Control, Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor.

Composites include the Behavioral Regulation Index, Metacognition Index, and the General Executive Composite. The Inhibit subscale is defined as a child's skills in controlling impulses and appropriately stopping his/her own behavior at the proper time. The Shift subscale measures a child's skills to move freely from one situation, activity, or aspect of a problem to another as the situation demands, to transition, and to solve problems flexibly. The Emotional Control subscale assesses the child's skills with modulating emotional responses appropriately. The Initiate subscale evaluates a student's skills in beginning a task or activity and independently generating ideas. Working Memory assesses the student's ability to hold information in his/her mind for the purpose of completing a task, as well as to stay with, or stick to, an activity. The Plan/Organize subscale evaluates a student's skills in anticipating future events, setting goals, developing appropriate steps ahead of time to carry out an associated task or action, carrying out tasks in a systematic manner, and understanding and communicating main ideas or key concepts. The Organization of Materials subscale assesses the child's skills with keeping a workspace, play areas, and materials in an orderly manner. Finally, the Monitor subscale evaluates a student's skills in checking his/her work, assessing his/her performance during or after finishing a task to ensure attainment of the goal, and keeping track of the effect of his/her own behavior on others.

T-Scores are utilized, with a mean of 50 and a standard deviation of 10. The BRIEF ratings are negative indicators; that is, high scores indicate a lack of functioning in a category. Because high ratings reflect a lack of functioning, the higher the t-score is for a scale, the greater is the deficiency of behavior perceived by the rater in that area. T-scores of 65 and higher are considered to be of clinical significance.

The parent ratings are based on a normative sample of 720 students. Internal consistency for the teacher forms of the measure ranges from .80 to .98. Interrater reliability on the teacher ratings ranged from .90 to .98 for the indices, when considering the normative sample. Test-retest reliability on the normative sample for parent ratings ranged from .83 to .92. The BRIEF was developed to have strong content validity, because items were selected from clinical interviews with parents and teachers to find common descriptions and complaints that reflect behavioral descriptions of executive functions. No other executive function measures were available at the time of publication to determine construct validity, but the authors did find significant correlations with measures designed to assess attention or behavioral concerns.

Procedure

This study passed review by the PCOM's Institutional Review Board. This exploratory study utilized archival records of students who receive special education services with classifications of Specific Learning Disabilities. Archival records from evaluations of students who met all inclusion criteria were used for this study. School psychologists who are state and/or nationally certified were asked to volunteer anonymous data for this study. Individual student records were reviewed by the school psychologists to determine if all required scores were available. If the school psychologists required permission from their respective districts in order to release requested data, the school psychologist had the School Psychologist Agreement (see Appendix A) signed and returned to the investigator. School psychologists were asked to enter data into a document entitled *Dissertation: Student Data Collection Workbook* (see Appendix C). The school psychologist volunteers were provided with the workbook and asked to provide the standard and t-scores for the appropriate measures. Only gender, grade, and disability category were collected as additional variables.

Regarding scores, school psychologists were asked to provide standard scores for the WJ III COG and WJ III ACH. For the WJ III COG, scores for the core seven subtests were requested (Verbal Comprehension, Visual-Auditory Learning, Spatial Relations, Sound Blending, Concept Formation, Visual Matching, Numbers Reversed). Additionally, composite scores, including General Intellectual Ability, Verbal Ability, Thinking Ability, and Cognitive Efficiency were part of the inclusion criteria. For the WJ III ACH, the following subtest scores were requested in the area of reading: Letter-Word Identification, Reading Fluency, Passage Comprehension, and Word Attack. In the area of math, the following subtest scores were requested: Calculation, Math Fluency, and Applied Problems. For the BASC-2 PRS and BRIEF PRS, T-scores were collected for all indices and subscales. At no time did the student investigator or primary investigator have access to confidential information or to filed data.

Although more than 500 data requests had been sent out via email, only five responses were received; of these, only three met all inclusion criteria for the study. Therefore, the study additionally utilized a convenience sample provided by one certified school psychologist/licensed psychologist. Data were provided anonymously through an excel spreadsheet. Data meeting all inclusion criteria were utilized. The data, which were subjected to several statistical analyses, were input to SPSS Version 21 (statistics computer package) for statistical analyses.

Analyses

Initially, the WJ-III Cognitive index/subtest scores were correlated with achievement scores through the Pearson Correlation Method. Specifically, the correlational method was used to determine significant relationships between cognitive scores and achievement scores, as well as direction of the relationships, in a sample of students with SLD. Specific cognitive-academic

patterns were explored through this methodology. Bivariate correlations were additionally performed between cognitive and socio-emotional rating scales scores and between cognitive and executive rating scale scores.

To define significant differences between students with different SLD groups (reading, math, reading/math), MANOVAs were utilized separately to compare these groups across the various dependent measures (subtests/subscales) of the WJ III COG, WJ III ACH, BASC-2, and BRIEF. Four different MANOVAs were performed. Significant mean differences were explored to further differentiate the groups across the study variables.

Chapter 4

Results

Descriptive Statistics

Table 2 reports the descriptive statistics for the WJ III COG variables across the entire sample of students with classifications of SLD. The mean of the General Intellectual Ability (GIA) was found to fall within the below average range. Interestingly, the means of both the Verbal Ability and Thinking Ability fell within the average range, whereas the mean of the Cognitive Efficiency cluster fell within the low average range. The highest subtest mean score was found in the area of Sound Blending, whereas the lowest subtest mean score was found for the Numbers Reversed subtest. The range of the mean scores fell between the very low and superior ranges.

Table 2

Means and Standard Deviations for Entire Sample across Cognitive Variables

Variable	*M*	*SD*	*Range*
Global Scores			
General Intellectual Ability Quotient	88	11	64-121
Verbal Ability Cluster	92	14	67-128
Thinking Ability Cluster	95	12	74-124
Cognitive Efficiency Cluster	81	10	57-109
Subtest Scores			
Verbal Comprehension	93	14	67-128

Visual Auditory Learning	88	10	66-114
Spatial Relations	96	10	57-119
Sound Blending	103	13	77-132
Concept Formations	95	14	67-124
Visual Matching	95	14	67-124
Numbers Reversed	86	11	52-108

The achievement means depicted in Table 3 illustrate similar average mean scores across all areas of achievement in this sample of students with SLD. Means for all academic subtests fell within the low average range. The highest mean score was noted on the Word Attack and Applied Problems subtests, whereas the lowest mean was found on the Math Fluency subtest. Interestingly, mean scores of subtests requiring higher-level abstract thinking were not drastically different from means of subtests assessing basic academic skills. The range of scores extended from the very low range to the high average range in this sample of students with SLD, indicating drastically different levels of performance across individuals.

Table 3

Means and Standard Deviations for Entire Sample across Achievement Variables

Variable	*M*	*SD*	*Range*
	Subtest Scores		
Letter Word ID	84	13	54-106
Word Attack	87	11	60-112
Passage Comprehension	84	12	49-107
Reading Fluency	83	13	56-116
Math Calculations	86	15	62-114
Applied Problems	87	13	47-113
Math Fluency	80	13	53-104
Spelling	84	12	55-107

The socio-emotional means depicted in Table 4 are generally age-typical levels of behaviors in the sample of students with SLD. Means across all indices and subscales on the parent ratings fell within the average range, with the exception of Attention Problems and Functional Communication, both of which fell within the at-risk range.

Table 4

Means and Standard Deviations for Entire Sample across Socio-emotional Variables

Variable	*M*	*SD*	*Range*
	Index/Subscale Scores		
Hyperactivity	55	13	31-87
Aggression	55	16	34-98
Conduct Problems	53	13	32-86
Externalizing Problems	55	15	32-95
Anxiety	51	11	31-82
Depression	55	12	37-92
Somatization	50	9	38-81
Internalizing Problems	53	10	33-77
Attention Problems	63	10	33-78
Atypicality	57	13	41-102
Withdrawal	55	12	36-92
Behavioral Symptoms Index	58	13	34-91
Adaptability	46	10	21-69
Social Skills	43	11	21-64

Leadership	40	8	21-58
Activities of Daily Living	41	10	21-63
Functional Communication	38	10	22-63
Adaptive Skills Index	40	9	18-60

The executive means depicted in Table 5 indicate generally age-typical levels of executive function capacities. Means on the parent ratings were clinically elevated on the Working Memory and Plan/Organize subscales, as well as on the Metacognition Index, whereas all other means fell within the average range.

Table 5

Means and Standard Deviations for Entire Sample across BRIEF Parent Rating Variables

Variable	*M*	*SD*	*Range*
Index/Subscale Scores			
Inhibit	56	14	38-100
Shift	58	13	37-90
Emotional Control	57	12	36-91
Behavioral Regulation Index	58	13	35-98
Initiate	62	11	39-84
Working Memory	67	12	39-93
Plan/Organize	65	11	43-88
Organization of Materials	56	9	34-72
Monitor	61	11	41-84
Metacognition Index	65	11	41-87
General Executive Composite	63	11	38-89

Relationships between Cognitive and Academic Variables

Pearson bivariate correlations were computed to determine if any significant relationships existed between measures of cognitive processes and academic achievement. The following results indicate that there are significant relationships found between many of the cognitive and academic variables. All relationships found were positively correlated, which demonstrates that the stronger the present level of cognitive functioning, the higher the level of achievement. Examination of these relationships as depicted in Tables 6 and 7 revealed multiple, significant correlations.

The GIA and Verbal Ability were significantly correlated with every academic area except for Math Fluency. Large effect sizes were noted between the GIA and all academic areas except for fluency measures, which were assessed as having moderate effect sizes. This demonstrates support for use of the GIA in making decisions about special education eligibility under the classification of SLD. The Verbal Ability was significantly correlated with all academic areas except for Math Fluency. The largest effect size was noted in the area of Passage Comprehension, demonstrating that Verbal Ability is a strong predictor of level of skill of passage comprehension. The Thinking Ability was significantly correlated with every achievement variable except for Reading and Math Fluency. Large effect sizes were noted for the relationships between the areas of Word Attack, Passage Comprehension, Math Calculations, and Applied Problems. Thinking Ability is not predictive of levels of Reading or Math Fluency. Cognitive Efficiency was significantly correlated with all achievement variables, although the strongest correlations had only moderate effect sizes.

Table 6

Correlation of WJ COG Index Scores and Achievement Scores

	GIA	VA	TA	CE	LW	WA	PC	RF	MC	AP	MF
GIA	----	.87**	.90**	.68**	.51**	.65**	.58**	.42*	.65**	.62**	.37*
VA		----	.75**	.45**	.41**	.41**	.50*	.39*	.51*	.48**	.22
TA			----	.40**	.41**	.58**	.50**	.30	.57**	.62**	.29
CE	.			----	.49**	.38*	.48**	.44**	.42**	.40*	.38*
LW					----	.82**	.72**	.69**	.30	.32*	.36*
WA						----	.67**	.64**	.38*	.35*	.33*
PC							----	.63**	.25	.46**	.19
RF								----	.28	.33*	.34*
MC									----	.69**	.75**
AP										----	.28
MF											----

Note. GIA = General Intellectual Ability; VA = Verbal Ability; TA = Thinking Ability; CE = Cognitive Efficiency; LW = Letter Word ID; WA = Word Attack; PC = Passage Comprehension; RF = Reading Fluency; MC – Math Calculation; AP = Applied Problems; MF = Math Fluency

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

Table 7

Correlation of WJ COG Subtest Scores and Achievement Scores

	VC	VAL	SR	SB	CF	VM	NR	LW	RF	MC	MF	PC	AP	WA
VC	----	.69**	.39*	.41**	.65**	.65**	.35*	.39*	.38*	.51**	.19	.49**	.48**	.40**
VAL		----	.33*	.41**	.52**	.54**	.32*	.28	.18	.41**	.33*	.36*	.28	.46**
SR			----	.17	.37*	.37*	.29	.09	.06	.27	.03	.18	.29	.26
SB	.			----	.10	.10	.10	.31*	.07	.43**	.22	.26	.28	.44**
CF					----	1.00**	.38*	.38*	.38*	.59**	.28	.50**	.68**	.47**
VM						----	.38*	.38*	.38*	.59**	.28	.50**	.68**	.47**
NR							----	.54**	.34*	.26	.25	.55**	.30	.36*
LW								----	.69**	.30	.36*	.72**	.32*	.82**
RF									----	.28	.34*	.63**	.33*	.64**
MC										----	.57**	.27	.64**	.46**

MF		----	.19	.28	.33*
PC			----	.46**	.67**
AP				----	.35*
WA					----

Note. VC = Verbal Comprehension; VAL = Visual Auditory Learning; SR = Spatial Relations; SB = Sound Blending; CF = Concept Formations; VM = Visual Matching; NR = Numbers Reversed; LW = Letter Word ID; RF = Reading Fluency; MC – Math Calculation; MF = Math Fluency; PC = Passage Comprehension; AP = Applied Problems; WA = Word Attack

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

Relationships between Cognitive and Socio-emotional Variables

Pearson bivariate correlations were computed to determine if any significant relationships existed between measures of cognitive processes and socio-emotional functioning in a sample of students with SLD. The results which follow indicate that there were no significant relationships found between most of the cognitive and socio-emotional variables. Mixes of positive and negative correlations were noted. Interestingly, relative to Internalizing Problems, a positive, significant correlation was indicated between Numbers Reversed and Depression. No significant correlations were found between any areas of Externalizing Problems and cognitive processes. A moderate, negative correlation was found between Thinking Ability and Withdrawal, suggesting that students who have higher levels of functioning in the area of Thinking Ability tend to demonstrate less Withdrawal. Regarding the Behavioral

Symptoms Index, a moderate, significant negative relationship was also noted between Sound Blending and Withdrawal, indicating that students who have higher levels of Withdrawal demonstrate lower levels of functioning in Sound Blending. Moderate, significant relationships were found between Sound Blending and the Adaptive Skills areas of Leadership, Activities of Daily Living, and Functional Communication. No other significant correlations were found. Examination of relationships is depicted in Tables 8, 9, 10, and 11.

Table 8

Correlation of WJ COG Scores and Internalizing Problems Scores

	GIA	VA	TA	CE	VC	VAL	SR	SB	CF	VM	NR	IP	Anx	Dep	Som
GIA	----	.87**	.90**	.68**	.87**	.75**	.56*	.43**	.79**	.79**	.61**	-.04	.02	-.03	-.08
VA		----	.75**	.45**	.75**	.71**	.38*	.39*	.66**	.66**	.38*	-.09	.06	-.15	-.11
TA			----	.40**	.75**	.71**	.59**	.56**	.81**	.81**	.37*	-.15	-.06	-.09	-.18
CE	.			----	.44**	.36*	.38*	.15	.36*	.36*	.83**	.15	.05	.18	.12
VC					----	.69**	.39*	.41*	.65**	.65**	.35*	- .07	.10	-.14	-.10
VAL						----	.33*	.41**	.54**	.54**	.32*	-.04	.08	-.11	-.04
SR							----	.17	.37*	.37*	.29	.07	.15	.18	-.21
SB								----	.10	.10	.10	-.06	.00	-.12	.02
CF									----	1.00**	.38*	-.23	-.18	-.13	-.20
VM										----	.38*	-.23	-.18	-.13	-.20

NR		----	.51**	.28	.57**	.27
IP			----	.74**	.77**	.69**
Anx				----	.32*	.33*
Dep					----	.29
Som						----

Note. GIA = General Intellectual Ability; VA = Verbal Ability; TA = Thinking Ability; CE = Cognitive Efficiency; VC = Verbal Comprehension; VAL = Visual Auditory Learning; SR = Spatial Relations; SB = Sound Blending; CF = Concept Formations; VM = Visual Matching; NR = Numbers Reversed; IP = Internalizing Problems; Anx = Anxiety; Dep = Depression; Som = Somatization

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

Table 9

Correlation of WJ COG Scores and Externalizing Problems Scores

	GIA	VA	TA	CE	VC	VAL	SR	SB	CF	VM	NR	EP	Hyp	Agg	CP
GIA	----	.87**	.90**	.68**	.87**	.75**	.56*	.43**	.79**	.79**	.61**	.02	.13	.01	-.02
VA		----	.75**	.45**	.75**	.71**	.38*	.39*	.66**	.66**	.38*	-.05	.02	-.07	-.04
TA			----	.40**	.75**	.71**	.59**	.56**	.81**	.81**	.37*	-.05	-.06	-.04	-.07
CE	.			----	.44**	.36*	.38*	.15	.36*	.36*	.83**	.20	.31	.18	.06
VC					----	.69**	.39*	.41*	.65**	.65**	.35*	- .05	.03	-.08	-.05
VAL						----	.33*	.41**	.54**	.54**	.32*	-.03	.05	-.06	-.02
SR							----	.17	.37*	.37*	.29	.16	.28	.17	.07
SB								----	.10	.10	.10	-.00	.16	-.04	-.03
CF									----	1.00**	.38*	-.18	-.18	-.11	-.20
VM										----	.38*	-.18	-.18	-.11	-.20

NR		----	.14	.17	.10	.07
EP			----	.86**	.93**	.92**
Hyp				----	.75**	.72**
Agg					----	.17
CP						----

Note. GIA = General Intellectual Ability; VA = Verbal Ability; TA = Thinking Ability; CE = Cognitive Efficiency; VC = Verbal Comprehension; VAL = Visual Auditory Learning; SR = Spatial Relations; SB = Sound Blending; CF = Concept Formations; VM = Visual Matching; NR = Numbers Reversed; EP = Externalizing Problems; Hyp = Hyperactivity; Agg = Aggression; CP = Conduct Problems

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

Table 10

Correlation of WJ COG Scores and Behavioral Symptoms Index Scores

	GIA	VA	TA	CE	VC	VAL	SR	SB	CF	VM	NR	BSI	Aty	WD	AP
GIA	----	.87**	.90**	.68**	.87**	.75**	.56*	.43**	.79**	.79**	.61**	.02	.01	-.15	.12
VA		----	.75**	.45**	.75**	.71**	.38*	.39*	.66**	.66**	.38*	-.04	.05	-.03	-.00
TA			----	.40**	.75**	.71**	.59**	.56**	.81**	.81**	.37*	-.10	.00	-.33*	.02
CE	.			----	.44**	.36*	.38*	.15	.36*	.36*	.83**	.26	.32*	.03	.33*
VC					----	.69**	.39*	.41*	.65**	.65**	.35*	- .03	.05	-.02	.01
VAL						----	.33*	.41**	.54**	.54**	.32*	-.05	.03	-.10	.09
SR							----	.17	.37*	.37*	.29	.22	.21	.10	.23
SB								----	.10	.10	.10	-.13	.01	-.43**	-.10
CF									----	1.00**	.38*	-.18	-.09	-.27	-.03
VM										----	.38*	-.18	-.09	-.27	-.03

NR		----	.15	.21	-.12	.22
BSI			----	.86**	.52**	.73**
Aty				----	.33*	.63**
WD					----	.33*
AP						----

Note. GIA = General Intellectual Ability; VA = Verbal Ability; TA = Thinking Ability; CE = Cognitive Efficiency; VC = Verbal Comprehension; VAL = Visual Auditory Learning; SR = Spatial Relations; SB = Sound Blending; CF = Concept Formations; VM = Visual Matching; NR = Numbers Reversed; BSI = Behavioral Symptoms Index; Aty = Atypicality; WD = Withdrawal; AP = Attention Problems

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

Table 11

Correlation of WJ COG Scores and Adaptive Skills Index Scores

	GIA	VA	TA	CE	VC	VAL	SR	SB	CF	VM	NR	AS	Ada	SS	Lea	ADL	FC
GIA	----	.87**	.90**	.68**	.87**	.75**	.56*	.43**	.79**	.79**	.61**	.09	.01	.04	.22	.12	.19
VA		----	.75**	.45**	.75**	.71**	.38*	.39*	.66**	.66**	.38*	.14	.10	.15	.25	.16	.24
TA			----	.40**	.75**	.71**	.59**	.56**	.81**	.81**	.37*	.16	.10	.09	.24	.21	.25
CE	.			----	.44**	.36*	.38*	.15	.36*	.36*	.83**	-.02	-.16	-.10	.13	-.05	.00
VC					----	.69**	.39*	.41*	.65**	.65**	.35*	.14	.11	.16	.01	.24	.22
VAL						----	.33*	.41**	.54**	.54**	.32*	.01	.00	-.01	.06	.04	.17
SR							----	.17	.37*	.37*	.29	-.17	-.17	-.20	-.13	-.01	-.12
SB								----	.10	.10	.10	.31*	.25	.16	.35*	.34*	.35*
CF									----	1.00**	.38*	.17	.14	.16	-.03	.15	.20
VM										----	.38*	.17	.14	.16	.22	.15	.20

NR	----	.00	-.09	-.05	.14	-.05	-.00
AS		----	.81**	.74**	.85**	.86	.74
Ada			----	.61**	.57**	.76**	.50**
SS				----	.59**	.59**	.38*
Lea					----	.73**	.71**
ADL						----	.68**
FC							----

Note. GIA = General Intellectual Ability; VA = Verbal Ability; TA = Thinking Ability; CE = Cognitive Efficiency; VC = Verbal Comprehension; VAL = Visual Auditory Learning; SR = Spatial Relations; SB = Sound Blending; CF = Concept Formations; VM = Visual Matching; NR = Numbers Reversed; AS = Adaptive Skills Index; Ada = Adaptability; SS = Social Skills; Lea = Leadership Skills; ADL = Activities of Daily Living; FC = Functional Communication Skills

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

Relationships between Cognitive and Executive Variables

Pearson bivariate correlations were computed to determine if any significant relationships existed between measures of cognitive processes and executive function capacities in a sample of students with SLDs. The following results indicate that there were not many significant relationships found between most of the cognitive and executive variables. Mixes of positive and negative

correlations were noted. A moderately significant, positive correlation was noted between Verbal Ability and Metacognition Index, suggesting that students who have strong Verbal Abilities may have strong scores on the Metacognition Index. Specifically, moderate significant, positive correlations were noted between Organization of Materials and the GIA, Verbal Ability, and Verbal Comprehension subtest. No significant correlations were found between any areas of Behavioral Regulation Index and cognitive processes. Examinations of these relationships are depicted in Tables 12, 13, and 14.

Table 12

Correlation of WJ COG Scores and BRIEF Index Scores

	GIA	VA	TA	CE	VC	VAL	SR	SB	CF	VM	NR	GEC	BRI	MI
GIA	----	.87**	.90**	.68**	.87**	.75**	.56*	.43**	.79**	.79**	.61**	.14	.03	.26
VA		----	.75**	.45**	.75**	.71**	.38*	.39*	.66**	.66**	.38*	.16	-.04	.31*
TA			----	.40**	.75**	.71**	.59**	.56**	.81**	.81**	.37*	.02	.01	.08
CE	.			----	.44**	.36*	.38*	.15	.36*	.36*	.83**	.20	.12	.30
VC					----	.69**	.39*	.41*	.65**	.65**	.35*	.16	-.04	.31*
VAL						----	.33*	.41**	.54**	.54**	.32*	-.00	-.03	.07
SR							----	.17	.37*	.37*	.29	.06	.10	.01
SB								----	.10	.10	.10	-.10	.04	-.14
CF									----	1.00**	.38*	.07	-.05	.19
VM										----	.38*	.13	.07	.23

NR		----	.13	.07	.23
GEC			----	.83**	.91**
BRI				----	.58**
MI					----

Note. GIA = General Intellectual Ability; VA = Verbal Ability; TA = Thinking Ability; CE = Cognitive Efficiency; VC = Verbal Comprehension; VAL = Visual Auditory Learning; SR = Spatial Relations; SB = Sound Blending; CF = Concept Formations; VM = Visual Matching; NR = Numbers Reversed; GEC = Global Executive Composite; BRI = Behavioral Regulation Index; MI = Metacognition Index

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

Table 13

Correlation of WJ COG Scores and BRIEF Behavioral Regulation Index (BRI) Scores

	GIA	VA	TA	CE	VC	VAL	SR	SB	CF	VM	NR	BRI	Inh	Shi	EC
GIA	----	.87**	.90**	.68**	.87**	.75**	.56*	.43**	.79**	.79**	.61**	.09	.06	-.05	.02
VA		----	.75**	.45**	.75**	.71**	.38*	.39*	.66**	.66**	.38*	-.04	-.03	-.04	-.01
TA			----	.40**	.75**	.71**	.59**	.56**	.81**	.81**	.37*	.01	.07	-.11	-.04
CE	.			----	.44**	.36*	.38*	.15	.36*	.36*	.83**	.12	.11	.03	.13
VC					----	.69**	.39*	.41*	.65**	.65**	.35*	-.04	-.02	-.04	-.00
VAL						----	.33*	.41**	.54**	.54**	.32*	-.03	.02	-.12	-.06
SR							----	.17	.37*	.37*	.29	.10	.12	.03	.13
SB								----	.10	.10	.10	.04	.07	-.08	.01
CF									----	1.00**	.38*	-.05	-.00	-.11	-.13
VM										----	.38*	-.05	-.00	-.11	-.13

NR		----	.00	.07	.03	.05
BRI			----	.87**	.83**	.92**
Inh				----	.63**	.75**
Shi					----	.75**
EC						----

Note. GIA = General Intellectual Ability; VA = Verbal Ability; TA = Thinking Ability; CE = Cognitive Efficiency; VC = Verbal Comprehension; VAL = Visual Auditory Learning; SR = Spatial Relations; SB = Sound Blending; CF = Concept Formations; VM = Visual Matching; NR = Numbers Reversed; BRI = Behavioral Regulation Index; Inh = Inhibit; Shi = Shift; EC = Emotional Control

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

Table 14

Correlation of WJ COG Scores and Metacognition Index (MI) Scores

	GIA	VA	TA	CE	VC	VAL	SR	SB	CF	VM	NR	MI	Ini	WM	PO	OM	Mon
GIA	----	.87**	.90**	.68**	.87**	.75**	.56*	.43**	.79**	.79**	.61**	.26	.24	.20	.18	.39*	.11
VA		----	.75**	.45**	.75**	.71**	.38*	.39*	.66**	.66**	.38*	.31*	.21	.25	.30	.48**	.05
TA			----	.40**	.75**	.71**	.59**	.56**	.81**	.81**	.37*	.08	.05	.09	.01	.26	-.00
CE	.			----	.44**	.36*	.38*	.15	.36*	.36*	.83**	.30	.33*	.19	.18	.31	.25
VC					----	.69**	.39*	.41*	.65**	.65**	.35*	.31*	.22	.27	.29	.48**	.03
VAL						----	.33*	.41**	.54**	.54**	.32*	.07	.07	.14	.00	.23	-.01
SR							----	.17	.37*	.37*	.29	.10	.06	.09	-.07	.14	.00
SB								----	.10	.10	.10	-.14	-.11	-.04	-.22	.04	-.19
CF									----	1.00**	.38*	.19	.13	.12	.20	.26	.08
VM										----	.38*	.19	.13	.12	.20	.26	.08

NR		----	.23	.25	.14	.13	.14	.14
MI			----	.77**	.85**	.91**	.68**	.75**
Ini				----	.70**	.60**	.40**	.59**
WM					----	.70**	.54**	.51*
PO						----	.58**	.71**
OM							----	.33*
Mon								----

Note. GIA = General Intellectual Ability; VA = Verbal Ability; TA = Thinking Ability; CE = Cognitive Efficiency; VC = Verbal Comprehension; VAL = Visual Auditory Learning; SR = Spatial Relations; SB = Sound Blending; CF = Concept Formations; VM = Visual Matching; NR = Numbers Reversed; MI = Metacognition Index; Ini = Initiate; WM = Working Memory; PO = Plan/Organize; OM = Organization of Materials; Mon = Monitor

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

Inferential Statistics

SLD Group Differences across the Cognitive Dependent Variables

A multivariate GLM was computed using the WJ III COG as dependent variables, and with the three SLD groups serving as the between-subjects factor. Box's Test of the equality of covariance matrices was not computed because there were fewer than two nonsingular cell covariance matrices. Alpha level was set at $p = .05$ for all analyses. The Wilks' Lambda multivariate test of overall differences between groups demonstrated significance across the WJ III COG dependent variables $F(2, 56) = 2.765$, $p < .001$, partial $\eta^2 = .497$. Power was acceptable for the WJ COG dependent measures (power = 1.00), meaning that a type II error was unlikely. Levene's test of equality of error variances was not significant for any dependent variables.

Given the significance of the overall test, the univariate main effects were examined. Univariate between-subjects tests revealed that levels of the between-subjects variable, SLD groups, resulted in significant differences across the dependent measures of the WJ III cognitive variables. The largest effect sizes were found in the areas of GIA, Sound Blending, and Concept Formation. A comparison of means revealed that, in general, the Reading SLD group had the highest means across cognitive variables. The combined Reading and Math SLD group displayed the lowest means across cognitive variables, whereas the means for the Math SLD group fell in between those of the other two groups. However, a couple of cognitive variables differed from this pattern. For example, the Math SLD group scored the highest mean in the area of Cognitive Efficiency, followed by the Reading SLD group, and then the Combined Reading and Math SLD group. Similarly, on the Numbers Reversed subtest, the Math SLD group scored the highest mean, followed by the Reading SLD group, and then the Combined Reading and Math SLD group. Table 15 and Table 16 depict the *M*, *SD*, *F*, and η^2 across the SLD groups.

Table 15

Nomothetic Results for WJ III COG Factors and SLD Groups

		RDG (n = 10)	Math (n = 8)	RDG/M (n =22)	F[1]	eta[2]
GIA	*M*	99.80	94.63	81.50	8.24**	.989
	SD	11.12	7.36	8.35		
VA	*M*	102.5	99.3	86.27	3.34*	.276
	SD	15.2	8.71	11.77		
TA	*M*	107.20	97.75	89.50	6.56**	.429
	SD	11.68	6.34	9.98		
CE	*M*	86.70	89.88	76.59	3.21*	.269
	SD	11.54	8.82	8.30		

Note. GIA = General Intellectual Ability; VA = Verbal Ability; TA = Thinking Ability; CE= Cognitive Efficiency; SLD Group; RDG = Reading SLD Group; Math = Math SLD Group; RDG/M = Reading and Math Combined SLD Group

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

Table 16

Results for WJ COG Subtests and SLD Groups

		RDG (n = 10)	M (n = 8)	RDG/M (n = 22)	*F*	eta^2
VC	*M*	102.50	99.38	86.59	2.95*	.252
	SD	15.27	8.71	12.62		
VAL	*M*	96.9	94.13	83.50	7.27**	.454
	SD	9.74	5.30	9.28		
SR	*M*	99.90	99.25	94.14	1.30	.130
	SD	11.20	7.12	11.37		
SB	*M*	110.30	101.13	100.82	1.14	.116
	SD	11.05	5.93	15.58		
CF	*M*	109.00	98.50	87.36	6.80**	.438
	SD	10.96	13.27	10.28		
VM	*M*	109.00	98.50	87.36	6.80**	.438
	SD	10.96	13.27	10.28		
NR	*M*	89.80	95.13	81.32	2.76*	.240
	SD	13.79	5.93	9.88		

Note. VC = Verbal Comprehension; VAL = Visual Auditory Learning; SR = Spatial Relations; SB = Sound Blending; CF = Concept Formations; VM = Visual Matching; NR = Numbers Reversed; RDG = Reading SLD Group; M = Math SLD Group; RDG/M = Reading and Math Combined SLD Group

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

SLD Group Differences across the Academic Dependent Variables

A multivariate GLM was computed with the WJ III ACH as dependent variables, and with the three SLD groups serving as the between-subjects factor. Box's Test of the equality of covariance matrices was not computed because there were fewer than two nonsingular cell covariance matrices. Alpha level was set at $p = .05$ for all analyses. The Wilks' Lambda multivariate test of overall differences between groups demonstrated significance across the WJ III ACH dependent variables $F(2, 56) = 5.597$, $p = .000$, partial $\eta^2 = .667$. Power was acceptable for the WJ ACH dependent measures (power = 1.00), meaning that a type II error was unlikely. Levene's test of equality of error variances was significant for the following dependent variables: Letter Word ID, Passage Comprehension, and Word Attack.

Given the significance of the overall test, the univariate main effects were examined. Univariate between-subjects tests revealed that levels of the between-subjects variable, SLD groups, resulted in significant differences across the dependent measures of the WJ III achievement variables. The largest effect sizes were found in the areas of Math Calculations, Letter Word ID, Reading Fluency, and Word Attack. A comparison of means revealed that, in general, the Reading SLD group had lower scores than the Math SLD group on reading measures, and the Math SLD group had lower scores on the Math measures than the Reading SLD group. The combined Reading and Math SLD group displayed by far the lowest means across all academic variables. Table 17 depicts the *M*, *SD*, *F*, and η^2 across the SLD groups.

Table 17

Results for Achievement Measures and SLD Groups

		RDG (n = 10)	M (n = 8)	RDG/M (n = 22)	F^1	eta^2
LW	*M*	91.70	97.88	75.91	16.34**	.469
	SD	5.43	4.32	3.17		
RF	*M*	88.00	98.38	76.23	14.83**	.445
	SD	3.51	8.48	9.16		
MC	*M*	14.80	84.63	78.27	21.42**	.537
	SD	6.19	14.57	10.61		
MF	*M*	93.30	85.75	73.64	13.86**	.429
	SD	7.94	10.36	10.96		
PC	*M*	87.60	97.50	79.09	8.76*	.321
	SD	6.15	7.27	13.25		
AP	*M*	102.70	84.13	82.59	13.29**	.418
	SD	5.49	8.32	13.39		
WA	*M*	93.20	99.00	80.23	15.34**	.453
	SD	6.98	6.02	10.63		

Note. LW = Letter Word ID; RF = Reading Fluency; MC = Math Calculations; MF = Math Fluency; SP = Spelling; PC = Passage Comprehension; AP = Applied Problems; WA = Word Attack; RDG = Reading SLD Group; M = Math SLD Group; RDG/M = Reading and Math Combined SLD Group

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

SLD Group Differences across the Socio-emotional Dependent Variables

A multivariate GLM was computed with the BASC-2 Parent Ratings, using the socio-emotional scores as dependent variables, with the three SLD groups serving as the between-subjects factor. Box's Test of the equality of covariance matrices was not computed because there were fewer than two nonsingular cell covariance matrices. Alpha level was set at $p = .05$ for all analyses. The Wilks' Lambda multivariate test of overall differences between groups demonstrated no significance across the BASC-2 dependent variables $F(2, 40) = 1.333$, $p = .188$, partial $\eta^2 = .545$. Power was acceptable for the WJ COG dependent measures (power = .856), meaning that a type II error was unlikely. Levene's test of equality of error variances was significant for the dependent variables of Withdrawal and Functional Communication. The univariate main effects were also examined. Univariate between-subjects tests revealed that levels of the between-subjects variable, SLD groups, did not result in significant differences across the dependent measures of any of the BASC-2 variables. Means scores were similar across each BASC-2 socio-emotional variable for all three SLD groups. Table 18 and Table 19 depict the *M*, *SD*, *F,* and η^2 across the SLD groups.

Table 18

Results for BASC-2 Indices and SLD Groups

		RDG (n = 10)	M (n = 8)	RDG/M (n = 22)	*F*	eta^2
EP	*M*	53.80	52.50	56.64	.262	.014
	SD	15.73	12.47	14.38		
IP	*M*	50.70	54.50	54.09	.433	.023
	SD	11.13	3.35	8.73		
BSI	*M*	57.30	57.50	59.64	.134	.007
	SD	16.90	11.82	12.70		
AD	*M*	40.80	42.63	40.41	.140	.008
	SD	12.17	9.48	9.45		

Note. EP = Externalizing Problems; IP = Internalizing Problems; BSI = Behavioral Symptoms Index; AD = Adaptive Skills; Combined SLD Group; RDG = Reading SLD Group; Math = Math SLD Group; RDG/M = Reading and Math Combined SLD Group

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

Table 19

Results for BASC-2 Subscales and SLD Groups

		RDG (n = 10)	Math (n = 8)	RDG/M (n =22)	F	eta^2
Hyp	*M*	56.80	53.50	56.50	.166	.009
	SD	15.73	13.01	12.85		
Agg	*M*	56.90	53.00	55.36	.114	.006
	SD	22.37	15.35	15.28		
CP	*M*	51.60	50.38	55.73	.616	.032
	SD	16.22	9.05	3.35		
Anx	*M*	47.50	54.88	52.14	.969	.050
	SD	9.72	13.68	11.23		
Dep	*M*	55.90	51.63	57.59	.669	.035
	SD	16.04	9.25	11.67		
Som	*M*	48.80	54.63	50.23	.864	.045
	SD	8.45	13.82	8.54		
Aty	*M*	59.30	56.63	56.41	.152	.008
	SD	15.50	11.74	14.22		
WD	*M*	49.20	60.50	55.86	2.11	.102
	SD	8.25	5.92	14.39		
AP	*M*	62.90	63.50	63.18	.008	.000
	SD	13.22	8.12	9.50		

Ada	*M*	46.30	48.25	45.32	.213	.011
	SD	14.11	10.08	9.52		
SS	*M*	43.10	39.63	44.18	.440	.023
	SD	10.36	12.78	11.99		
Ldr	*M*	41.50	42.75	39.95	.326	.017
	SD	9.26	9.43	8.39		
ADL	*M*	41.60	43.50	40.64	.216	.012
	SD	12.24	8.05	10.56		
FC	*M*	40.70	43.13	35.50	2.06	.100
	SD	13.89	10.62	7.57		

Note. Hyp = Hyperactivity; Agg = Aggression; CP = Conduct Problems; Anx= Anxiety; Dep = Depression; Som = Somatization; Aty = Atypicality; WD = Withdrawal; AP = Attention Problems; Ada = Adaptability; SS = Social Skills; Ldr = Leadership; ADL = Activities of Daily Living; FC = Functional Communication; RDG = Reading SLD Group; Math = Math SLD Group; RDG/M = Reading and Math Combined SLD Group

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

SLD Group Differences across the Executive Dependent Variables

A multivariate GLM was computed, with the BRIEF executive scores functioning as dependent variables, and with the three SLD groups serving as the between-subjects factor. Box's Test of the equality of covariance matrices was not computed because there were fewer than two nonsingular cell covariance matrices. Alpha level was set at $p = .05$ for all analyses. The Wilks' Lambda multivariate test of overall differences between groups did not demonstrate significance across the BRIEF dependent variables F (2, 54) = .818, $p < .691$, partial $\eta^2 = .250$.

Power was measured at .538 for the BRIEF dependent variables. Levene's test of equality of error variances was significant for the dependent variables of Shift and GEC. The univariate main effects were also examined. Univariate between-subjects tests revealed that levels of the between-subjects variable, SLD groups, did not result in significant differences across the dependent measures of the BRIEF executive variables. Means scores were similar across each BRIEF executive variable for all three SLD groups. Table 20 depicts the *M*, *SD*, *F*, and η^2 across the SLD groups.

Table 20

Results for BRIEF Parent Ratings and SLD Groups

		RDG (n = 10)	M (n = 8)	RDG/M (n = 22)	F^1	eta^2
Inh	*M*	57.80	52.63	56.59	.316	.017
	SD	19.13	8.53	13.52		
Shi	*M*	58.00	55.00	60.55	.474	.025
	SD	20.85	8.53	11.85		
EC	*M*	59.50	52.38	58.50	.838	.043
	SD	13.42	8.99	15.49		
BRI	*M*	60.80	53.88	59.55	.657	.034
	SD	18.77	7.75	12.59		
Ini	*M*	62.60	67.38	61.23	.884	.046
	SD	12.22	9.11	11.39		
WM	*M*	66.30	70.25	67.27	.248	.013
	SD	14.96	7.06	12.47		
PO	*M*	67.70	66.25	64.95	.196	.010
	SD	12.94	7.77	12.12		
OM	*M*	61.50	54.63	55.00	1.70	.010
	SD	10.48	7.61	10.15		
Mon	*M*	64.90	59.88	60.50	.632	.033
	SD	11.25	8.34	11.98		

MI	*M*	67.60	66.13	64.09	.352	.019
	SD	13.82	7.93	11.04		
GEC	*M*	65.20	62.38	63.41	.131	.007
	SD	16.24	5.97	11.48		

Note. Inh = Inhibit; Shi = Shift; EC = Emotional Control; BRI = Behavioral Regulation Index; Ini = Initiate; WM = Working Memory; PO = Plan/Organize; OM = Organization of Materials; Mon = Monitor; MI = Metacognition Index; GEC = Global Executive Composite; RDG = Reading SLD Group; M = Math SLD Group; RDG/M = Reading and Math Combined SLD Group

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

Chapter 5

Discussion

The current study was designed to determine and describe meaningful SLD profiles through examination of patterns of strengths and weaknesses across cognitive, academic, socio-emotional, and executive variables, using standard scores in a school-aged population of students identified with SLD. Collapsing students with any type of learning difficulty into one group is problematic because it ignores students' differing patterns of strengths and deficits among variables assessed, and it does not allow for the possibility that students may experience similar academic deficits that might be caused by very different learning profiles. Furthermore, a homogenous classification ignores the fact that subtypes of SLD are likely connected to different patterns of socio-emotional adjustment and executive dysfunction (Hain, 2008). Advances in assessment of these potential maladjustments and dysfunctions have been made possible through the use of neurological methods; without consideration of such comorbidity in assessments, identification of students for special education services and development of Individualized Educational Plans (IEPs) cannot be accurate or appropriate. The present study demonstrated that cognitive and academic variables are highly correlated to each other. However, significant correlations were not found between cognitive variables and socio-emotional or executive variables. Overall, this study found that meaningful profiles of children with SLD could not be determined. Therefore, it was not possible to delineate specific patterns across cognitive, academic, socio-emotional, and executive variables. This is in contrast to previous research, which has demonstrated evidence for SLD profiles, and even subtypes, by examining patterns of performance across similar variables.

An important finding was the significant, positive correlations noted between cognitive processes and academic achievement. Previous research has supported this finding, suggesting that students with SLD demonstrate tremendous variation in their cognitive profiles (Campos, Almeida, Ferreira, Martinez, & Ramalho, 2013). These variable cognitive abilities will affect the accuracy, retention, and rate of the academic skills they learn in school (Campos, et al., 2013). In the current study, when using the WJ III COG and WJ III ACH, the GIA and Verbal Ability were significantly correlated, with large effect sizes with every academic area except for Math Fluency. This demonstrates support for use of the global ability score in making decisions about special education eligibility under the classification of SLD. It also supports consideration of more specific cognitive/academic relationships. For example, results of the current study demonstrated that Verbal Ability is a strong predictor of reading, especially of passage (reading) comprehension. Thinking Ability was found to be predictive of most areas of academic achievement, except for the areas of Reading or Math Fluency. Although Cognitive Efficiency was only moderately predictive of academic variables, it was the only cognitive area significantly correlated with measures of academic fluency. These significant and positive correlations could be used to further define SLD constructs and could be used to classify children with learning problems more accurately, which could lead to better IEPs. For example, the definition of SLD in reading could be expanded to require lower scores in the area of verbal ability and reading, whereas the definition of SLD in math might encompass lower scores in both Verbal and Thinking abilities, as well as lower math scores. However, Cognitive Efficiency, although an important piece of a student's cognitive profile, may not be useful in determining SLD in any area. Additionally, it is important that students' cognitive levels be considered when creating specially designed instruction for students with SLD to allow for accurate interventions.

Further, the strength of these correlations between cognitive and academic variables also has implications for students who do not demonstrate SLD, but instead demonstrate low cognitive ability. These students are more than likely going to struggle to access the regular education curriculum, yet they are not eligible for special education services unless an RTI classification method is utilized. Although this is accurate, because low cognitive ability does not qualify as an area of special education disability, these results clearly support the need for significant accommodations to be made in the classroom for learners with this type of cognitive profile to ensure that these students meet with academic success.

Limitations of the Study

Several issues must be discussed regarding limitations of the present study before implications are drawn from the results. First, and perhaps most importantly, the final sample size of 40 was very much limited. Results may drastically differ if this study were to be replicated with a much larger sample size. The students whose test scores were utilized came primarily from the Pittsburgh, PA surrounding area, most likely of similar socio-economic status, and this may also have produced limiting results. Considering this limitation, the location of these students sampled in the United States, these results might not generalize to other states or to populations throughout the country. Complete demographic information was not collected, which limits the ability to discuss ethnicity, socio-economic status, or region. Results therefore may not generalize to other samples of students with differing demographic characteristics. Also, students with classifications of SLD in Written Expression were not included in this study because they did not meet all inclusion criteria regarding test scores. Students with SLD in Written Expression may present with profiles of strengths and weaknesses different from those discussed in this document. Additionally, only parent rating scale scores were used for the

BASC-2 and BRIEF. It is important to realize that behavior of children often differs across school and home environments, because school tends to be a much more structured setting with behavioral expectations different from that in the home setting. Therefore, it is possible that if teacher rating scale scores had also been utilized, scores may have differed.

The majority of data from students included in the final sample came from a convenience sample, which included a mixture of students who had been classified with SLD by a certified school psychologist/licensed psychologist either at the school district where he works or at his private practice. Of the students who received SLD classifications through evaluations that had been done at the private practice, a large number who had initially met inclusion criteria for this study were eliminated because of having comorbid diagnoses. It was a concern of the researchers that including data from these students would bias the results, and it would be best to use students who had classifications only of SLD. However, a large number of these students who were eliminated from the study had diagnoses such as ADHD or Cognitive Disorder, NOS. The researchers were told that the students who had been diagnosed with Cognitive Disorder, NOS had significant executive function deficits. Because the BRIEF was one of the measures utilized in this study, the elimination of these students from the sample might help explain the reason why very few elevated scores were found on the BRIEF in the final sample used in the study. Also, students with other diagnoses (i.e., Anxiety Disorder, Depressive Disorder) were eliminated from the final sample; this, therefore, might help explain the reason why scores were primarily average throughout the sample on the BASC-2. Despite these factors, it is important to note that there have been previous studies that included students who presented only with an SLD classification (without comorbidity) that found significant results.

Future Directions

A future direction could include replicating the methods with a larger and more representative sample size, as well as including a sample with SLD of Written Expression in the study. With a large sample size, a cluster analysis of subtest scores could be performed to determine if SLD subtypes could be derived from patterns of performance across cognitive, academic, socio-emotional, and executive variables. If significance were to be found in such a study, it would be helpful to describe, explicitly, the patterns of performance found across each subtype that emerged; it would also be well to describe targeted interventions that would benefit each subtype based on their areas of need, while capitalizing on their areas of strength. Previous research has demonstrated that students with classifications of SLD are a heterogeneous group of individuals who possess unique strengths and weaknesses, but a study such as this could help explain particular patterns of performance and allow for more accurate development of IEPs. It could also be interesting to replicate such a study, utilizing a cluster analysis, with various popular cognitive tests (i.e., WISC-IV, Stanford Binet-V, KABC-II, DAS-II) to discover if similar profiles might emerge, or if they would differ according to the cognitive measure utilized in the study.

Overall, meaningful subtypes of SLD need to be identified according to patterns of performance across cognitive, academic, socio-emotional, and executive variables. Previous research has demonstrated the fact that there are very different patterns of performance (abilities and deficits) exhibited by children classified with SLD, suggesting that they actually compose a heterogeneous group (Rourke, 1999). In addition to the cognitive and achievement factors involved in SLD, many students also experience difficulty with socio-emotional adjustment and executive dysfunction (Hain, 2008; Helland & Asbjornsen, 2000; McCloskey, 2009; Rourke, 2008). To assist in understanding the effects of comorbidity on other areas of difficulty on SLD,

researchers have begun to develop subtypes of SLD through identification of unique patterns of performance (strength and weaknesses) across multiple domains (i.e., cognitive, academic, socio-emotional, and executive functioning) (Crews & D'Amato, 2009; Hain, et al., 2008; Rourke, 1999; Rourke, 2005). Comorbidity and common areas of deficit exist in students with SLD across these different variables. Although the present study did not find that meaningful profiles of students with SLD exist, there were many limitations that may have affected the generalizability of the results. An abundance of research has been done suggesting that common patterns of performance do exist; however, research findings have been very conflicting in describing subtypes that have emerged. Therefore, it is imperative that research in this area continues to further investigate this focus, because results have important implications for students with classifications of SLD in the school setting.

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Appendix A

Request for Data Letter

Dear School Psychologist,

We would appreciate your participation in a study entitled *Identification of Specific Learning Disability Profiles: Consideration of Patterns across Cognitive, Academic, Socio-emotional, and Executive Variables.* The research is being conducted by Amanda M. Garrett, Psy. D. Candidate, as a partial requirement for the Doctor of Psychology degree, and the principal investigator and supervisor of the research project is Lisa A. Hain, Psy.D.

The purpose of this project is to examine patterns of cognitive, socio-emotional, and executive functioning in children with specific learning disabilities (SLD). The archival data sought includes scores from the Woodcock Johnson III Tests of Cognitive Ability (WJ-III Cognitive), the Woodcock Johnson III Tests of Achievement (WJ-III Achievement), the Behavior Assessment System for Children – Second Edition, Parent Rating Scales (BASC-2 PR), and the Behavior Rating Inventory of Executive Function Parent Rating Scales (BRIEF PR).

We are asking you to provide standard scores/scaled scores of the WJ-III Cognitive, the standard scores/scaled scores from WJ-III Achievement, the T-scores from the BASC-2 parent form, and the T-scores from the BRIEF parent form. Because this is an *archival record review*, there will be *no contact* between Dr. Hain or me and the child, family, or team members. In fact, we ask you to report only the WJ-III Cognitive, WJ-III Achievement, BASC-2, and BRIEF scores, age, grade, gender, and disability label, without including the child's name or any identifying information. There will be no harm to the students nor is any involvement of the students needed, and all data will be presented in summative form, with no individual data identified. Although there will be no benefit to the individual child, we will be willing to provide participants with a summary of the results after the study is completed.

We thank you in advance for your attention and possible participation. If you wish to participate, you will be asked to sign an agreement form indicating that you have provided permission for the archival data to be utilized in this study. If you need further assistance or have any questions, please contact either Amanda M. Garrett at AmandaGar@pcom.edu or Lisa A. Hain at LisaHai@pcom.edu.

_____ _____

Amanda M. Garrett, Ed.S., NCSP Lisa A. Hain, Psy. D.

Appendix B

School Psychologist Agreement

School Psychologist Name: _____

School: _____

Date: _____

I, _____, hereby allow the use of my archival WJ-III Cognitive, WJ-III Achievement, BASC-2 Parent Rating, and BRIEF Parent Rating scores in the research project entitled *Identification of Specific Learning Disability Subtypes: Consideration of Patterns across Cognitive, Academic, Socio-emotional, and Executive Variables.* I understand the archival data will be anonymous and will not be reported by individual, practitioner, or school. I have obtained school district permission if needed for the release of this data.

Signatures:

_____ Date:

School Psychologist

_____ Date:

Director (Supervisor) of Special Education (if needed)

_____ Date:

Superintendent (if needed)

Appendix C

Dissertation: Student Data Collection Workbook

Participant Identification Code #:_____

Date data was removed from student file:_____

Check that each assessment has scores provided in full.

_____ WJ-III Cognitive Subtest Standard Scores

_____ WJ-III Achievement Subtest Standard Scores

_____ BASC-2 PRS T-scores

_____ BRIEF PRS T-scores

Other Variables: (Please indicate the following for the data file.)

Age: _____

Grade: _____

Gender: _____

LD Subtype(s): Check all that apply.

___ Oral Expression

___ Listening Comprehension

___ Basic Reading Skills

___ Reading Fluency Skills

___ Reading Comprehension

___ Math Calculation

___ Math Problem-Solving

___ Written Expression

WJ-III Cognitive Subtest Scores

Measure	Standard Score
Verbal Comprehension	
Visual-Auditory Learning	
Spatial Relations	
Sound Blending	
Concept Formation	
Visual Matching	
Numbers Reversed	

Notes:

WJ-III Cognitive Index Scores

Measure	Standard Score
Verbal Ability - Standard Scale	
Thinking Ability – Standard Scale	
Cognitive Efficiency – Standard Scale	

Notes:

WJ-III Achievement Subtest Scores

Measure	Standard Score
Letter-Word Identification	
Reading Fluency	
Story Recall	
Understanding Directions	
Calculation	
Math Fluency	
Spelling	
Writing Fluency	
Passage Comprehension	
Applied Problems	
Writing Samples	
Story Recall - Delayed	
Word Attack	
Picture Vocabulary	
Oral Comprehension	
Editing	
Reading Vocabulary	
Quantitative Concepts	
Academic Knowledge	
Spelling of Sounds	
Sound Awareness	

Punctuation and Capitalization	

Notes:

WJ-III Achievement Index Scores

Measure	Standard Score
Broad Reading	
Basic Reading Skills	
Reading Comprehension	
Oral Language - Standard	
Listening Comprehension	
Oral Expression	
Broad Math	
Math Calculation Skills	
Math Reasoning	
Broad Written Language	
Basic Writing Skills	
Written Expression	
Academic Skills	
Academic Fluency	
Academic Applications	
Phoneme/Grapheme Knowledge	

Notes:

BASC-2 Scores

Area	T-Score
Hyperactivity	
Aggression	
Conduct Problems	
Externalizing Problems	
Anxiety	
Depression	
Somatization	
Internalizing Problems	
Attention Problems	
Learning Problems	
School Problems	
Atypicality	
Withdrawal	
Behavioral Symptoms Index	
Adaptability	
Social Skills	
Leadership	
Study Skills	
Functional Communication	
Adaptive Skills	

Notes:

BRIEF Scores

Area	T-Score
Inhibit	
Shift	
Emotional Control	
Behavioral Regulation Index	
Initiate	
Working Memory	
Plan/Organize	
Organization of Materials	
Monitor	
Metacognition Index	
Global Executive Composite	

Notes: