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Exploration of Specific Learning Disability Subtypes Differentiated across Cognitive, Achievement, and Emotional/behavioral Variables

Lisa A. Hain
Philadelphia College of Osteopathic Medicine, LisaHai@pcom.edu

Philadelphia College of Osteopathic Medicine

Department of Psychology

EXPLORATION OF SPECIFIC LEARNING DISABILITY SUBTYPES DIFFERENTIATED ACROSS COGNITIVE, ACHIEVEMENT, AND EMOTIONAL/BEHAVIORAL VARIABLES

By Lisa A. Hain

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Dissertation Approval

This is to certify that the thesis presented to us by LISA HAIN

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

acceptable in both scholarship and literary quality.

Committee Members' Signatures:

James Brad Hale, Ph.D., Chairperson

Jennifer Hillman, Ph.D.

George McCloskey, Ph.D.

Robert A. DiTomasso, Ph.D., ABPP, Chair, Department of Psychology

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Abstract

The emphasis on the ability-achievement discrepancy approach for SLD identification diminished the importance of robust examination into patterns of cognitive strengths and weaknesses as related to achievement deficits. This approach directed attention away from related psychosocial deficits previously reported in this population by concentrating on the quantitative differences between standard scores. The cognitive and academic deficits of children with SLD have been well studied, but little is known about the emotional/behavioral functioning of children with SLD, and even less about the interconnections between the neurocognitive and emotional/behavioral systems. Children with disparate types of neurocognitive assets and deficits may experience learning problems specific to academic domains, and subtypes of SLD could be related to differential patterns of psychosocial adjustment. In an attempt to further the investigation of these relationships, the current study explored SLD subtypes ($N = 113$) through hierarchical cluster analysis of the WISC-IV standard subtests with emotional/behavioral functioning assessed through BASC-2 teacher ratings. Six cognitive SLD subtypes emerged, differentiated across cognitive, academic, and psychosocial variables. Statistically significant group differences were found across these variables through multivariate repeated measures MANOVA and Bonferroni post hoc analyses. The Crystallized/Language and the Executive/Working Memory subtypes demonstrated severe cognitive and academic deficits and were prone to experience global emotional/behavioral dysfunction. Two subtypes demonstrated apparent right hemisphere-based learning difficulties and were differentiated by neurocognitive assets and deficits. Although achievement difficulties were noted in math areas for both

subtypes, the Fluid Reasoning subtype had additional difficulty with Reading Comprehension and more emotional/behavioral concerns than the Visual/Spatial subtype. The Processing Speed and the High Functioning/Inattentive subtypes had less severe cognitive and academic deficits, but the High Functioning/Inattentive subtype had difficulties with attention and hyperactivity, and the Processing Speed subtype had attention difficulties and internalizing problems. This study demonstrated the fact that delineating both academic and behavioral patterns for different subtypes could help practitioners with more accurate identification practices, not only for entitlement purposes, but also for the development of individualized education programs that meet academic and psychosocial needs of children with SLD. Future research could benefit from investigation of SLD subtype patterns of functioning across cognitive, academic, and psychosocial factors.

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Chapter 1

Introduction

Of interest to most educational practitioners and particularly to school psychologists is the number of students who demonstrate disabling conditions for which they require specialized instructional techniques and supportive academic settings. Approximately, 6.5 million students are served through special education; 85 percent to 90 percent of these are served through reliance on educational categories of disability (Reschly & Ysseldyke, 2002). Of greatest concern are the children with specific learning disabilities (SLD) who represent a fast growing and largest classification of disabled children in the school settings (National Research Center on Learning Disabilities, 2005). According to the President's Commission on Excellence in Special Education, during the years between 1990 to 2000, a 36 percent increase occurred in the diagnosis of SLD (PCESE, 2002), so that the SLD classification now represents over one-half of all classified students in the United States (Truscott, Catanese, & Abrams, 2005). Exact prevalence rates of SLD are difficult to discern; however, estimates suggest that 6 percent of students (2.72 million) nationwide are affected with SLD and need specially designed instructional services offered through special education (Fuchs, Deshler, & Reschly, 2004). A confounding element in the effective assessment and intervention for children with SLD is comorbidity with other disorders; rates between SLD and emotional/behavioral disabilities range from 19 percent to 75 percent (Sonuga-Barke, 1998).

According to the Surgeon General of the United States (U.S. Public Health Service, 2000), annually in the U.S. 1 in 5 children exhibit signs and symptoms of a DSM-IV disorder and 5 percent of children suffer from an emotional disorder that causes severe impairment. Children with SLD are potentially at heightened risk for peer relationship problems (Gresham & MacMillan, 1997), lowered self-esteem (Kavale & Nye, 1986), and problems with social perception, social cognition, and communicative competence (Bryan, Burstein, & Ergul, 2004). Outcome studies of children with SLD suggest serious academic deficits which result in school failures (National Longitudinal Transition Study, 2005) and higher drop out rates when compared with typical peers (Bender & Wall, 1994). Youth with SLD are often overrepresented in the juvenile justice system (Quinn, Rutherford, Leone, Osher, & Poirer, 2005) with 55 percent of adjudicated youth being identified with learning difficulties (Ottnow, 1998). The comorbidity extends into adulthood with SLD and mental illness affecting approximately 15 percent to 80 percent of adults (Bouras & Drummond, 1992). Despite these findings, the Federal definition of SLD does not consider emotional/behavioral deficits of children and youth (Elksnin & Elksnin, 2004), suggesting that poor adult outcomes are a final, common pathway for many of these children with learning and emotional/behavioral disorders.

SLD identification and eligibility procedures are currently undergoing dramatic changes, leading to a period that will perhaps become a pivotal point in the history of school psychology and in the future of determining eligibility for special education services. This state of change entails possible removal of established procedures such as the ability-achievement discrepancy approach which is now positioned for competition against a response to intervention (RtI) approach for eligibility as a student with SLD. Although the fundamental definition of that which constitutes SLD has not been modified with IDEA 2004, the definition is fragile at best, and is generally ignored, if RtI procedures, only, are put into practice. This approach has been criticized because RtI procedures are unable to establish the necessary *basic psychological processes* that are deficient and eventuate in specific cognitive, academic, and psychosocial disabilities. This practice remains ignorant of the literature that connects SLD with specific aspects of cognitive and neuropsychological integrity and dysfunction (Fiorello, Hale, & Synder, 2006; Hale, Kaufman, Naglieri, & Kavale, 2006; Mather & Gregg, 2006; Semrud-Clikeman, 2005). Despite this apparently dichotomous viewpoint between ability-achievement discrepancy and RtI, a third method is also a viable candidate for implementing aspects of RtI and of cognitive/neuropsychological assessment in the determination of SLD, one that addresses both the statutory and regulatory IDEA SLD requirements (Hale et al., 2006).

In addition to this change regarding SLD identification and eligibility is an ongoing dialogue regarding how to utilize and interpret cognitive assessment results. Within this dialogue are ongoing debates between nomothetic or idiographic approaches in the identification of the basic psychological processes. One position holds that only the FSIQ clearly demonstrates predictive capability for areas of achievement in determining SLD and that global scores are preferred over idiographic analysis (Glutting, Watkins, & Youngstrom, 2003; Smith, 2005; Watkins, Glutting, & Lei, 2007). The opposition advocates for idiographic analysis in determining patterns of strengths and weaknesses in cognitive profiles which are directly related to the area of suspected achievement deficit in order to identify differential SLD subtypes (Fiorello et al., 2006; Flanagan, Ortiz, Alfonso, & Dynda, 2006; Hale & Fiorello, 2004; Mayes & Calhoun, 2008; Naglieri, 1999; Snow & Sapp, 2000). This approach appears consistent with typical school psychology practice, in which ninety percent of school psychologists who were surveyed indicated that they examine both factor scores and subtest profiles in cognitive assessment and interpretation (Pfeiffer, Reddy, Kletzel, Schmelzer, & Boyer, 2000).

In addition to the cognitive and achievement factors involved in SLD, many children experience difficulty with emotional/behavioral adjustment (Rourke, 2008). The emotional and behavioral systems are intricately related to the students' learning systems, complicating the clinical identification and treatment of SLD. The comorbidity between cognitive functioning and inter-relationships with emotional and behavioral variables is often discounted despite extensive research demonstrating that SLD is more than a problem in the learning system (Arnsten & Li, 2005; Bryan et al., 2004; Mattison, Hooper, & Carlson, 2006; Mayes & Calhoun, 2008; Nussbaum & Bigler, 1986; Nussbaum, Bigler, & Koch, 1986; Rourke, 2008; Speece, McKinney, & Appelbaum, 1985, 1986; Wei-dong 2004; Ring, Zia, Lindeman, & Himlok, 2007). The extant literature has also revealed subtypes of SLD based on specific neurocognitive profiles and specific academic areas and have examined the comorbid role of psychosocial functioning (D'Amato, Dean, & Rhodes, 1998; Fiorello et al., 2006; Forrest, 2004; Fuerst, Fisk, & Rourke, 1989, 1990; Groth-Marnat & Teal, 2000; Hanna-Pladdy, 2007; Hendriksen et al., 2007; Mammarella et al., 2006; McKinney & Speece, 1986; Rourke, 1989; Rourke & Fuerst, 1991, 2000; Schatz, Ballantyne, & Trauner, 2000; Speece et al., 1986; Wang, Huettel, & DeBellis, 2008).

Collapsing children with cognitive, learning, and psychosocial problems into a single "SLD" group further confounds differential diagnosis and service delivery for this enigmatic population. It is well known that SLD samples are highly heterogeneous, thereby demonstrating the multi-faceted nature of the disorder; therefore collapsing distinct subtypes into a heterogeneous, single sample can lead to ambiguous research and clinical results (Fiorello et al., 2006; Rourke, 1994). These SLD subtypes need to be extrapolated to bridge the gap between research and instructional and therapeutic approaches provided in the educational community. Examining SLD subtype cognitive, achievement, and emotional/behavioral variability could elucidate inconsistent findings in studies using heterogeneous SLD groups, and delineating these subtypes could advance educational decision making. Given the mounting neuropsychological evidence demonstrating differential SLD subtypes based upon neurocognitive and psychosocial functioning, it would be best practice to investigate the impact of multiple factors (i.e. cognition, behavior, and environment) in children's learning (Bandura, 1978) and conceptualize a mental trilogy (i.e. cognitive, emotional, and motivational) in assessment of children's learning deficiencies (LeDoux, 2002).

The current study was undertaken to identify and describe meaningful cognitive subtypes of children with SLD as determined by hierarchical cluster analysis, and to examine subtype differences on standardized cognitive measures, standardized academic measures and BASC-II behavior ratings. Although the study was designed to address research questions rather than explicit research hypotheses, the results could highlight how children with different types of neurocognitive assets and deficits experience learning problems in different academic domains (e.g., reading, writing, and math). In addition, these could be related to different patterns of psychosocial adjustment (e.g., internalizing, externalizing, adaptive behavior). Research questions were used because the majority of the SLD research has used heterogeneous, single SLD samples, and for SLD subtyping studies, different researchers have found different patterns of psychosocial adjustment based on different methodologies and samples.

Differentiating cognitive, academic and emotional/behavioral patterns could aid practitioners with more accurate SLD identification practices, not only for determining special education eligibility, but also for developing effective individualized education programs that meet the academic and psychosocial needs of children with SLD. It is clear that researchers should undertake studies involving subtypes if relevant conclusions and implications are to be delineated for children with SLD (Rourke, 2008). Through examination of the cognitive, academic, and psychosocial functioning of SLD subtypes, this study sought to further the understanding of this heterogeneous and enigmatic population, so that affected children could be better served in the educational community.

Chapter 2

Literature Review

Eligibility Procedures in Identification of SLD

Procedures for identifying SLD have been modified because of the Individuals with Disabilities Education Act (IDEA 2004), transforming eligibility as a student with SLD. These newest regulations include several remarkable changes in the practice of SLD assessment, identification, and entitlement (Zeikel, 2007). The legal definition of SLD has remained unchanged since its original enactment. IDEA 2004 defines a specific learning disability in Title 20 United States Code Section 1401(30) [cited as 20 USC 1401(30)] as follows:

> (30) Specific Learning Disability.
>
> (A) In General. The team '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 disorder may manifest itself in the imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations.
>
> (B) Disorders Included. Such term includes conditions such as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia (34 C.F.R. 300.8).

In addition, IDEA 2004 regulations stipulate that the school team must determine if the child is not achieving adequately for the child's age or does not meet State-approved grade-level standards when provided with learning experiences and instruction appropriate for the child's age and grade–level standards. The academic areas for SLD eligibility include oral expression, listening comprehension, written expression, basic reading skills, reading fluency skills, reading comprehension, mathematics calculation, or mathematics problem solving [see 34 CFR 300.309(a)(1)].

Learning disabilities have generally been identified through the use of a discrepancy between measured ability based on cognitive performance and achievement; however, utilization of this methodology (ability-achievement discrepancy approach) accounts for narrow assessment of learning strengths and weaknesses (Joshi, 1999) and is considered a weak methodological manner in determining the presence of SLD (Fuchs, Mock, Morgan, & Young, 2003). Much has been written on the limitations of using the ability-achievement discrepancy approach in determining SLD (see Berninger, 2001; Fuchs et al., 2003; Hale, 2008; Kavale, Kaufman, Naglieri, & Hale, 2005; Lyon, 1995; Mather & Gregg, 2006; Vellutino, 2001). The discrepancy approach has been criticized for yielding inconsistent results not only with over-identification of children who have high scores on intelligence tests, yet have average achievement, but also with under-identification of children who have low scores on intelligence tests and below-average achievement (Kavale, Holdnack, & Mostert, 2005; Semrud-Clikeman et al., 1992; Semrud-Clikeman, 2005).

Newest regulations have provided for alternative methodology in determining SLD. According to Title 20 of Section 1414, subsection b(6), [cited as 20 USC 1414(b)(6)], in determining whether or not a child has SLD, IDEA 2004 does not require the use of a severe discrepancy between intellectual ability and achievement and allows the use of a process that determines if a child responds to scientific, research-based intervention.

A process based on a child's response to scientific, research-based intervention is synonymous with RtI approaches, first proposed by Gresham (2002) as a viable alternative to the discrepancy model. In the RtI model, children with learning problems receive individualized, scientific, research-based interventions designed to remediate their deficiencies. Progress data is collected and compared with the child's initial performance in order to ascertain a response to the intervention. The process occurs through three tiers; tier one uses school-wide screening and group intervention; tier two is responsible for identification of individual students who fail to respond to tier one interventions, and also provides individually tailored interventions; and tier three determines long-term programming for students (special education) who fail to respond to tier two interventions (Kovaleski, 2003). Identification models that incorporate RtI present an opportunity to provide early intervention and pre-referral services to reduce inappropriate referral and identification (Fletcher, Coulter, Reschly, & Vaughn, 2004). Although RtI has strengths in its ability to help struggling students immediately so that intervention is not postponed until placement in special education (Fuchs et al., 2003), RtI is not a stand alone method (Hale, 2008). The RtI approach has been criticized as ignoring the legal definition of a specific learning disability with the basic psychological processing deficit(s) requiring elucidation (Hale et al., 2006). An RtI approach does not allow for examination of underlying causative factors for the achievement deficiencies, nor does it provide any additional information to guide intervention for nonresponders

(Hale, 2008). Many reasons could be given to account for a child's inability to respond to the intervention such as poor teacher training in carrying out the intervention, whether or not the intervention was implemented with integrity, and the amount of progress that is needed to substantiate a response to the intervention (Hale, 2008).

An alternative proposal is inclusion of assessment of cognitive functioning as a fundamental factor in the decision making process for eligibility. This viewpoint is more closely aligned with the IDEA 2004 definition of SLD in order to pinpoint the basic psychological processing deficit(s). According to IDEA (2004) 300.304(b) and section 614(b)(2), the evaluation for SLD must include a variety of assessment tools and strategies and cannot rely on a single procedure as the sole criterion for determining eligibility for special education and related services. Therefore, RtI is only one method in the process of identifying children in need of special education. This has led some researchers to hypothesize a hybrid approach to SLD diagnosis, one which incorporates the best both of RtI and of cognitive assessment (see Hale et al., 2006). Hale and colleagues postulate that RtI is warranted for widespread adoption in the schools (Hale, 2008) in tier one and tier two, but before tier three comprehensive cognitive assessment is conducted, including examination of the basic psychological processes directly attributing to the SLD. This hybrid approach is the only model that addresses both the statutory and regulatory DEA requirements and lends to successful tier three interventions (Hale et al., 2006; Hale, 2008). Despite RtI's contribution to early intervention and the subsequent decrease in the percentage of children identified as needing special education (Burns, Appleton, & Stehouwer, 2005), it continues to ignore the underlying psychological processes that are directly attributing to the learning disability, and it also continues to ignore other factors such as a child's executive functioning and emotional/behavioral functioning in determining the exact needs of individual children.

More recently, different models of identifying SLD have been proposed. One such model, the Discrepancy/Consistency Model, utilizes a discrepancy and consistency methodology which entails examining discrepancies between the cognitive strengths and the achievement strengths and the cognitive deficits and the achievement weaknesses (Naglieri, 1999). This model also ensures that there is consistency between the cognitive processing weakness and the academic weakness. Flanagan and colleagues (2006) have also developed a similar model that includes a seven step process of identifying SLD which includes examination of academic difficulties and cognitive processing strengths and deficits (Flanagan, Ortiz, Alfonso, & Dynda, 2006). In addition, the Concordance/Discordance Model (C-DM) developed by Hale & colleagues (Hale & Fiorello, 2004; Hale, Fiorello, Bertin, & Sherman, 2003; Hale et al., 2008) also utilizes a discrepancy approach based on cognitive strengths and weaknesses. Initially, cognitive strengths and weaknesses are determined. Concordance is examined between the deficient achievement area and deficient cognitive processes that are related to that presumed area of academic deficiency. Discordance is examined between the deficient achievement area and cognitive processing strength. When a significant difference exists (as measured by the standard error of the difference) between the cognitive strength and the achievement weakness (discordance), and no significant difference exists between the cognitive weakness and the achievement deficit (concordance), an SLD in that deficient achievement area is then identified. Accordingly, this model appears more dynamic in helping to identify children with SLD by examining both cognitive processing strengths and weaknesses which informs appropriate individualized intervention (see Hale et al., 2006).

Basic Psychological Processes

Historically, to identify SLD a typical assessment included assessment of cognitive and neuropsychological functioning in order to establish the disorder in one or more of the basic psychological processes (Berninger & Richards, 2002; Mather & Gregg, 2006; Semrud-Clikeman, 2005). These assessments of cognitive and neuropsychological functioning often included standardized tests of intelligence. These standardized instruments were successful in helping to define a student's level of overall intellectual functioning and more recently have become important in examining cognitive strengths and deficits of the child in determining the presence of SLD. One such instrument is the Wechsler Intelligence Scale for Children – Fourth Edition (WISC-IV; Wechsler, 2003) which has become more theoretical in its approach, yielding four factor scores and process subtests that are more sensitive to the robust nature of cognitive functioning (Keith, Goldenring-Fine, Taub, Reynolds, & Kranzler, 2006; Wechsler, 2003). The WISC-IV is being used not only to assess a child's overall intellectual level as measured by global ability, but it also examines more specific cognitive processes through subtest patterns of performance that are then linked to specific areas of academic deficits. These brain-behavior relationships between cognitive and achievement variables suggest that certain cognitive deficits are likely linked with subtypes of SLD (Berninger & Richards, 2002; Bryan et al., 2004; Geary, Hoard, & Hamson, 1999; Hale et al., 2006; Mather & Gregg, 2006; Mazzocco, 2001; Semrud-Clikeman, 2005).

The interpretation of tests of cognitive functioning in determining SLD can take both an idiographic and nomothetic approach, as evidenced by debates between proponents of subtest analysis that differentiate SLD subtypes and those who condemn this practice, preferring the FSIQ for determining SLD (see Fiorello, Hale, McGrath, Ryan, & Quinn, 2002; Prifitera & Dersh, 1993; Smith, 2005; Watkins & Canivez, 2004). This debate has raged for at least three decades with earlier studies demonstrating distinct cognitive profiles in SLD populations using the Wechsler Intelligence Scale for Children-Revised (WISC-R; Wechsler, 1974) normative sample and later utilization of the WISC-III (WISC-III; Wechsler, 1991) and WISC-IV (WISC-IV; Wechsler, 2003) in determining SLD subtypes.

Proponents of global score interpretation argue that the global ability score is the most reliable comparison for children with SLD (McDermott, Glutting, Jones, Watkins, & Kush, 1989). A plethora of research has tried to establish the fact that subtest scatter and subtest profiles do not discriminate diagnostic groups and that hypothesized relationships between subtest profiles and academic disorders fail to achieve statistical significance (Dana & Dawes, 2007; Glutting et al., 2003; Robinson & Harrison, 2005; Smith, 2005; Watkins & Glutting, 2000; Watkins et al., 2007). Likewise, subtest-based profiles, interpretation, and subsequent recommendations of underlying cognitive skills are considered unreliable (Watkins & Canivez, 2004; Watkins, Kush, & Glutting, 1997);

therefore, caution in the interpretation of subtest analysis has been advised (Yuan, 1999). Proponents of global score interpretation state that the FSIQ "is the most parsimonious and powerful predictor of academic achievement" (Glutting, Youngstrom, Ward, Ward, & Hale, 1997, p. 300) and advise examiners to "just say no to subtest analysis" (McDermott, Fantuzzo, & Glutting, 1990, p. 290). Nonetheless, these attempts to nullify the usefulness of factor and subtest scores in predicting achievement have been found primarily by the use of flawed statistical methodology, entailing the use of forced entry hierarchical regression which is not appropriate for use with collinear variables (see Fiorello et al., 2002; Fiorello, Hale, Holdnack, Kavanagh, Terrell, & Long, 2007).

Proponents of subtest analysis and subtest-based patterns of performance have traditionally argued that subtest analysis is clinically fruitful and is seen as valid and reliable for children with variable cognitive profiles and for children with SLD (Fiorello et al., 2002; Fiorello et al., 2006; Hale & Fiorello, 2004; Kaufman, 1994; Mayes & Calhoun, 2008; Vargo, Groser, & Spafford, 1995). Proponents advocating for the subtest analysis approach argue that because of the variability both in the index scores and in the FSIQ of children with SLD (Fiorello et al., 2002; Hale, Fiorello, Kavanagh, Hoeppner, & Gaither, 2001) that the FSIQ not be interpreted for these children. It has been found that when the FSIQ is used in the examination of children with flat and variable test profiles, this measure does not necessarily represent global intellectual functioning either for children with disabilities or for typical children with significant profile variability (Fiorello et al., 2002; Mayes & Calhoun, 2004).

Collapsing across all SLD subtypes, use of the FSIQ as the measure of cognitive functioning tends to obscure important differences. When collapsing distinct subtypes into a heterogeneous mixture, low scores are found overall and a decrease in the ability to notice distinct connections between cognition and achievement is evident. For instance, specific patterns of cognitive functioning have been linked to SLD, with lower scores reported across specific WISC-R subtests of Arithmetic, Digit Span, and Coding (Vance, Fuller, & Ellis, 1983), and lower scores found on the WISC-III subtests of Symbol Search, Coding, Arithmetic, and Digit Span (Prifitera & Dersh, 1993). This profile was termed SCAD and children with this profile tended to have difficulty with motivation and with the ability to resist distraction (Kaufman, 1994). Consequently, the ACID profile emerged; this is characterized by low subtest scores on Arithmetic, Coding, Information, and Digit Span. The ACID profile based on WISC-III subtest profile patterns was found for children with dyslexia (Vargo et al., 1995) and Attention Deficit Hyperactivity Disorder (ADHD) (Snow & Sapp, 2000). Children with neurological disorders (ADHD, Autism, Bipolar Disorder, and SLD) were found to have low mean Processing Speed (PSI) and low Freedom from Distractibility (FDI) scores (Mayes & Calhoun, 2005).

In addition, Mayes & Calhoun (2004) found three specific cognitive profiles differentiated by WISC-III factor and subtest scores for children with Autism, children with ADHD and SLD, and children with Traumatic Brain Injury (TBI). For children with Autism, low scores were found for the subtests of Coding and Comprehension and for the FDI composite score. Children with ADHD and SLD were differentiated from those with Autism by a stronger performance on the Comprehension subtest. Children with TBI were differentiated by low scores on the Performance IQ (PIQ) (Mayes & Calhoun, 2004). Children with High-Functioning Autism were found to have above average scores on the WISC-IV Perceptual Reasoning and Verbal Comprehension composites but below average scores on the Working Memory and Processing Speed composites (Mayes & Calhoun, 2008). Therefore, examination of index scores and subtest scores help not only to differentiate between children with various learning disorders, but also to pinpoint more specific subtypes of SLD.

Subtypes of SLD within the larger heterogeneous population of SLD have been identified and further examined across cognitive variables. These studies have utilized cluster analytic techniques to derive homogeneous groupings of children with differing SLD typologies. Obrzut (1979) found four SLD subtypes in a population of 144 male children who were characterized as normal, dysphonetic, dyseidetic, and alexia (mixed); Doehring, Hoshko, & Bryans (1979), however, found a linguistic, a phonological, an intersensory-integration, and a unclassified subtype. Morris, Blashfield, & Satz (1986) stipulated the existence of five SLD subtypes which were indicated by global language impairment, specific language impairment, mixed language and perceptual impairment, perceptual-motor impairment, and normal profiles.

One of these earlier studies examined SLD subtypes, utilizing the WISC-R in a cluster analysis (Snow, Cohen, & Holliman, 1985). In a sample of 106 children with SLD, six distinct subtypes were derived. Subtype one displayed problems with perceptual organization and attention; the second subtype presented with deficits in verbal comprehension and language; the third subtype displayed severe attentional deficits; the fourth subtype had mild deficits in verbal comprehension; the fifth subtype evidenced mild strengths and weaknesses, and subtype six demonstrated a normal profile (Snow et al., 1985). Furthermore, Hicks & Spurgeon (1992) located subtypes based on literacy, intelligence, auditory processing, and visual/verbal processing.

A more recent, large scale study utilizing 1,144 children with SLD also utilized cluster analysis through examination of neuropsychological profiles to target more homogeneous subtypes (D'Amato et al., 1998). Four interpretable clusters emerged which were further distinguished as a neuropsychological subtype characterized by verbal/sequential/arithmetic deficits, a subtype with motor speed and cognitive flexibility deficits, a third with mixed language/perceptual deficits, and a no deficit subtype.

Cognitive Patterns of Performance in SLD Subtypes

The subtyping of SLD has also resulted in two hypothesized subtypes known as verbal learning disability (VLD) and nonverbal learning disability known as NVLD (Drummond, Ahmad, & Rourke, 2005). The NVLD syndrome has been reviewed extensively by Rourke and colleagues, substantiating a single NVLD construct (Rourke, 1989; Rourke & Fuerst, 1991; Rourke, 1994; Rourke, 2008). Rourke (1989) postulates a NVLD subtype characterized by well developed psycholinguistic and language-related skills relative to visual/spatial/organizational skills (VIQ>PIQ), which tends to result in higher levels of psychosocial disturbance (Fuerst et al., 1989; Fuerst et al., 1990). Rourke postulates that right hemisphere dysfunction in NVLD results in nonverbal, visual/spatial deficits due to deficits in white matter hindering intermodal integration (Rourke, 1995).

The NVLD subtype is partly differentiated by low scores on Coding, Block Design, and Object Assembly (Rourke, 1995).

However, neuropsychological studies indicate that hemisphere of damage differentially relates to the errors in visual/spatial processing (Groth-Marnat & Teal, 2000). For instance, children with focal brain damage tended to display disparate profiles on the Block Design subtest. Children with right hemisphere lesions tended to have a greater percentage of global pattern errors, and children with left hemisphere damage tended to make more local detailed errors on the task. Therefore the verbal-nonverbal position was challenged, suggesting that the right hemisphere was responsible for global/pattern aspects of visual processing and the left hemisphere was more involved with local/detail aspects of visual processing (Groth-Marnat & Teal, 2000). These results suggest that the NVLD syndrome may not be truly based on deficits in "nonverbal" processing.

Johnson & Myklebust (1967) were the first investigators to determine disability subtypes based on a verbal and nonverbal dichotomy and asserted that, potentially, more than one subtype of NVLD existed. They stipulated that one NVLD subtype presented with visual spatial deficits and the other subtype had deficits in social perception. According to Forrest (2004), the NVLD construct suffers from large heterogeneity and from a constellation of cognitive strengths and weaknesses which may not always eventuate in social perception difficulties. The NVLD syndrome encompasses a "broad spectrum of children over a wide variety of diseases" (Forrest, 2004, p. 131).

Forrest (2004) compared performances of three groups of children, those with NVLD, those with VLD, and controls. The results demonstrated that current assessment practices do not identify NVLD well. This study also substantiated the idea that children with NVLD demonstrated lower rates of psychopathology than children with VLD; this is not aligned with results in which children with NVLD demonstrated higher rates of psychosocial disturbance (Fuerst et al., 1989). Finally, it appears that the visual/perceptual deficits of children with NVLD included a primary deficit in locating objects in space, but that these deficits did not always result in math difficulties or social difficulties (Forrest, 2004).

However, Hendriksen et al. (2007) investigated three learning disability subtypes which were termed AMD (attention with or without motor function disability), VLD (verbal learning disability), and NVLD (nonverbal learning disability). This study revealed that the AMD and VLD subtypes were the most frequently reported and as with the Forrest (2004) study, NVLD was difficult to classify. The VLD subtype was characterized by deficits in language skills (dyslexia and speech language impairment) and the AMD subtype was characterized by deficits in attention, motor control, and perception. The VLD group showed the fewest behavior problems, but the AMD subtype demonstrated externalizing disorders and the NVLD subtype engaged in more internalizing disorders such as prior research suggests (Rourke, 1994). The VLD group demonstrated poor performance on the reading tasks and the NVLD subtype demonstrated difficulties with arithmetic (Hendriksen et al., 2007). These conflicting findings showcase the diversity of the VLD and NVLD syndromes, thereby substantiating more homogeneous subtypes under these larger umbrella terms.

Relationship between Cognitive Processes and Academically-Based SLD

As these studies indicate, the SLD construct is highly heterogeneous when examined across cognitive processes and becomes even more complicated when attempts are made to determine how specific cognitive processes affect a child's learning in school. Historically, SLD has been seen as a learning deficit in a specific academic area, although in reality, cognitive deficits likely lead to a variety of learning difficulties across multiple academic domains. Recent research has contributed a wealth of information that pinpoints some of the neuroarchitecture and processing demands that are involved in performing academic tasks. This has led to the delineation of SLD subtypes within academic areas.

Reading disabilities (RD) is a broad classification that includes word reading difficulties, reading comprehension difficulties, and reading fluency difficulties. Reading disabilities can stem from phonological processing problems, orthographic processing problems and naming speed deficits, or a combination of deficits which lead to specific types of reading problems (Badian, 2001). Both phonological awareness and rapid naming speed are identified as processes related to successful reading (Wagner & Torgensen, & Raschotte, 1994); deficiencies in both areas can lead to a double deficit RD (Wolf & Bowers, 1999). Furthermore, a deficiency in phonological, orthographic, and naming speed processes can result in a triple deficit RD (Badian, 1995). Children with double or triple deficits in reading are at greater risk for reading failure (Lovett, Steinbach, & Frijters, 2000; Wolf & Bowers, 1999). Several studies have substantiated direct relationships between basic psychological processes and deficient reading skills. These relationships include poor phonological processing skills and deficient word reading ability (Badian, 2001; Stanovich, 1980; Stanovich & Siegel, 1994; Wagner et al., 1994); orthographic processing problems resulting in orthographic reading disabilities (Badian, 2005); weak subword orthographic-phonological connections limiting word specific representations (Barker, Torgenson, & Wagner, 1992; Compton, 2002); slow speed of orthographic, phonological, and semantic word reading systems in the processing of linguistic information (Breznitz, 2001, 2002) and poor rapid naming ability (Bowers, 2001). Likewise, children with learning difficulties perform poorly on measures of verbal working memory (Pickering & Gathercole, 2004), with specific deficits in the phonological loop in working memory linked to word reading disabilities (Kibby, Marks, Morgan, & Long, 2004). With so many factors involved in reading, it is not surprising that four reading disability subtypes have been found in children with SLD in the area of reading (Fiorello et al., 2006). These different subtypes were termed according to the cognitive deficits that were displayed in reading tasks; these are primarily Global, Phonemic, Fluency-Comprehension, and Orthographic in nature (Fiorello et al., 2006).

According to accumulated neuropsychological research, the left hemisphere and its connections are likely involved in aspects of reading. Neuroimaging studies have demonstrated that orthographic processing occurs in the left occipital and occipital-temporal regions (Fiez & Petersen, 1998); positron emission tomography (PET) has also demonstrated activation in the left temporal and parietal regions for phonological processing (Demb, Poldrack, & Gabrieli, 1999). The left hemisphere works with related neural networks for successful reading which involves the face motor cortex, the cerebellum, and the orbitofrontal cortex (Kujalo, Pammer, Cornelissen, Roebruck, & Fornis, 2007). During word reading the occipitotemporal cortex is involved with early letter string and word specific processing, whereas reading comprehension involves synchronization between the left superior temporal and orbitofrontal cortices (Kujalo et al., 2007).

The role of the visual system in reading is also important with a demonstrated link between visual-spatial processing deficits and children with reading disabilities (Terepocki, Kruk, & Willows, 2002). Prior research has demonstrated that the visual system impacted upon reading success (see Lovegrove, 1993; Lovegrove, Martin, & Slaghvis, 1986; Stein, 1993), and more recently, a relationship between letter reversals and visual-orthographic processing in dyslexic readers has been documented (Badian, 2005). In addition, research has demonstrated that children with RD show impaired performance on the Clock Drawing Test, suggesting problems with the visuoconstructive ability of children with RD, and possible neglect of the left side of space (Eden, Wood, & Stein, 2003). These children are characterized by spatial construction deficits similar to those found in patients with right hemisphere lesions; they often look at the right side of the book rather than the left and tend to favor the right side over the left side even if the information is presented to the left of the children (Eden et al., 2003). Visual manifestations have been studied in the framework of the magnocelluar pathways theory. A magnocellular deficit has been named in a study involving adults with dyslexia

(Lovegrove et al., 1986) and is suggested as a deficit in children with RD who tend to demonstrate poor eye movement control and visual confusion (Eden, Stein, Wood, & Wood, 1995). Increased right parietal-occipital activity for visual processing in word reading has been demonstrated (Flynn, Deering, Goldstein, & Rahbar, 1992).

Berninger & Richards (2002) also indicate that language, cognition, and memory are important to reading. According to these investigators, ideas are translated into different levels of language in memory. In terms of language deficits, a limited vocabulary may result in difficulties in acquiring fluency in printed word identification, and RD may be caused by deficiencies in the semantic, syntactic, or phonological components of language (Vellutino, Fletcher, Snowling, & Scanlon, 2004). It is equally important to recognize comorbidity between language disability and reading disability. Differences are noted between these disorders on measures of phonological processing, short-term auditory memory and spelling; the children who display language and reading deficits perform at a lower level than the children with reading or language deficits (Eisenmajer, Ross, & Pratt, 2005).

Earlier approaches to understanding the role of language centered on the lateralization approach which postulated that each hemisphere was primarily responsible for different actions, with the left hemisphere being seen as the "verbal" hemisphere and the right hemisphere being seen as "nonverbal" (Lindell, 2006). However, it is much too simplified to consider that the hemispheres work in isolation from other brain processes. Newer evidence disputes the notion that language is solely a function of the left hemisphere, suggesting that the right hemisphere makes contributions in processing language as well (Berninger & Richards, 2002; Lindell, 2006). Although damage to the left side of the temporal lobe can lead to Wernicke's aphasia, damage to the right temporal lobe can result in inability to name sounds and in dysprosody (Kaplan, Sadocki, & Grebb, 1994). The right cortex is involved with voice onset time, acoustic features and prosody, multiple meanings of words, visual details in words, maintaining activation of individual words, and activation of multiple related concepts (Berninger & Richards, 2002). The right hemisphere is also responsible for prosodic and paralinguistic aspects of speech production, reception, and interpretation (Lindell, 2006).

The link between audition and language development is also important to listening (receptive language) and speaking (expressive language) in school (Berninger & Richards, 2002). Speech language impairment is detected when there is a significant deficit in language relative to normal cognitive development (Tallal, Stark, & Mellitis, 1985). Children with language disability may likely have difficulty with processing rapidly changing acoustic signals in short-term memory and with understanding receptive (language by ear) and/or expressive language (language by mouth or hand) (Berninger & Richards, 2002). According to these researchers, it is difficult to determine differences between children with auditory processing problems or primary language disabilities from those with dyslexia. They cite the need for more research to concentrate on whether or not reading problems are due to oral language disability (language by ear and mouth) versus specific reading disability (language by eye), for which instructional practices are most effective (Berninger & Richards, 2002). The neuroarchitecture of language allows the brain to create different functional systems for language, each linked to a different end organ (ears, mouth, eyes, and hand) (Berninger & Richards, 2002). For children with SLD difficulties in other academic subjects may likely be due to deficiencies in processing both expressive and receptive language.

Similar to reading, deliberation also surrounds broad math disabilities and math disability subtypes. Neuropsychological research has helped shed light into the multiple causes of math disability. Damage to the left parietal lobe results in difficulty with written language and mathematical calculations, right-left orientation and finger agnosia and is often referred to as Gerstmann Syndrome because there is less gray matter in that region of the brain (Kaplan, et al., 1994; Mayer et al., 1999). Patients with math disabilities because of right hemisphere damage often experience problems with proper alignment of columns or the neglect of stimuli in the left visual field, resulting in a host of math difficulties (Langdon & Warrington, 1997; Rourke, 2008). Successful math performance most likely depends on bilateral hemispheric functioning (Benbow & Lubinski, 1997; Hale & Fiorello, 2004).

Because of these possible causes of math disability, subtypes have been found in the SLD population. Hale and Fiorello (2004) find it doubtful that there is a pure math disability. They have postulated the existence of multiple reasons for MD and have located unique subtypes. Children with the semantic subtype of MD have difficulties with number association and math fact automaticity (Geary, 1993), whereas the procedural subtype utilize poor strategies and experience working memory problems (Geary, Hoard, & Hamson, 1999). The visual-spatial subtype is characterized by poor visual-spatial and organizational ability, including problems with column alignment and place values

(Rourke & Fisk, 1988). More recently, Hale et al. (2008) report five disparate math SLD subtypes in the form of Fluid/Quantitative, Mild Executive/Working Memory, Right Hemisphere/NVLD, Numeric/Quantitative, and Dyscalculia-Gerstmann Syndrome, based upon performances across math achievement areas.

Similar to the other academic areas, written language research is beginning to uncover the processes needed for successful written language. Writing is considered language by hand and involves many more processes than that involved in reading (Berninger & Richards, 2002). The writing system is more constrained by increased working memory and executive demands. For instance, when reading one can refer to written text at any time, reducing memory involvement, but the writing brain calls upon all language systems because ideas cannot be expressed without them (Berninger & Richards, 2002). Furthermore, prefrontal areas are implicated in written language disability because working memory and other executive function deficiencies are apparent in creating and editing the final written product (Wilson & Proctor, 2000).

Handwriting is also related to WLD because early handwriting difficulties are linked to poor knowledge of orthographic codes and to problems with writing in later years; transcription skills need to be taught and demonstrated as early as the preschool years (Berninger & Richards, 2002). Successful spelling is related to phonological, orthographic, and morphological language skills (Berninger & Hooper, 2006). In addition, written language success depends in part on semantic knowledge (Berninger, 1994). The left temporal lobe has been noted as important for semantic memory in portraying meaning in written language (Daniele, Giustolisi, Silveri, Colosimo, &

Gainotti, 1994). In addition, metacognitive functions (Wong, 1991), developmental influences (Gregg, 1992) and linguistic and orthographic processes are related to problems in written language (Dusques, 1988). Grammar and syntax are also important to success in the use of written language, with implications that damage to the inferior frontal areas (Broca's area) will result in difficulties with syntax (Delazer, Girelli, Semenza, & Denes, 1999). Approximately 17 percent of children with WLD demonstrate problems with syntactic skills (Hooper et al, 1994).

Subtypes have also been posited for the written language disabilities. According to Sandler et al. (1992), one WLD subtype is characterized by fine motor and linguistic deficits; a second subtype with visual spatial deficits and poor handwriting, but good spelling and idea development; a third subtype with problems in spelling and organization; and a fourth WLD subtype with poor letter production and sequencing deficits (see Sandler et al., 1992). Wakely, Hooper, deKruif, & Swartz (2006) have devised a classification scheme for written language to aid in developing interventions for specific written language deficits. Written language skills were based on seven classifications: average ability, low semantic ability, low grammar ability, expert ability, low spelling-reading ability, and poor text quality. Children with SLD in written language had global impairment in semantics, grammar, spelling and overall text quality of the written product (Wakely et al., 2006).

Given the neurocognitive literature and the extent of SLD subtypes evident in academic areas, it is highly unlikely that SLD is a homogeneous group; rather, the heterogeneity is most likely obscuring important differences. In addition to the already mentioned academic difficulties, other brain systems are intimately involved in processing language, reading, writing, and math. These systems also rely on working memory and executive processes. Neuroimaging studies using positron emission tomography (PET) have shown that separable parts of the brain are involved in working memory and those areas appear to be the orbital frontal lobe, the dorsolateral prefrontal cortex, and the posterior parietal cortex (Haut, Kuwabara, Leach, & Arias, 2000), primarily in the right hemisphere. Working memory has been tied to numerous academic problems in reading, mathematics, and written expression (Geary et al., 1999; Swanson & Alexander, 1997; Wilson & Proctor, 2000). Active working memory becomes involved in tasks such as long division and word problems which have an extended process that requires holding on to key information, but also requires executing the needed operations to solve the problem. Poor working memory can be responsible for problems with place value, borrowing and carrying, and for difficulties with algorithms that involve several steps (Levine, 1999). Verbal working memory is usually associated with the phonological loop which, if deficient, can lead to language and reading disabilities (Pickering & Gathercole, 2004). Children with WLD also have deficits in integrating perception, attention, language, and memory processes with writing processes (Swanson, 1988).

The learning systems involved in performance of academic tasks demonstrate the complex nature of brain processing. Anterior and frontal regions are also differentially related to psychological processes. Accordingly, at least five frontal-subcortical circuits which involve the frontal lobe, basal ganglia, and thalamus are involved in reciprocal relationships and are responsible for executive and emotional/behavioral functioning

(Van Essen, Anderson, & Felleman, 1992). The five circuits are described as 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 functions; the orbital prefrontal circuit responsible for emotional self-regulation and the anterior cingulate circuit responsible for online monitoring and decision making (Hale & Fiorello, 2004). Damage to these cortical-subcortical circuits can result in dysexecutive syndromes leading to a diverse set of deficits in cognition, academic achievement, and psychosocial functioning (Hanna-Pladdy, 2007).

Emotional and Behavioral Processes in SLD

Cognitive psychology or the information processing approach has dominated the view of intelligence, which has resulted in a lack of attention to emotional processing and the connections between the emotional and learning systems (Le Doux, 1996; Phelps, 2005). With advances in techniques for studying the human brain, and through research utilizing animal models, the importance of emotions in understanding cognitive functioning is much more evident today (Le Doux, 1996). Advances into the neural basis of human cognition and emotions demonstrate involvement between these systems from early perception to decision-making and to even higher level processes such as reasoning (Le Doux, 2002). The amygdala influences cognitive functioning in reaction to emotional stimuli (Phelps, 2005), with primary functions involving modulating neural systems underlying cognitive social behaviors in response to emotional cues (Anderson & Phelps, 2000). Therefore emotion and memory are intricately related in encoding, consolidation of information, and in the subjective sense of remembering, with emotional processes influencing encoding through modulation of attention and perception (Le Doux, 1996). Cognitive processes are necessary components in understanding the neural systems and in the processing of emotion (Phelps, 2005). These cognitive processes also involve executive functioning and working memory in regulation of emotions and subsequent behavioral responses (Smith & Jonides, 1999). In fact, working memory and executive functions (planning, organizing, developing, monitoring, evaluating, and modifying) are implicated in cognitive and emotional/behavioral difficulties (Le Doux, 2002).

When examining the heterogeneity evident in the SLD population, it is clear that different cognitive processes and academic difficulties result in a plethora of specific learning disability subtypes. The complexity of heterogeneity is increased when examining SLD subtypes across emotional and behavioral variables. Emotional disabilities affect 9 to 13 percent of children and adolescents in the United States (Mark & Buck, 2006), with estimates suggesting that approximately 2 million children are classified as emotionally disturbed (Shaffer et al., 1996). Recent estimates suggest that the identification of children with behavioral problems has doubled in the last 2 decades (Kelleher, McInerny, Gardner, Childs, & Wasserman, 2000). These emotional disturbances result in specific types of behaviors exhibited by children. The main types are categorized into internalizing and externalizing subtypes, but problems with the executive control in the regulation of emotional and behavioral responses are also considered pertinent. Students with SLD can have both internalizing and externalizing behavioral deficits at the same time (Grigorenko, 2001; Willcutt & Pennington, 2000). In addition, these cognitive and emotional difficulties are linked to specific areas of academic functioning.

For instance, anxiety disorders tend to occur more often with mathematics disabilities in arithmetic and dyscalculia (Garnett & Fleischner, 1987; Prior, Smart, Sanson, & Oberklaid, 1999). Increased rates of mood disorders are found in conjunction with SLD (Cantwell & Baker, 1991), and children diagnosed with depressive disorders are seven times more likely to have SLD (Fristad, Topolosky, Weller, & Weller 1992). Depression negatively influences measures of encoding and retrieval from episodic memory; moderate relationships exist between depression and tests of psychomotor speed and sustained attention (Zakzanis, Leach, & Kaplan, 1998). Children with SLD have increased risk for hyperactivity (Cantwell & Baker, 1991) and the comorbidity between ADHD and SLD can be as low as 10 percent to a high of 60 percent, depending on the sample examined (Halperin, Gittelman, Klein, & Rudel, 1984). Children with RD demonstrate higher levels of inattentive behaviors (Rowe & Rowe, 1992) and exhibit significantly higher rates of internalizing and externalizing disorders (Willcutt & Pennington, 2000).

Likewise, neuropsychological assets and deficits that underlie SLD are hypothesized to be the same deficits underlying the emotional/behavioral deficits (Rourke, 1994). McKinney and colleagues postulated the existence of subtypes of children with SLD because research findings could not account for the full spectrum of SLD characteristics. Several studies were then conducted to extrapolate these differing subtypes, based on behavioral functioning. Seven behavioral subtypes were derived; one subtype demonstrated deficits in task-orientation, independence and mild inattention; two subtypes indicated normal classroom behavior; a third subtype had mild inattention, high distractibility and hostility with low rates of considerateness (extroverted and poorly socialized group); a fourth subtype was prone to dependence and introversion; a sixth subtype was composed of mixed deficits; and the final subtype exhibited global behavioral impairments (Speece et al., 1985). Furthermore, a three-year longitudinal examination of the same sample revealed that the proportion of children with SLD with adaptive and maladaptive subtypes was similar across years, demonstrating the stability of the SLD behavioral subtypes over time (McKinney & Speece, 1986).

Nussbaum & Bigler (1986) and then Nussbaum et al., (1986) examined the neuropsychological and behavior profiles of 75 learning disabled children utilizing cluster analysis, which resulted in the identification of three subtypes. The first subtype exhibited the most severe and the most generalized deficits in performance; the second subtype showed a moderate degree of impairment and greater verbal deficits, and the third subtype exhibited the least amount of impairment, with slightly greater deficits in visual/spatial/motor functioning. The behavioral profiles suggested some common factors across the groups with significant elevations on scales of Depression, Social Withdrawal, Hyperactivity, Adjustment, and Anxiety (Nussbaum & Bigler, 1986; Nussbaum et al., 1986).

Through a series of studies, Rourke and colleagues identified SLD subtypes based on psychosocial functioning. The profile of one subtype indicated normal psychosocial adjustment; a second subtype exhibited evidence of significant internalized psychopathology, and a third subtype had a profile suggestive of externalized psychosocial maladjustment, such as children with ADHD (Fuerst et al., 1989). In another study, Fuerst & colleagues also posited six subtypes of emotional/behavioral psychopathologies in children with SLD. These include normal, mild anxious, mild hyperactive, somatic concerns, and internalizing and externalizing subtypes (Fuerst et al., 1990). Rourke suggests that relationships exist between patterns of cognitive functioning and type and degree of psychosocial dysfunction; children with stronger psycholingistic and language skills and weaker visual/spatial skills tend to demonstrate significant psychopathology (Rourke & Fuerst, 1991). This appears to relate to Rourke's white matter model which stipulates that a lack of white matter hinders intermodal integration of information.

The seriousness of this comorbidity between SLD and EBD is also frequently observed in children with ADHD, usually categorized as an externalizing disorder. In ADHD, the inattentive type tends to occur more regularly with SLD and internalizing disorders (Beiderman, Faraone, & Lapey, 1992; Jensen, Martin, & Cantwell, 1997). Conversely, children with ADHD, predominately hyperactive/impulsive type, are more likely to have co-morbid externalizing behavior disorders (Jensen, et al., 1997). Children with ADHD also have an increased risk for executive functioning deficits, which place them at high risk for significant impairments in academic functioning (Biederman, et al., 2004). It is clear that the combination of SLD/EBD can have deleterious effects on the learning, behavior, and socioemotional development of affected children.

Right-Left Distinctions

Internalizing behaviors are characterized by withdrawal, dysphoria, depression, and anxiety (Quay, 1986); behaviors of a more internalizing nature are described as "over-controlled" (Achenbach & Edelbrock, 1978). Utilizing a neuropsychological approach, children with left hemisphere dysfunctions experience internalizing disorders (Rourke & Fuerst, 1991), and these children appear more withdrawn, anxious, fearful, and depressed (Boetsch, Green, & Pennington, 1996). Students with anxiety engage in cognitive errors, are sensitive to anxiety, and have less control of their belief systems in handling their anxiety (Weems, Costa, Watts, Taylor, & Cannon, 2007). Students with learning disabilities are also at greater risk for depression (Maag & Reid, 2006); however, cognitive behavioral interventions are effective for these students in the school settings (Maag & Swearer, 2005). Furthermore, several studies have indicated that children with left hemisphere dysfunction have higher rates of psychopathology of the internalizing type than children with right hemisphere and visual-spatial dysfunction (Nussbaum et al., 1986; Forrest, 2004). Unfortunately, studies of long-term psychiatric outcomes of adolescent internalizing disorders indicate that about 70 percent of youngsters continue to have internalizing disorder as adults (Colman, Wadsworth, Croudace, & Jones, 2007). This has implications for early screening, proper evaluation, and appropriate interventions of emotional and behavioral problems in children with SLD.

Externalizing disorders have been termed "under-controlled" behaviors, which appear as defiance, aggression, and impulsivity (Achenbach & Edelbrock, 1978). Children with externalizing behaviors have peer relationship problems; they also have lowered self-esteem and a history of acting out behaviors (Hinshaw, 1992). These externalizing behavior disorders are persistent and are connected to learning difficulties, which result in academic underachievement and even school failure (Hinshaw, 2000). Suicidal behavior associated with individuals with externalizing disorders has also been documented (Verona, Sachs-Ericsson, & Joiner, 2004). Likewise, anterior right hemisphere dysfunction can result in hyperactivity and in externalizing behaviors such as that seen in ADHD (Nussbaum, Bigler, Koch, & Ingram, 1988).

Four main theories dominate the literature to explain emotional processing and subsequent behaviors based on lateralization of the brain (see Demaree, Everhart, Youngstrom, & Harrison, 2005 for review). The right hemisphere hypothesis states that the right hemisphere is specialized for perception, expression, and experience of emotion, regardless of the type of emotion that is being processed (Borod, Koff, & Caron, 1998; Heilman & Bowers, 1990). Support for this model comes from studies examining brain injured patients with right or left hemisphere lesions; right hemisphere lesions result in poor ability to recognize or discriminate facial affect (Adolphs, Damasio, Tranel, & Damasio, 1996; Borod, et al., 1998). Furthermore, evidence from neuroimaging studies indicated that the right hemisphere governs the recognition and expression of affective prosody (Buchanan et al., 2000). The right hemisphere has also been linked to psychopathology. Anxiety has been associated with relative right hemisphere activity (Everhart & Harrison, 2000; Heller, 1993), depressive states associated with increased right versus left anterior activity and decreased right posterior activity (Heller, 1993), and mania associated with right anterior lesions (Gainotti, 1972).

Alternatively, the valence model postulates that the right hemisphere is specialized for negative emotion, but the left hemisphere is specialized for positive emotion (Ehrlichman, 1987). Studies utilizing anesthetized right or left hemispheres have found that when the right hemisphere is anesthetized, there is a euphoric reaction with diminished apprehension, smiling, laughing, and a sense of well-being; an anesthetized left hemisphere results in a "catastrophic" reaction of crying, guilt, complaints, and worries (Silberman & Weingartner, 1986). EEG studies have also supplied evidence for increased left hemisphere activity with positive emotional states and increased right hemisphere activity with negative emotional states (Davidson & Henriques, 2000; Lee et al., 2004; Waldstein et al., 2000).

Frontal Distinctions and Executive Dysfunction

The approach-withdrawal model has primarily consumed the valence model by associating approach behaviors and withdrawal behaviors subsequent to processes within the left and right hemisphere brain regions (Demaree et al., 2005). This model purported that most negative emotions (fear, disgust) elicit withdrawal behaviors and more positive emotions elicit approach behaviors (Demaree et al., 2005). This model also hypothesizes that frontal brain regions are implicated in the emotional elicitation of behavior, with heightened levels of left-frontal arousal resulting in positive affect and approach behaviors (Sobotka, Davidson, & Senulis, 1992). Some studies have indicated that individual variability exists about whether the left or the right hemisphere is involved in processing negative emotions (see Murphy, Nimmo-Smith, & Lawrence, 2003), which carry implications for treating mood, anxiety, and personality disorders (Schiffer, et al., 2007).

Two anatomical pathways have been postulated to underlie emotional systems involving frontal regions. One is the behavioral activation system (BAS) and the other one, the behavioral inhibition system (BIS). The BAS is implicated in activation of behavior in response to conditioned rewarding stimuli and is important both for approach and for active avoidance behaviors, both being positive in nature (Demaree et al., 2005). The BIS is implicated in inhibition of behaviors to stimuli that are novel, feared, and conditioned to be aversive; activation is associated with withdrawal behaviors and negative emotions such as anxiety (Demaree et al., 2005). High BAS is associated with increased left frontal activation (Coan & Allen, 2003) and high BIS with greater right frontal activation (Sutton & Davidson, 1997). Depressive symptomatology is linked to greater BIS activation than BAS, and mania is explained by greater BAS than BIS activation (Allen, Urry, Hitt, & Coan, 2004; Bearden, Hoffman, & Cannon, 2001).

Demaree et al., (2005) propose a third factor of dominance to the BAS/BIS model. Dominance has been defined as feelings of control and influence over everyday situations and relationships versus feelings of being controlled by others or situations (Mehrabian, 1995). More generally, dominance plays an important role in distinguishing internalizing versus externalizing behavior problems. Internalizing disorders are associated with low dominance such as anxiety, depression, and feelings of sadness (Blumberg & Izard, 1986), whereas, externalizing and disruptive behaviors are often associated with high dominance emotions such as anger (Bradley, 2000). Approach behaviors are often associated with dominance and withdrawal behaviors are often associated with submission or low dominance (Mehrabian, 1996). Likewise, Demaree and colleagues (2005) suggest that dominance results from left frontal arousal and submission with right frontal arousal. Depression has been linked to decreased left frontal arousal with reductions in approach behavior (Garcia-Toro, Montes, & Talavera, 2001), but anxiety has been associated with increased right anterior arousal and consequent withdrawal behaviors (Davidson, Marshall, Tomarken, & Henriques, 2000). The BAS/BIS model and the dominance view together suggest internalizing, externalizing, and executive control interactions, with internalizing disorders suggestive of low dominance withdrawn behaviors (anxiety or depression) and externalizing disorders suggestive of dominant approach behaviors (oppositional, aggressive). It is evident that a strict lateralized hemispheric account of emotional and behavioral functioning does not adequately represent the complex nature of brain processing.

Frontal regions also house the executive functions thought to result in dysexecutive syndromes (Hanna-Pladdy, 2007). Executive functioning refers to the command and control functions of the prefrontal cortex (PFC) (Powell & Voeller, 2004) with connections between the PFC and subcortical structures involving catecholamine transmission (Arnsten & Li, 2005). Executive functions exert control over the brain's computational program in making decisions, in monitoring and evaluating performance, and in selecting strategies (Sternberg, 1984) and involves the "where" or "whether" aspects of behavior (Barkley, 2000). Executive functions work in interaction with cognitive processes in the processing of information. Cognitive performance when measured globally is separable from executive functioning (Schuck & Crinella, 2005), but when utilizing a subtest analysis approach, low subtest scores on Arithmetic, Coding, Information, Digit Span, and Symbol Search from the Wechsler tests have been correlated with executive dysfunction (Prifitera & Dersh, 1993). Furthermore, executive functioning is associated with verbal, visual, and working memory, substantiating considerable overlap between and among these domains (Duff, Schoenberg, Scott, & Adams, 2005; Friedman, et al., 2006). These executive dysfunctions result in impaired regulation of cognition, attention, behavior, arousal, and emotions (Powell & Voeller, 2004) and are related to the ability to inhibit inappropriate behaviors and thoughts, regulate attention, monitor actions, and organize the environment (Arnsten & Li, 2005).

Executive functioning deficits have been suggested as an important factor in many childhood disorders (Kazdin, 1985; Lezak, 1995), in addition to being a key feature of many psychiatric disorders (Powell & Voeller, 2004). The frontal-subcortical circuits may also be developmentally on different tracks especially in adolescence during which there is possible immaturity of the brain in the executive processes that limits emotional regulation (Wang et al., 2008). Furthermore, the prefrontal cortex, including the dorsolateral and orbital cortical structures, has been implicated in numerous disorders. Symptoms of ADHD appear to stem from under-activation of these circuits and symptoms of Obsessive Compulsive Disorder (OCD) due to over-activation of these same circuits (Hale, Fiorello, & Brown, 2005). Personality changes are also evident with lesions of the superior frontal gyrus and white matter in the frontal region, resulting in personality changes. The implication is that the dorsal prefrontal cortex and frontal lobe white matter are involved in the emergence of personality change which involves conscious regulation of emotional states (Max et al., 2006). Likewise, children and adolescents with EF deficits often display difficulties in behavioral, emotional, social, and academic areas (Whitaker, Detzer, Isquith, Christiano, & Casella, 2004). Global executive dysfunctions have been found in children with autism in cognitive flexibility and organization (Kenworthy et al., 2005); executive functioning has been found to be a main deficit in ADHD (Barkley, 1997; Denckla, 1996; Seidman, Biederman, Faraone, Weber, & Ouellette, 1997; Sullivan & Riccio, 2006). In children with SLD, there is a higher incidence of behaviors associated with executive dysfunction when compared with those who have no formal diagnosis (Sullivan & Riccio, 2006).

Deficits in attention, hyperactivity, poor social skills, and executive functions are characteristics common both to students with SLD and with ED (Rock, Fessler, & Church, 1997). Children with SLD have difficulty with executive function strategic control processes (Cottini & Nicoletti, 2005) resulting in difficulties with developing and utilizing strategies, utilizing compensation techniques, or identifying resources to help manage SLD (Rock et al., 1997). These same researchers hypothesized a conceptual model for diagnosing, interpreting, and intervening with students who have SLD and BD. According to this model, complex multiple learning and behavioral problems are at the core of the model, with six specific areas contributing to the more global problems. These areas have been identified as cognitive processing, behavioral functioning, social/emotional adjustment, academics, language functioning, and executive functioning (Rock, et al., 1997). Although the cognitive, behavioral, and emotional outcomes of executive dysfunction are common to a wide range of childhood neuropsychological conditions, they are often difficult to treat and ameliorate (Powell & Voeller, 2004).

Comorbidity between SLD and Emotional/Behavioral Functioning

Children with SLD who also experience emotional/behavioral difficulties are often at the highest risk of peer relationship problems (Gresham & MacMillan, 1997) and are less well accepted than typical peers (Ochoa & Olivarez, 1995). Peer rejection is most often attributed to externalizing behaviors of aggression and noncompliance (Erhardt & Hinshaw, 1994) with these children being deemed socially incompetent (Kavale & Forness, 1996). Social skill deficits are often to blame in poor peer relationships because children with SLD have poor problem solving skills and engage in more interfering internalizing and externalizing behaviors (Swanson & Malone, 1992). Given the fact that students with SLD experience negative emotions and have poor emotional regulation (Bryan et al., 2004), it is not surprising that 70 percent of students with SLD have reported lower self-esteem than non-SLD peers (Kavale & Nye, 1986). There is a great likelihood that children with SLD have obligatory cognitive functioning deficits, and there appears to be causality between lowered self-concept and cognitive functioning (Wei-dong, 2004). Their difficulties with processing emotional stimuli (Obrzut, Bryden, Lange, & Bulman-Fleming, 2007) likely lead to problems with social perception (e.g. poor judgment of emotions), with poor nonverbal perceptions; these may also be impediments to poor social cognitions, to poor communicative competence (Bryan et al., 2004) and to difficulties navigating their social environments (Hinshaw, 1992). Thus, for these children, high levels of peer rejection and loneliness, low self-concept, and high levels of depression and anxiety may be experienced (Alyagon-Levin, 2007; Margalit & Alyagon-Levin, 1994).

Children with comorbid SLD/EBD are most likely to drop out of school with persistent behavioral deficits accounting for their high drop-out rates (Bender & Wall, 1994). The National Longitudinal Transition Study found that outcome studies for children with SLD indicate that they are more apt to have serious academic deficits in secondary school, with 30 percent scoring two standard deviations below the national mean (NLTS2, 2005). Furthermore, a longitudinal study implemented through the National Center for Special Education Research found that children with SLD are more likely to fail courses and drop out of school, having a 75 percent graduation rate when compared with non-disabled peers (NLTS2, 2005). Youth with learning disabilities are significantly overrepresented in the juvenile justice system; recent estimates suggest that at least 35 percent of youth in the juvenile justice system are eligible for special education services (Quinn et al., 2005). Rates of learning disability are astonishingly high among prisoner populations; in studies conducted among incarcerated juveniles, learning disabilities have been estimated to occur in up to 55 percent of youth nationwide (Ottnow, 1988). Interestingly, children with verbal-based SLD and frontal subcortical difficulties often are adjudicated delinquents and are incarcerated, whereas, the children with NVLD are not (Hale & Fiorello, 2004). This is contrary to what Rourke would substantiate (Fuerst et al., 1999). These statistics highlight the very important nature of early intervention and appropriate assessment practices in order to identify all the components of a child's cognitive and emotional/behavioral difficulties, thereby improving outcomes for children with SLD. Greater effort should be made to detect and assess SLD and its related problems in children in order to plan future care and transition to adulthood, especially for those with comorbid disabilities.

Chapter Three

Method

Source for Data

The participant data were drawn from a sample of 157 school-aged children who had been diagnosed with SLD in the school setting. The archival data from nine participating school districts in Eastern Pennsylvania were solicited from PA certified school psychologist's recent school-based psychoeducational evaluations. The data from the multiple school districts are representative of metropolitan (*n* = 3), suburban (*n* = 4), and rural areas (*n* = 2). Detailed information regarding the socioeconomic status of the selected children was not available, although most data were drawn from a homogeneous, lower to middle class population in Eastern Pennsylvania located throughout Berks, Chester, and Northampton Counties. Permission was sought from participating school psychologists for utilization of this data, following approval by the Philadelphia College of Osteopathic Medicine's Institutional Review Board (IRB).

Inclusion and Exclusion Criteria

The data collected consisted of a convenience sample of students served through special education support programs. All data used were archived data that was anonymous. Data were limited to students between the ages of 6-16. Exclusion criteria included student files that did not contain a BASC-2 teacher rating scale, current WISC-IV, and current achievement testing results in the areas of reading, mathematics, and/or written language completed simultaneously in the same evaluation. In addition, data were not accepted if the file did not have full WISC-IV subtest scaled scores and all four index scores or if the BASC-2 TRS was not completed in full (e.g., missing items, missing scores).

Because of the current changes in the way in which SLD is identified, this study utilized the Concordance-Discordance SLD identification model (C-DM) developed by Hale and colleagues (Hale & Fiorello, 2004; Hale et al., 2003; Hale et al., 2008). This model was used to determine whether or not the children in the archival sample met criteria for the presence of a specific learning disability by examining cognitive strengths and weaknesses and the relationships of these with specific academic areas. For this study, the WISC-IV (*M* = 100; *SD* = 15) was used as the sole test for examining the cognitive strength and weakness. The C-DM model uses the Standard Error of the Difference (SED; Anastasi & Urbina, 1997) in identifying cognitive strengths, cognitive weaknesses and achievement weaknesses and was used in this study between the WISC-IV and standardized achievement tests. The SED is defined as: SED = SD * SQRT(2 – r_{xx} – r_{yy}). The SED total was then multiplied by 1.96 to determine the confidence interval for determining level of significance (e.g., 95% Confidence Interval = +/- SED * 1.96) (Hale et al., 2008; Hale, Flanagan, & Naglieri, 2008). The children with SLD demonstrated cognitive discordance (between the highest WISC-IV factor score and the lowest WISC-IV factor score), cognitive-academic discordance (between the highest WISC-IV factor score and the lowest achievement subtest score) and cognitive-academic concordance (no significant difference between the lowest WISC-IV factor score and achievement subtest score).

The WISC-IV factor scores and subtest scores were used for C-DM, with standard scores provided with the file data and reliability coefficients for age level reported in the WISC-IV manual and achievement test manuals. In some cases the cognitive factor concordant or discordant with the academic domain in question was not always easy to locate in the factor scores alone and alternative factor structures appeared to be the cause of the SLD (see Keith et al., 2006) for a discussion on alternative factor structures for the WISC-IV). In these cases, the subtest scores were combined to form a new factor through averaging the subtest scores and transforming into a standard score. The reliability coefficients of the subtests were then recomputed by averaging the coefficients for use in the C-DM.

The data that were identified through this model were classified with a subtype of SLD in reading, math, written language and/or a combination of these subtypes; these warranted a mixed classification and were included in the study analyses. Furthermore, the total sample is composed only of those archived data that met the C-DM of SLD determination. After all inclusion and exclusion criteria were examined, 42 participants failed to meet C-DM criteria and were excluded from further examination. Two participants were excluded because of missing scores on the BASC-2 TRS. The final sample of 113 participants ranged in age from 6 to 16 (M = 10.86, SD = 2.8). Table 1 displays descriptive information and C-DM classifications.

Table 1

Basic Demographic Characteristics of Sample

	n	%
Gender		
Males	72	64
Females	41	36
Grade		
First	7	6.2
Second	17	15
Third	19	16.8
Fourth	10	8.8
Fifth	10	8.8
Sixth	13	11.5
Seventh	8	7.1
Eighth	18	15.9
Ninth	5	4.4
Tenth	5	4.4
Eleventh	1	.9
C-DM Classification		
Reading	17	15
Math	18	15.9

Table 1 (continued)

	n	%
Written Language	6	5.3
Reading/Math	13	11.5
Reading/Written Language	13	11.5
Math/Written Language	8	7.1
Reading/Math/Written Language	38	33.6

Measures

The first measure utilized was the WISC-IV standard battery which is considered a reliable and valid measure of individual cognitive functioning according to Wechsler (2003). The WISC-IV measure consists of multifactor-determined subtests that is widely used and respected (Baron, 2005). The WISC-IV is internally consistent with reliability coefficients of the subtests ranging from .79 to .90 and reliability coefficients for the composite scores ranging from .88 to .97. The WISC-IV is considered equally reliable for children with learning disabilities and is considered to have adequate stability over time (Wechsler, 2003).

The Wechsler scales have been criticized as being atheoretical in the development of the instrument (Flanagan, 2000). Although this was most likely true for the earlier versions of the Wechsler scales, the newer WISC-IV is much more theoretical in its design (Wechsler, 2003). Initial internal validity studies have demonstrated that the WISC-IV measures what it purports to measure through subtest exploration (Wechsler, 2003); however, the four factor structure of the WISC-IV has been called into question. Several researchers, namely Flanagan (2000) and Keith et al., (2006), have examined the Wechsler scales over time through the Cattell-Horn-Carroll (CHC) approach and have found different factor structures for the WISC-IV. According to Flanagan (2000), the WISC-IV does not directly measure aspects of auditory processing (Ga) or long-term retrieval (Glm), both aspects of CHC.

Another approach in understanding the neurocognitive relations assessed by the WISC-IV is through demands analysis which is conducted to determine the processing skills needed to perform the task and to interpret a child's performance based on these demands. This approach is part of the cognitive hypothesis testing model (CHT) (Hale & Fiorello, 2004). According to this approach, a pattern of functioning across several subtests can lead to several hypotheses about the neuropsychological integrity and functioning that may be deficient, leading to specific types of learning and psychosocial difficulties. Further assessment is then conducted to test out these hypotheses. It is also important to note that although the WISC-IV subtests purport to measure a specific skill, it is equally important to see how the child solved the tasks, because the subtests can measure different things for different children. It is likely that a variety of cognitive processes are necessary to complete any given task (Hale & Fiorello, 2004). Therefore the following descriptions of subtests are to provide simply a general understanding of some of the skills tapped by the WISC-IV measure.

The WISC-IV standard battery is composed of ten core subtests (Block Design, Similarities, Coding, Vocabulary, Digit Span, Picture Concepts, Matrix Reasoning, Letter Number Sequencing, Comprehension, and Symbol Search). Four index scores (Verbal Comprehension, Perceptual Reasoning, Working Memory, and Processing Speed) and a Full Scale Intelligence Quotient (FSIQ) are computed from these subtests. In addition, subtest process scores can be computed to provide greater in-depth information regarding a student's performance.

According to Wechsler (2003), the Verbal Comprehension Index requires utilization of reasoning, comprehension, and conceptualization in measuring verbal abilities. It consists of the Similarities, Vocabulary, and Comprehension subtests. The Similarities subtest is thought to measure concept formation and reasoning with verbal information. The Vocabulary subtest measures word knowledge, fund of knowledge, concept formation and verbal expression (Wechsler, 2003). The Comprehension subtest measures reasoning with verbal information and conceptualization, verbal comprehension, and expression. It also involves knowledge of conventional behavior, social judgment, and common sense (Sattler, 2001).

According to alternate approaches such as CHC or demands analysis, the verbal-nonverbal dichotomy is somewhat misleading because the subtests are probably measuring many aspects of cognitive processing. The Vocabulary subtest can be considered a measure of long-term retrieval and word knowledge for some children (Hale & Fiorello, 2004). Fiorello et al., (2006) found that the Vocabulary and Information subtests are measures of auditory-crystallized-language based skills. Deficient language skills in expressive and receptive language can also hinder performance on the subtests which compose the VCI, indicating the dependence on language for this measure (Sattler, 2001). Groth-Marnat and colleagues also suggest that the VCI measures facility with concept formation and language skills (Groth-Marnat, Gallagher, Hale, & Kaplan, 2000). According to Keith and colleagues, the VCI can be interpreted confidently because the subtests that compose the VCI measure are thought to measure comprehension, knowledge, and crystallized intelligence (Keith et al., 2006). This was also true with the WISC-III; the VCI is a measure of crystallized language and knowledge with Vocabulary loading on the Gc measure (Flanagan, 2000).

The Perceptual Reasoning Index assesses perceptual reasoning, fluid reasoning, and perceptual organization. It consists of the Picture Concepts, Matrix Reasoning, and Block Design subtests. The Picture Concepts subtest is thought to measure abstract reasoning and the ability to reason categorically, and may also include verbal mediation and naming (Keith et al., 2006). The Matrix Reasoning subtest measures fluid reasoning, visual information processing, and abstract reasoning. These two subtests together measure inductive reasoning which is a major component of fluid reasoning (Keith et al., 2006). The Block Design subtest assesses analyzation and visualization of abstract visual stimuli and integrated brain functioning (Kaufman, 1994).

However, Block Design may be better described as a measure of visual processing rather than fluid reasoning (Flanagan, 2000; Keith et al., 2006). According to Keith and colleagues, the Perceptual Reasoning factor measures two different cognitive processes, fluid reasoning (Gf) and visual processing (Gv) (Keith et al., 2006) and Block

Design is seen as a measure of Gv (Flanagan, 2000). The Block Design subtest has also been shown to measure spatial ability (Groth-Marnat & Teal, 2000) and ability to separate figure and ground (Sattler, 2001). The Block Design subtest is thought to measure many cognitive processes such as visual processing, processing of part to whole relationships, discordant and divergent thought processes (analysis), concordant or convergent thought processes (synthesis) and attention and executive functioning (planning and strategy usage) (Hale & Fiorello, 2004).

The Working Memory Index assesses attention, concentration, and working memory. It consists of Digit Span (Forward and Backward) and Letter Number Sequencing. It is important to note the differences between theses tasks because they likely measure different aspects of functioning (Hale, Hoeppner, & Fiorello, 2002). Digit Span Forward measures rote learning and memory, attention, encoding, and auditory processing and sequencing (Sattler, 2001). The Digit Span Forward subtest loaded on the CHC short-term memory (Gsm) factor in the Flanagan (2000) study. The DS forward task also appears to measure immediate rote auditory memory and measures aspects of the phonological loop for holding information in immediate memory (Hale et al., 2002; Hale & Fiorello, 2004). Digit Span Backward is a measure of working memory involving mental manipulation and visuospatial imaging (Sattler, 2001; Wechsler, 2003). However, this latter area has been disputed. According to Hale et al. (2002), the Digit Span Backward subtest does not measure visuospatial imaging, but instead measures working memory and mental flexibility. Digit Span Backward also likely measures aspects of self-regulatory executive functions such as planning, strategizing, organizing, executing, monitoring, maintaining, evaluating, and changing behavior (Hale & Fiorello, 2004). The WMI measures a mixture of short-term memory (Gsm) and fluid reasoning (Gf) when Arithmetic is included. Digit Span and Letter Number Sequencing are measures of short-term and working memory processes (Keith et al., 2006).

The Processing Speed Index is thought to assess speed of mental and graphomotor processing. It consists of the Coding and Symbol Search subtests (Wechsler, 2003). The Coding subtest assesses short-term memory, learning ability, visual perception, visual-motor coordination, cognitive flexibility, attention, motivation, and is a good measure of processing speed or psychomotor speed (Keith et al., 2006; Sattler, 2001). The Symbol Search subtest involves short-term memory, visual-motor coordination, cognitive flexibility, visual discrimination, and concentration (Sattler, 2001). However, Symbol Search may also be better described as visual processing. In the Keith et al., (2006) study, Symbol Search loaded with Block Design on the Gv factor. Symbol Search also taps sustained attention and visual discrimination, requiring less motor requirement (Hale & Fiorello, 2004). Coding measures visual motor integration, graphomotor skills, and processing speed (Hale & Fiorello, 2004). Coding also loaded on the processing speed (Gs) factor in the Flanagan (2000) study. Overall, the PSI can be interpreted confidently because the component subtests measure a coherent factor (Keith et al., 2006).

The second measure utilized was the BASC-2 Teacher Rating Scales (BASC-2; Reynolds & Kamphaus, 2004), which is a standardized broad-band behavior rating scale completed by the child's teacher. The BASC-2, which was designed to facilitate differential diagnosis of emotional and behavioral disorders, is considered multidimensional by examining both positive and negative indicators of psychosocial functioning (Kamphaus, Reynolds, Hatcher, & Kim, 2004). Behavior rating scales such as the BASC-2 enable educational practitioners to further define the internalizing, externalizing, and psychosocial problems in children with SLD. The use of teacher ratings is proper practice because teachers are often the first line observer of child behaviors in the school setting and by obtaining behavior ratings, the emotional and behavioral deficits of children with SLD can be defined (Gresham, 2002). Teacher ratings are important in screening children for possible psychopathology not only in adolescence, but also for the prediction of future psychosocial functioning in adulthood (Carbonneau, Tremblay, Vitaro, Saucier, & Jean-Francois, 2005). Teacher ratings are also useful for discriminating between children with various disorders by assessing the characteristics of emotional/behavioral functioning (Riccio, Cohen, Garrison, & Smith, 2005).

The BASC scales demonstrated validity in differentiating children with ADHD (Jarratt, Riccio, & Siekierski, 2005), and was also valid in determining frontal lobe and executive deficits in children, differentiating those with these disorders from typical peers (Sullivan & Riccio, 2006). It has been valid for children with social skill deficits as well (Flanagan, Alfonso, Primavera, Povall, & Higgins, 1996). Furthermore, the BASC scales are valid for examining academic, social and emotional adjustments in children and adolescents and can help describe emotional/behavioral subtypes evident in children through the use of teacher ratings (Lindstrom, Lease, & Kamphaus, 2007). Because of its multi-method approach, the BASC-2 is a tool that provides rich information pertaining to a child's functioning in multiple settings and to differential diagnosis method approach (Kamphaus et al., 2004).

In this study, teacher perceptions of social, emotional, and behavioral functioning observed in the classroom setting were assessed using BASC-2 archival data. During the completion of the BASC-2, teachers were requested to circle one of four descriptions of the targeted behavior in the question item, rating the child on a 1 to 4 type scale with Never = 1, Sometimes = 2, Often = 3, and Almost Always = 4. The BASC-2 includes 139 items on the TRS. A child's profile on the scales is expressed in the form of *T* scores standardized by age and grade with a mean of 50 and a standard deviation of 10; elevations above the mean suggest a greater likelihood of emotional/behavioral symptoms. For the adaptive skills scales, lower scores are suggestive of less adaptive skills (high scores are better and lower scores are perceived as lacking the positive quality). The psychometric properties of reliability of the BASC-2 include good test-retest reliability of .91, good inter-rater reliability of .80, and internal consistency of .89. Furthermore, the BASC-2 has been seen as the standard in terms of behavior rating scales utilized in the school setting, with convergent validity established through significant correlations between the original BASC and the BASC-2 (Waggoner, 2005).

The 15 different areas utilized in this study included the *T* scores for the following clinical and adaptive scales: Hyperactivity, Aggression, Conduct Problems, Anxiety, Depression, Somatization, Attention Problems, Learning Problems, Atypicality, Withdrawal, Adaptability, Social Skills, Leadership, Study Skills, and Functional Communication. In addition, the Internalizing, Externalizing, Behavioral Symptoms

Index and Adaptive Skills composites were examined for differences in means across the SLD subtypes. The BASC-2 Manual (Reynolds & Kamphaus, 2004) provides a description of each clinical scale and can be consulted for more thorough explanation: Hyperactivity (over active, impulsive); Aggression (acts in a hostile manner either in a verbal or physical manner that is threatening to others); Conduct Problems (antisocial and rule breaking behaviors); Anxiety (nervous, fearful about real or imagined problems); Depression (unhappiness, sadness, thoughts of suicide); Somatization (overly sensitive to minor physical problems); Attention Problems (easily distracted and difficulty concentrating); Learning Problems (learning difficulties as observed in the school setting); Atypicality (behaves in ways that are immature or different than typical peers); Withdrawal (avoiding social contacts); Adaptability (adaptation to changing situations and ability to recover from difficult situations); Social Skills (possessing sufficient social skills and/or experiencing social difficulties); Leadership (ability to work under pressure, and/or an ability to bring others together to complete a work assignment); Study Skills (ability to demonstrate effective study skills); and Functional Communication (expressive and receptive communication skills, seeking out and finding of information). The Hyperactivity, Aggression, and Conduct Problems domains are considered externalizing disorders; but, the Anxiety, Depression, and Somatization domains are considered internalizing disorders. The BSI is composed of Hyperactivity, Aggression, Depression, Attention Problems, Atypicality, and Withdrawal. The Adaptive Skills composite is composed of the Adaptability, Social Skills, Study Skills, Leadership, and Functional Communication domains.

Achievement scores were also examined in the areas of reading, math, and written language of the archival data sample. Achievement scores derived from nationally standardized, individually administered instruments and included either the Wechsler Individual Achievement Test, Second Edition (WIAT-2; Wechsler, 2001), the Woodcock Johnson Tests of Achievement, Third Edition (WJ-III; Woodcock, McGrew, & Flanagan, 2001) or the Kaufman Tests of Educational Achievement, Second Edition (KTEA; Kaufman & Kaufman, 2004). All of these instruments have good reliability and validity and have been used extensively in evaluations for SLD. Internal consistency reliability estimates of the WIAT-II subtests are generally high (above .85) and .90 and above for the composite scores. The WIAT-II is useful in schools, clinics, private practices and residential treatment facilities. In the school-aged sample, test-retest correlations for the subtests (across intervals of approximately 10 days) were consistently above .85 and test-retest correlations for the composite scores were above .90. The corresponding subtests of the WIAT and the WIAT-II are strongly correlated (above .80) in the school-aged sample for those subtests with minimal content changes (WIAT-2; Wechsler, 2001). The KTEA-2 is also highly reliable and valid. It is considered internally consistent with average reliability scores of .90 for reading, math, spelling, and nonsense word decoding, and average reliability for other subtests at .80 and higher. The large sample was representative of the U. S. census (KTEA; Kaufman & Kaufman, 2004). The WJ-III is a good measure for assessing academic achievement in children and adolescents. The reliability characteristics of the WJ-III indicate that most of the subtests have reliability coefficients of .80 or higher and the coefficients rise to .90 and higher for the cluster scores (WJ-III; Woodcock, McGrew, & Flanagan, 2001).

These achievement scores were part of the evaluation for the identification of a specific learning disability conducted by the respective school psychologists and were included in the data file. The achievement scores were utilized initially for the C-DM needed for the classification of SLD that preceded statistical analysis. Standard scores were provided for the achievement assessments. These scores were then also utilized in determining differences between the SLD subtypes across academic domains.

Procedure

Archival records of students identified with a specific learning disability in the school setting were used for this study. School psychologists who are state and/or nationally certified (i.e., Nationally Certified School Psychologist) were asked to volunteer data for this study. Individual student records were reviewed by the respective school psychologists to determine if BASC-2 teacher rating scales were present as well as WISC-IV subtest scaled scores and four factor indices from the standard battery. Achievement standard scores were documented for all areas across available reading, math, and/or written language domains, but cases were not excluded with missing achievement domains. This data was entered into a document entitled *Dissertation: Student Data Collection Worksheet* (see Appendix A) by the participating school psychologist. Each file was assigned a participant identification code number in the workbook. The student name and other confidential information was not procured or released to the study investigators. Only gender, age, grade, and disability category were collected as additional variables. At no time did the student investigator or primary investigator have access to confidential information or to filed data. The school psychologist volunteers were provided with the workbook and were asked to supply the raw, scaled, and standard scores for the WISC-IV and the achievement measures, and the *T* scores for the BASC-2 TRS clinical, adaptive and composite domains. Participating school psychologists provided the workbook scores to the student investigator.

Concordance and discordance was then established for the sample and this data was also recorded into the workbook. Those data meeting the criteria were utilized. The workbook database of participant data was transferred to the SPSS Version 14 and SPSS Version 16 statistics computer package for statistical analyses.

Analyses

The WISC-IV subtests were subjected to a hierarchical cluster analysis to determine if different cognitive subtypes would emerge in a sample of children with specific learning disabilities. The cluster analysis utilized the Average Linkage Within Groups variant of the Unweighted Pair-Group Method Arithmetic Average (UPGMA) as the amalgamation or linkage rule. This variant also combines clusters so that the average distance between all possible pairs of cases in the resulting cluster is as small as possible, thereby minimizing within group variability. The Euclidean method was chosen as the distance measure involved in determining the amount of distance that serves as a criterion for grouping items.

Multivariate repeated measures MANOVA was conducted between the six cognitive SLD subtypes and both the BASC-2 TRS composite scores and the BASC-2

TRS clinical and adaptive scales. The emotional/behavioral variables served as the repeated measures dependent variables (within-subject factor) and the six cognitive SLD subtypes served as the between-subjects factor. ANOVA was also computed between the cognitive SLD subtypes and cognitive and achievement variables. Post hoc tests were utilized for multiple group comparisons.

Chapter 4

Results

Descriptive Statistics

Reported in Table 2 are descriptive statistics for the sample for the WISC-IV variables. The FSIQ was average which was expected, albeit on the lower end of the average range. The VCI and PRI means were relatively comparable and in the average range; however, the WMI and PSI means tended to be lower for this sample of children with SLD, with the WMI mean falling in the low average range; this has been found in numerous clinical populations (see Kaufman, 1994; Mayes & Calhoun, 2004; Prifitera & Dersh, 1993). Furthermore, the standard deviations of the VCI and PSI tended to be larger, suggesting greater variability, whereas the WMI tended to have lower standard deviation and less dispersion among the scores. Means across the VCI and PRI subtests fell in the average range. Lowered means were found for the subtests of Digit Span, Letter-Number Sequencing, Coding, and Symbol Search, which would be expected given the lower WMI and PSI composite mean scores. The standard deviations tended to be comparable across the subtests. The highest subtest mean was found for Picture Concepts and the lowest mean score was found for the Digit Span subtest.

Table 2

Means and Standard Deviations for Entire Sample across WISC-IV Variables

Variable	*M*	*SD*	*Range*
	Global Scores		
Full Scale Intelligence Quotient	92.43	12.44	66-127
Verbal Comprehension Index	95.96	13.84	53-124
Perceptual Reasoning Index	97.19	12.46	63-129
Working Memory Index	88.82	11.58	62-116
Processing Speed Index	90.91	13.75	59-128
	Subtest Scores		
Similarities	9.66	2.75	4-16
Vocabulary	9.38	2.83	1-16
Comprehension	9.13	2.88	1-15
Block Design	9.02	2.80	4-17
Picture Concepts	10.12	2.68	1-16
Matrix Reasoning	9.46	2.71	4-16
Digit Span	7.89	2.45	1-14
Letter-Number Sequencing	8.40	2.59	1-15
Coding	7.99	2.85	1-18
Symbol Search	8.72	2.69	1-14

The achievement means depicted in Table 3 illustrate low average mean scores for Word Reading, Reading Comprehension, Math Calculation, and Written Expression in this sample of children with SLD, although means for Reading Decoding, Math Reasoning, and Spelling fell in the average range. Reading Decoding received the highest mean score; whereas, Math Calculation received the lowest mean score.

Table 3

Means and Standard Deviations for Entire Sample across Achievement Variables

Variable	*n*	*M*	*SD*	*Range*
Reading Decoding	83	93.73	12.61	63-127
Word Reading	108	89.81	14.88	43-126
Reading Comprehension	106	88.50	14.70	41-122
Math Calculation	111	88.67	13.68	44-124
Math Reasoning	110	90.51	14.94	40-143
Spelling	95	91.76	14.56	44-141
Written Expression	88	89.28	12.60	55-118

Note. Variables are standard scores from several achievement measures including the Woodcock Johnson Tests of Achievement, Third Edition (WJ-III ACH; Woodcock, McGrew, & Mather, 2001), the Wechsler Individual Achievement Test, Second Edition (WIAT-2; Wechsler, 2001), and the Kaufman Test of Educational Achievement, Second Edition (KTEA-2; Kaufman & Kaufman, 2004).

Table 4 reports the means and standard deviations of the BASC-2 variables in this sample of children with SLD. Heightened means were found for the clinical areas of Depression, Attention Problems, Learning Problems, and Atypicality, with the mean scores falling in the clinically significant range. The clinical composite scores of School Problems and the Behavioral Symptoms Index were also elevated and in the clinically significant range. In addition, the Study Skills and Functional Communication subscales, and the Adaptive Skills composite means were clinically significant with these scores, suggesting low adaptive skills for this sample of children with SLD. Standard deviations for Anxiety, Attention Problems, and School Problems were lower than expected and suggest a small degree of dispersion across these means and limited sample variability.

Table 4

Means and Standard Deviations for Entire Sample across BASC-2 TRS Variables

Variable	*M*	*SD*	*Range*
Hyperactivity	58.80	14.78	40-142
Aggression	56.06	14.12	42-99
Conduct	56.19	13.00	41-100
Externalizing Problems	57.51	13.92	40-99
Anxiety	53.12	11.43	38-99
Depression	60.54	14.80	42-117

Table 4 (continued)

Variable	*M*	*SD*	*Range*
Somatization	54.88	14.05	42-107
Internalizing Problems	57.64	13.32	39-103
Attention Problems	61.66	9.28	38-80
Learning Problems	62.48	10.94	30-85
School Problems	62.99	9.69	38-81
Atypicality	61.81	17.18	41-114
Withdrawal	57.59	12.24	38-90
Behavioral Symptoms Index	61.89	13.36	23-62
Adaptability	42.42	9.23	41-96
Social Skills	42.01	9.71	23-66
Leadership	40.80	7.06	27-63
Study Skills	38.82	7.56	23-60
Functional Communication	39.14	8.31	19-61
Adaptive Skills Composite	39.46	7.38	23-59

Note. The adaptive scales include Adaptability, Social Skills, Leadership, Study Skills, Functional Communication and the Adaptive Skills Composite. Low *T* scores suggest poor adaptive functioning.

Cognitive Learning Disability Subtypes

The SLD population is often considered heterogeneous in terms of cognitive strengths and weaknesses (Hale & Fiorello, 2004); therefore, utilization of cluster analysis can be valuable for discovering the underlying cognitive constructs associated with this heterogeneous SLD sample. In this study, cluster analysis was undertaken with the purpose of identifying and classifying homogeneous subtypes of children with SLD, based on direct cognitive performance on the WISC-IV subtests. The cluster analysis utilized the Average Linkage Within Groups variant of the Unweighted Pair-Group Method Arithmetic Average (UPGMA) as the amalgamation or linkage rule. This method combines clusters so that the average distance between all possible pairs of cases in the resulting cluster is as small as possible, thereby minimizing within group variability and increasing homogeneity of the cluster. The results of the Average Linkage Within Groups variant of the UPGMA revealed six cognitive subtypes according to the agglomeration schedule coefficient changes from Step 6 (9.58) to Step 5 (10.01). Exploring the means of the WISC-IV subtests and composite scores across the six clusters helped to clarify the differential cognitive subtypes in the SLD sample. These SLD subtypes were identified as *Visual/Spatial (V/S)), Fluid Reasoning (FR), Crystallized/Language (C/L), Processing Speed (PS), Executive/Working Memory (E/WM),* and *High Functioning/Inattentive (HF/I).*

Cognitive SLD subtype characteristics are displayed in Table 5. All subtypes were composed of more males than females; however, the Crystallized/Language and Executive/Working Memory SLD subtypes had a much higher percentage of males than the other subtypes. Age was primarily even across the subtypes, although the Crystallized/Language SLD and Executive/Working Memory SLD subtypes were younger, overall, than the other subtypes. SLD classification based on the C-DM of identifying SLD specified that the Visual/Spatial and the Executive/Working Memory SLD subtypes were primarily composed of mixed disorders in reading, math, and written language, and the Processing Speed SLD and High Functioning/Inattentive SLD subtypes, were the only subtypes showing a pure written language disorder. The Fluid Reasoning SLD subtype was primarily characterized by a reading and math disorder, and the Crystallized/Language SLD subtype was primarily characterized by a reading disorder.

Table 5

Participant Characteristics on Demographic Variables within Cognitive SLD Subtypes

		Cluster					
		V/S	Fluid	C/L	PS	E/WM	HF/Inattention
n		14	10	15	30	19	25
Gender (%)							
	Female	43	40	13	40	26	48
	Male	57	60	87	60	74	52
Age							
	M	11.64	10.00	9.93	11.33	9.68	11.64
	SD	2.64	2.98	2.89	2.51	2.21	3.20

Table 5 continued

	Cluster					
	V/S	Fluid	C/L	PS	E/WM	HF/Inattention
Classification (%)						
Reading	22	30	40	7	10	4
Math	14	20	7	13	16	24
Writing	0	0	0	10	0	12
Rdg/Math	14	20	13	7	16	8
Rdg/WL	7	0	7	23	0	16
Math/WL	0	0	0	7	21	8
R/M/WL	43	30	33	33	37	28

Note. Rdg/Math = Reading and Math Learning Disability; Rdg/WL = Reading and Written Language Learning Disability; Math/WL = Math and Written Language Learning Disability; R/M/WL = Reading, Math, and Written Language Learning Disability. V/S = Visual/Spatial SLD; Fluid = Fluid Reasoning SLD; C/L = Crystallized/Language SLD; PS = Processing Speed SLD; Executive/Working Memory SLD; HF/I = High Functioning/Inattentive SLD.

In addition, Figure 1 and Figure 2 provide a graphic display of the cognitive variables across the six cognitive SLD subtypes.

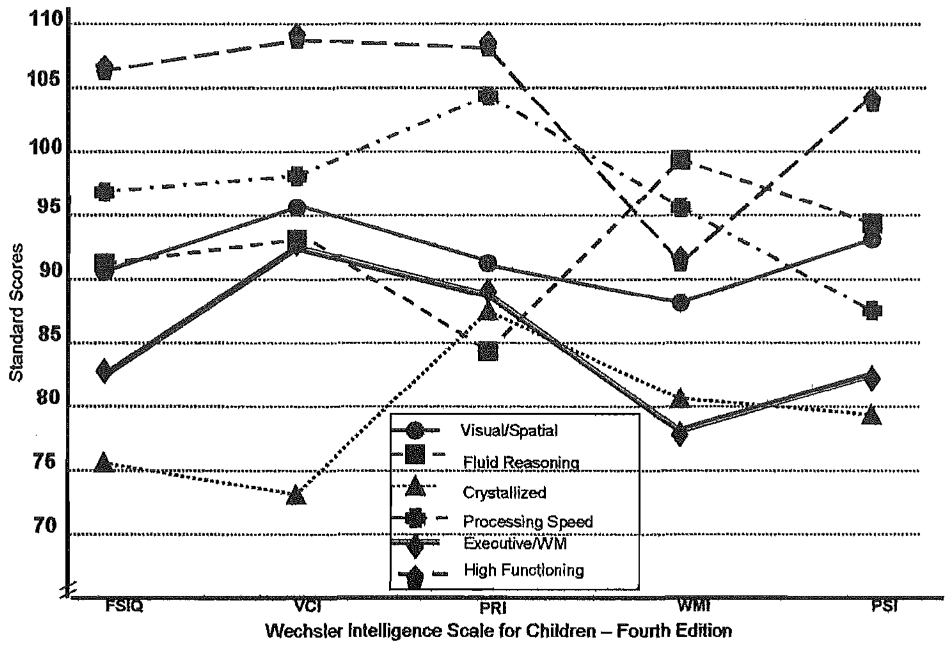

Figure 1. Composite profiles for the cognitive SLD subtypes. FSIQ = Full Scale Intelligence Quotient; VCI = Verbal Comprehension Index; PRI = Perceptual Reasoning Index; WMI = Working Memory Index; PSI = Processing Speed Index.

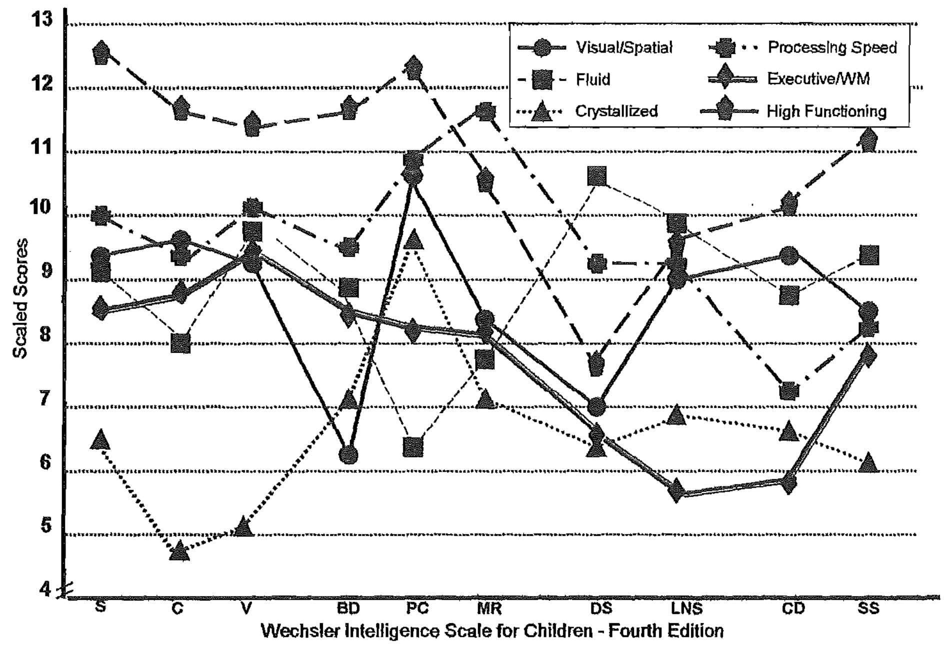

Figure 2. Subtest profiles for cognitive SLD subtypes. S = Similarities; C = Comprehension; V = Vocabulary; BD = Block Design; PC = Picture Concepts; MR = Matrix Reasoning; DS = Digit Span; LNS = Letter-Number Sequencing; CD = Coding; SS = Symbol Search.

Before further interpretation began, the contribution of achievement variables across these cognitive SLD subtypes was explored. Examination of the achievement variables helped to ascertain further, the relationships between these variables that compose the differential cognitive SLD subtypes. Therefore, each cognitive subtype was further described by examining the means across both the cognitive and achievement variables to further define each cognitive SLD subtype.

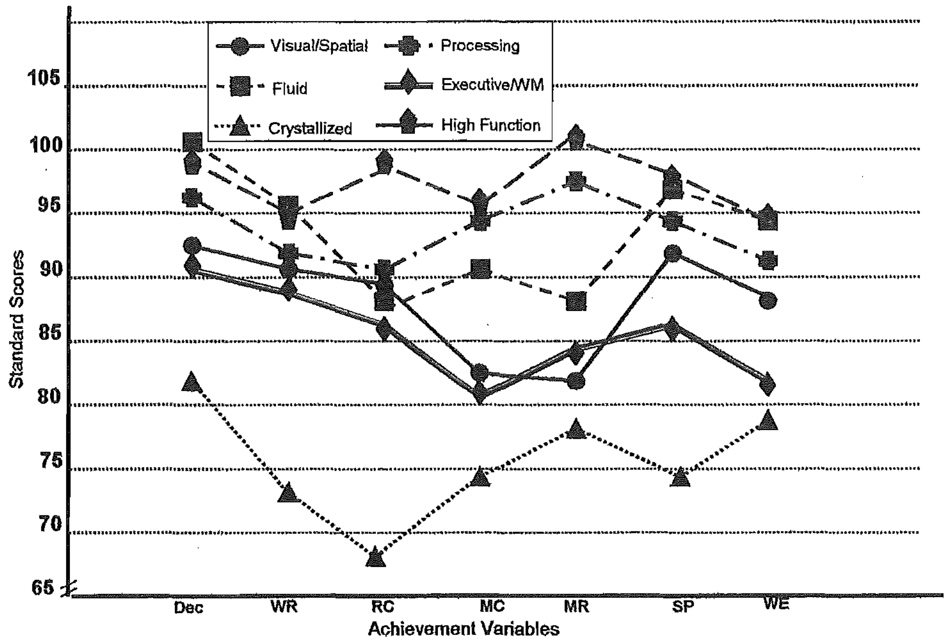

Figure 3. Cognitive SLD subtypes across achievement variables. Dec = Decoding; WR = Word Reading; RC = Reading Comprehension; MC = Calculation; MR = Math Reasoning; SP = Spelling; WE = Written Expression.

Visual/Spatial Learning Disability. This subtype was characterized by a relatively consistent cognitive profile across the WISC-IV composites with difficulties noted by relatively lower PRI and WMI mean scores. Composite score analysis tended to obscure important cognitive differences that were prevalent when examining patterns of subtest scores within this SLD subtype. This group scored primarily within average ranges across the VCI subtests. Across the PRI subtests, moderate variability was noted. Although the PRI was within the average range, a subtest analysis approach revealed marked deviations across the subtests. On the Block Design subtest, this group demonstrated deficiencies receiving the lowest BD subtest mean out of the six SLD subtypes. The overall average PRI was inflated by a high mean score on the PC subtest and low average performance on MR.

The overall WMI was the lowest scored composite area, reflecting poor DS performance and an average LNS performance. Therefore the difficulties associated with the lowered WMI appeared to be most closely related to the lowered DS mean score. The DS subtest does consist both of Digits Forward and of Digits Backward tasks; however, in this study, these separate areas were not further examined. Although the PSI fell into the average range, a subtest approach validated the need for closer inspection because the SS mean score was lower than the CD mean score, indicating more difficulty with spatial processing (Gs) as measured by SS and BD (Keith et al., 2006).

Examination of the achievement means for this SLD subtype demonstrated that subtest mean scores for Decoding, Word Reading, and Reading Comprehension fell in the average range. Variability was noted in the written language tasks. Although Spelling was in the average range, the Written Expression subtest mean fell slightly below the average range, suggesting mild difficulties with the aspect of written language. This subtype was described primarily by poor performance on Math Calculation and Math Reasoning ($SS < 85$). The means for these subtests were in the low average range and were the lowest subtest means across all areas of academics within this group, suggesting that skill weaknesses underlying BD, MR, and DS may to be blame for their difficulties in the math areas.

Fluid Reasoning. This subtype was characterized by a moderate amount of variability across the WISC-IV composites. Examination of the composite scores tended to dilute differences both within and across the composite areas. The VCI mean was in the average range, but important differences existed in the subtest means. The Similarities and Vocabulary subtest means were in the average range as well, but the mean for the Comprehension subtest fell in the low average range and was the second lowest mean score for this area across subtypes. The PRI was also variable in this subtype. This SLD subtype appeared to have poorly developed fluid categorical reasoning because their performances on PC were the lowest scored area across all SLD subtypes. Although the BD mean score fell within average ranges, the MR mean score fell outside of the average range. When the PC and MR subtest means were furthered examined, support for a fluid reasoning SLD subtype surfaced; this appears to be aligned with a Gf factor as described by the Keith et al. (2006) confirmatory factor analysis of the WISC-IV measure. This subtype had intact subtest scores across the WMI and had the highest scores on the DS and LNS subtests of the six SLD subtypes. Mild variability was noted in the PSI because CD tended to have a lower mean score than SS, but both mean scores fell within average ranges.

Examination of achievement means across the reading, math, and writing domains revealed variability. In reviewing the reading areas, Decoding and Word Reading means were in the average range. Likewise, the Spelling and Written Expression subtest means of this subtype were also within average ranges. The areas of greatest need academically were in Reading Comprehension, Math Reasoning, and Math Calculation.

Crystallized/Language. This subtype had a FSIQ mean score in the borderline range; however, a severe amount of variability was inherent to this subtype across global scores. The VCI mean score for this group was the lowest mean score of the six SLD subtypes, with the subtest scaled mean scores not higher than 7. Within the PRI, this group evidenced variability across the subtests with a better performance on the PC subtest tending to inflate the overall PRI. The PC subtest mean fell in the average range, whereas the BD and MR subtest means fell in the low average range. This group had the lowest mean score for MR and the second lowest mean score for BD. Examination of the WMI and PSI found comparable means across the subtests, indicating moderately deficient working memory and processing speed. This group had the lowest mean score for DS and SS.

Review of achievement means for this subtype demonstrated academic deficiencies across all reading, math, and written language subtests. This group evidenced the lowest mean scores on Decoding, Word Reading, Reading Comprehension, Math Calculation, Math Reasoning, Spelling, and Written Expression. This subtype had its highest mean score in the area of Decoding and its lowest mean score for Reading Comprehension. Despite the highest mean score found for the area of Decoding, the means in the area of reading overall were lower than the means for the areas of math and written expression.

Processing Speed. This fourth subtype is characterized by relatively high verbal subtest means and a VCI mean in the average range, suggesting intact reasoning and language skills. This subtype had the second highest mean score for the VCI and the second highest mean scores for the Similarities and Vocabulary subtests. This subtype also had the second highest mean scores for the PRI and the BD and PC subtests. The Processing Speed SLD subtype outperformed all other subtypes on the MR subtest. The PRI was the highest composite mean score for this group across all SLD subtypes. This subtype had relatively comparable subtest mean scores for DS and LNS, which fell in the average range. The PSI mean score for this group was the third lowest of the six subtypes and is markedly different from the other relative mean scores across the composites and subtests within this subtype. Lowered mean scores for the SS and CD subtests were revealed.

Exploration of the achievement means revealed that this subtype had all subtest means in the average range. The lowest mean subtest scores were found for Reading Comprehension and Written Expression. The highest mean subtest score was in Math Reasoning. This subtype also had the second highest Reading Comprehension, Math Calculation, and Math Reasoning subtest means of the six SLD subtypes, suggesting only mild deficiencies in the areas of academics when compared with the other subtypes.

Executive/Working Memory. This subtype was characterized by variability across the composites and recorded the second lowest FSIQ mean. Verbal reasoning skills as evidenced by the VCI clearly were within the average range, but the Vocabulary subtest mean score was higher than the Similarities and Comprehension subtest means. This subtype had relatively intact perceptual reasoning skills when measured by the PRI, with subtest mean scores falling in the low average range. This subtype was characterized primarily by their deficits on the WMI and PSI, receiving the lowest WMI mean of the six SLD subtypes and the second lowest PSI mean score. This subtype evidenced difficulty in DS and LNS, with the mean score being the lowest across all subtypes. Within the PSI, this group had the lowest mean score for CD and the second lowest mean score for SS across all SLD subtypes. The greatest areas of deficit were found in working memory and executive functioning.

Achievement deficits were noted across all areas, with the exception of Decoding which fell in the average range. The Word Reading mean was slightly below the average range. All other subtest means fell below the average range (SS < 85). In comparison with the other SLD subtypes, this group had the second lowest subtest means for Decoding, Word Reading, Reading Comprehension, Math Calculation, Spelling, and Written Expression. The lowest subtest means within the subtype were found for Math Calculation and Written Expression.

High Functioning/Inattentive. This SLD subtype was the highest functioning group across all areas of the WISC-IV, with the exception of the WMI Index. Examination of the composite mean scores and the subtest mean scores indicated that this group had the highest mean scores on all VCI and PSI subtests. The subtest scores within the indexes were also relatively comparable. Across the PRI subtests, this subtype outperformed all groups on BD and PC, having the second highest mean score for MR. However, variability was noted within the WMI; the mean score for DS was much lower than the mean score for LNS. Therefore the WMI appeared to be reduced primarily by the DS subtest performance because the LNS mean score fell in the average range.

Achievement means are primarily consistent with the cognitive profile with all subtest means in the average range. The Word Reading and Written Expression subtest means were the lowest for this subtype across academic areas. The highest mean score was found for Math Reasoning. This group outperformed the other subtypes on Reading Comprehension, Math Calculation, Math Reasoning, and Spelling.

SLD Subtype Differences across the Cognitive and Achievement Variables

Table 6 and Table 7 display the *M*, *SD*, and *F* statistic of the WISC-IV variables across the cognitive SLD subtypes. Significant group differences were found for all subtypes on all variables of the WISC-IV. One way analysis of variance was computed to determine significant differences between the six SLD subtypes and the WISC-IV composite and subtest variables. As is noted, there were significant group differences between the SLD subtypes on all cognitive measures. Post-hoc comparisons utilizing Bonferroni multiple comparisons showed significant differences between the subtypes on the FSIQ, VCI, PRI, WMI, and PSI. Multiple comparisons utilizing the Bonferroni method was also conducted for the WISC-IV subtest variables. Significant subtype differences existed between groups on the subtest variables.

Table 6

Nomothetic Results for WISC-IV Composites and Cognitive SLD Subtypes

		V/S (n = 14)	Fluid (n = 10)	C/L (n = 15)	PS (n = 30)	E/WM (n = 19)	HF/I (n = 25)	F^1
VCI	*M*	95.64[f]	93.50[f]	73.40[a,b,d,e,f]	98.53[f]	93.47[f]	109.44	30.11
	SD	8.58	11.44	10.58	8.61	7.96	8.94	
PRI	*M*	91.86[d,f]	84.30[d,f]	87.27[d,f]	104.30[f]	89.89[d,f]	108.32	23.78
	SD	11.46	11.34	7.63	9.02	6.24	7.89	
WMI	*M*	88.29	99.10	80.07[b,d,f]	95.23	77.00[a,b,d,f]	91.56	15.37
	SD	10.52	12.46	10.10	5.81	8.14	9.80	
PSI	*M*	93.71[f]	94.70	79.53[a,b,f]	87.73[f]	82.68[f]	104.72	14.47
	SD	6.55	9.06	11.64	13.46	9.28	10.48	
FSIQ	*M*	90.50[f]	90.60[f]	75.00[a,b,d,e,f]	96.60[f]	83.11[d,f]	106.80	47.76
	SD	6.71	10.39	5.31	6.62	5.62	8.09	

Note. FSIQ = Full Scale IQ; VCI = Verbal Comprehension Index; PRI = Perceptual Reasoning Index; WMI = Working Memory Index; PSI = Processing Speed Index. V/S = Visual/Spatial SLD; Fluid = Fluid Reasoning SLD; C/L = Crystallized/Language SLD; PS = Processing Speed SLD; Executive/Working Memory SLD; HF/I = High Functioning/Inattentive SLD.

[a]Less than Visual/Spatial subtype.

[b]Less than Fluid Reasoning subtype.

[c]Less than Crystallized/Language subtype.

[d]Less than Processing Speed subtype.

[e]Less than Executive/Working Memory subtype.

[f]Less than High Functioning/Inattentive subtype.

[1]All *F* ratios significant at $p < .001$

Table 7

Results for WISC-IV Subtests and Cognitive SLD Subtypes

		V/S (n = 14)	Fluid (n = 10)	C/L (n = 15)	PS (n = 30)	E/WM (n = 19)	HF/I (n = 25)	*F*[1]
S	*M*	9.21[f]	9.10[f]	6.40[a,b,d,e,f]	10.00[f]	8.58[f]	12.52	18.57
	SD	1.36	2.55	2.06	2.11	2.24	1.96	
C	*M*	9.57[f]	8.00[f]	4.73[a,b,d,e,f]	9.47[f]	8.95[f]	11.72	22.40
	SD	2.44	2.05	2.46	1.97	1.87	1.81	
V	*M*	9.14	9.70	5.07[a,b,d,e,f]	10.03	9.26[f]	11.28	15.92
	SD	2.38	2.40	1.90	1.99	2.51	2.15	
BD	*M*	6.14[b,d,e,f]	8.90[f]	7.07[d,f]	9.53[f]	8.37[f]	11.72	15.57
	SD	1.16	2.18	1.90	2.38	2.11	2.52	
PC	*M*	10.71	6.30[a,c,d,f]	9.67[f]	10.83	8.21[a,d,f]	12.20	16.21
	SD	2.94	2.31	1.95	1.44	2.22	1.97	
MR	*M*	8.36[d,f]	7.80[d,f]	7.00[d,f]	11.67	8.16[d,f]	10.56	15.26
	SD	2.13	1.68	1.13	2.67	2.08	1.98	

Table 7 (continued)

		V/S (n = 14)	Fluid (n = 10)	C/L (n = 15)	PS (n = 30)	E/WM (n = 19)	HF/I (n = 25)	F^1
DS	*M*	7.00[b,d]	10.70	6.33[b,d]	9.27	6.42[b,d]	7.68[b]	10.68
	SD	2.03	1.41	2.41	1.81	1.53	2.57	
LNS	*M*	9.00	9.90	6.80[b,d,f]	9.23	5.63[a,b,d,f]	9.52	11.48
	SD	2.54	2.60	2.27	1.83	2.52	1.61	
CD	*M*	9.36	8.70	6.67	7.27[f]	5.95[a,f]	10.16	9.02
	SD	1.94	1.70	2.22	3.09	1.90	2.52	
SS	*M*	8.50[f]	9.50	6.00[a,b,d,f]	8.37[f]	7.95[f]	11.16	11.30
	SD	1.55	1.95	2.80	2.38	2.32	1.99	

Note. S = Similarities; C = Comprehension; V = Vocabulary; BD = Block Design; PC = Picture Concepts; MR = Matrix Reasoning; DS = Digit Span; LNS = Letter-Number Sequencing; CD = Coding; SS = Symbol Search. V/S = Visual/Spatial SLD; Fluid = Fluid Reasoning SLD; C/L =Crystallized/Language SLD; PS = Processing Speed SLD; Executive/Working Memory SLD; HF/I = High Functioning/Inattentive SLD.

[a]Less than Visual/Spatial subtype.

[b]Less than Fluid Reasoning subtype.

[c]Less than Crystallized/Language subtype.

[d]Less than Processing Speed subtype.

[e]Less than Executive/Working Memory subtype.

[f]Less than High Functioning/Inattentive subtype.

[1]All F ratios significant at $p < .001$

To differentiate groups based on academic achievement further, one way analysis of variance was computed to determine significant differences between the six SLD subtypes on the achievement variables. Table 8 depicts the means, standard deviations, and F statistic for these variables across the six SLD subtypes. As is noted, there were significant subtype differences between all the SLD subtypes on the achievement measures. Post-hoc analysis through the Bonferroni method yielded important subtype differences among the specific achievement measures.

Table 8

Results for Achievement Measures and Cognitive SLD Subtypes

		V/S (n = 14)	Fluid (n = 10)	C/L (n = 15)	PS (n = 30)	E/WM (n = 19)	HF/I (n = 25)	F^1
DC	*M*	92.83	100.67	81.50[b,d,f]	95.71	91.94	98.00	3.35
	SD	11.39	12.44	10.08	9.91	11.86	14.97	
WR	*M*	91.43	95.50	73.20[a,b,d,e,f]	92.21	89.00	94.91	5.82
	SD	10.67	10.28	14.61	14.44	14.04	13.54	
RC	*M*	89.64	88.50	67.71[a,b,d,e,f]	90.81	85.24[f]	99.67	14.09
	SD	10.56	12.85	13.69	10.06	11.88	11.51	

Table 8 (continued)

		V/S (n = 14)	Fluid (n = 10)	C/L (n = 15)	PS (n = 30)	E/WM (n = 19)	HF/I (n = 25)	F^1
MC	*M*	83.07	91.60	74.00[b,d,f]	94.28	81.00[d,f]	95.32	6.87
	SD	13.84	8.24	24.35	12.47	8.38	12.94	
MR	*M*	82.07[d,f]	88.20	78.40[d,f]	97.04	84.21[d,f]	101.33	10.18
	SD	18.76	12.07	12.54	8.14	9.28	14.61	
SP	*M*	92.15	97.33	74.60[a,b,d,f]	94.73	85.80	97.59	5.54
	SD	8.57	12.77	19.64	13.01	11.32	12.90	
WE	*M*	88.46	94.11	78.78[f]	91.46	81.83	94.26	3.57
	SD	7.84	10.00	16.09	14.79	9.09	8.69	

Note. Achievement measures are scores from various standardized achievement tests-Woodcock Johnson Tests of Achievement, Third Edition (WJ-III ACH; Woodcock, McGrew, & Mather, 2001); Wechsler Individual Achievement Test, Second Edition (WIAT-2; Wechsler, 2001); Kaufman Test of Educational Achievement, Second Edition (KTEA; Kaufman & Kaufman, 2004). DC = Decoding; WR = Word Reading; RC = Reading Comprehension; MC = Math Calculation; MR = Math Reasoning; SP = Spelling; WR = Written Expression. V/S = Visual/Spatial SLD; Fluid = Fluid Reasoning SLD; C/L =Crystallized/Language SLD; PS = Processing Speed SLD; Executive/Working Memory SLD; HF/I = High Functioning/Inattentive SLD.

[a]Less than V/S subtype.

[b]Less than Fluid Reasoning subtype.

[c]Less than Crystallized/Language subtype.

[d]Less than Processing Speed subtype.

[e]Less than Executive/Working Memory subtype.

[f]Less than High Functioning/Inattentive subtype.

[1]All F ratios significant at $p < .01$

Examination of Cognitive SLD Subtypes and Emotional/Behavioral Variables

Figure 4 and Figure 5 graphically depict the BASC-2 TRS clinical and composite variables across the six SLD subtypes. Review of the means across these subtypes helped to delineate further differentiating factors between the SLD subtypes. As with the cognitive and achievement variables, the emotional/behavioral variables are also different between groups and further differentiate the SLD subtypes.

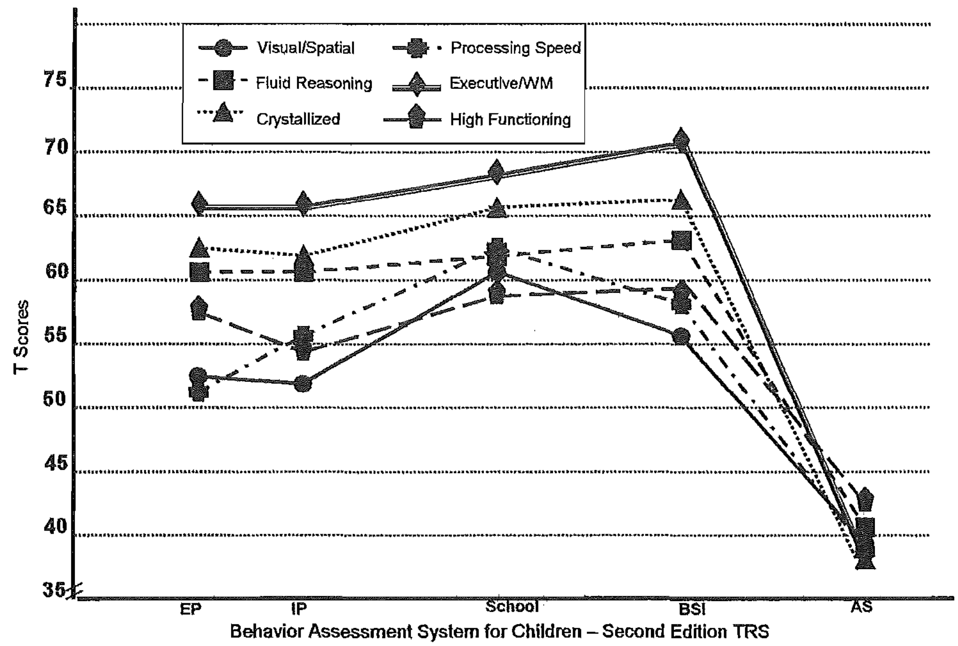

Figure 4. Cognitive SLD subtypes across the BASC-2 TRS composite variables. EP = Externalizing Problems; IP = Internalizing Problems; School = School Problems; BSI = Behavioral Symptoms Index; AS = Adaptive Skills.

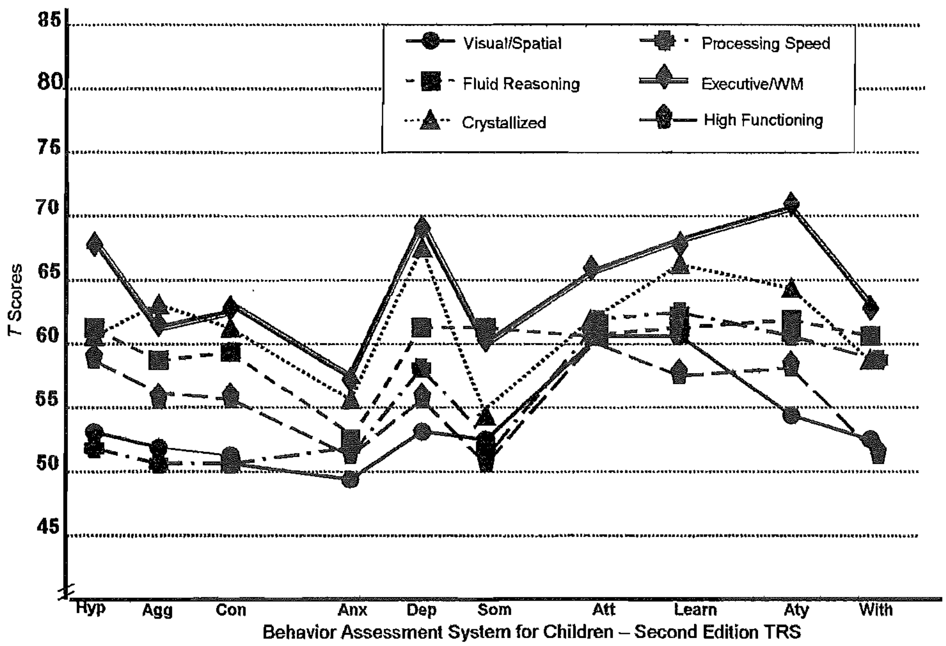

Figure 5. Cognitive SLD subtypes across the BASC-2 TRS clinical and adaptive variables. Hyp = Hyperactivity; Agg = Aggression; Con= Conduct; Anx = Anxiety; Dep = Depression; Som = Somatization; Att = Attention Problems; Learn = Learning Problems; Aty = Atypicality; With = Withdrawal.

Visual/Spatial. This subtype was characterized primarily by attention problems and learning problems because their means fell above the normal range, highlighting overall School Problems in the clinical range. All other means were in the non-clinical range. This group tended to have the second lowest means of the SLD subtypes for Hyperactivity, Aggression, Conduct Problems and Withdrawal on the clinical scales. This group had the lowest means of all subtypes for the clinical scales of Anxiety, Depression, and Atypicality.

Fluid Reasoning. The emotional and behavioral means for the BASC-2 clinical scales indicated higher means for the areas of Hyperactivity, Aggression, Conduct, Depression, Somatization, Attention, Learning, Atypicality and Withdrawal. All of these means fell near or above a *T* score - 60. This subtype appears to be characterized both by internalizing and by externalizing problems, with internalizing problems more evident. However, this subtype does not appear anxious because the mean for the area of Anxiety was the lowest of all clinical scales for this subtype. This subtype demonstrated comorbidity between internalizing and externalizing problems and a clinically significant BSI mean. Coupled with the Fluid Reasoning SLD profile, this subtype has many comorbid difficulties across academic and emotional/behavioral domains.

Crystallized/Language. This subtype had elevated means for the areas of Hyperactivity, Aggression, and Conduct Problems. The mean score for the area of Aggression was the highest mean for all subtypes. This subtype also demonstrated heightened means for the areas of Depression, Attention, Learning, Atypicality, and Withdrawal. This subtype had the second highest mean score for Depression, Hyperactivity, Conduct Problems, Learning and Atypicality across all subtypes and appears to have rather global difficulties in emotional/behavioral functioning.

Processing Speed. Emotional and behavioral means for this subtype demonstrated the lowest means of all SLD subtypes for Hyperactivity, Aggression, and Conduct Problems. The areas of most concern were found when reviewing means of the Attention Problems, Learning Problems, and Atypicality scales with means in the clinical range. The areas of Anxiety and Somatization were the second lowest means across all SLD subtypes. Depression and Withdrawal appeared to be borderline clinically significant with mean T scores approaching 60.

Executive/Working Memory. This group had the greatest global emotional and behavioral functioning difficulties as evidenced by the highest means for the clinical scales of all SLD subtypes on Hyperactivity, Conduct Problems, Anxiety, Depression, Attention Problems, Learning Problems, Atypicality, and Withdrawal. The second highest means were found for the clinical scales of Aggression and Somatization. Overall, this subtype had clinically significant mean scores both for Internalizing and for Externalizing Problems; this also is highly congruent and comorbid both with their cognitive deficits in attention and with executive processes and lowered academic achievement.

High Functioning/Inattentive. This subtype was characterized by heightened means for the area of Hyperactivity and Attention Problems, with means in those areas within clinical limits. This is also highly congruent with their cognitive profile weaknesses in attention. Means for the areas of Learning Problems and Atypicality were approaching the clinically significant range, but all other clinical means were in typical ranges, suggesting mild overall emotional and behavioral difficulties when rated by teachers in the classroom.

Subtype Differences across Emotional/Behavioral Variables

A multivariate GLM was computed with BASC-2 TRS composite scores as repeated dependent measures (within-subjects factor) and the six cognitive SLD subtypes derived from the cluster analysis serving as the between-subject factor. Box's Test of the equality of covariance matrices was not significant ($p = .084$); therefore, a multivariate approach to the data was appropriate. Alpha level was set at $p = .05$ for all analyses. The Wilks' Lambda multivariate test of overall differences among groups demonstrated a significant main effect for the BASC-2 TRS composite within-subjects effect $F(4, 104) = 64.504$, $p < .001$, partial $\eta^2 = .713$ across the levels of the cognitive SLD subtypes. The F statistic for Wilks' Lambda was exact. The interaction between the BASC-2 TRS composites and the cognitive SLD subtypes was not significant $F(20, 345) = 1.496$, $p = .08$. Power was acceptable for the BASC-2 TRS main effect (power = 1.00), and also acceptable for the BASC-2 TRS and cognitive SLD subtype interaction (power = .857). Therefore, a type II error is unlikely. Levene's test of equality of error variances was not significant for any dependent variables.

Univariate between-subjects tests showed that levels of the between-subjects variable, cognitive SLD subtypes, significantly affected the repeated dependent measures of the BASC-2 TRS composites $F(5, 107) = 4.254$, $p < .001$, $\eta^2 = .166$. Post-hoc comparisons utilizing the Bonferroni method through multiple comparisons revealed differences between the SLD subtypes across the BASC-2 TRS composite variables. Table 8, Table 9 and Table 10 depict the means, standard deviations and the *F* statistics for these variables across the SLD subtypes.

A multivariate GLM was also computed with BASC-2 TRS clinical and adaptive scores as repeated dependent measures (within-subjects factor) and the six cognitive SLD subtypes derived from the cluster analysis serving as the between-subject factor. Homogeneity of variances/covariances matrices and the Mauchly sphericity tests were analyzed to determine if the data met the criteria for univariate or multivariate approaches to the analyses. In this case, a multivariate approach to the data could not be completed due to violation of the equality of homogeneity of the covariance matrices of the dependent variable as determined by Box's M test $F(240, 10205) = 1.235, p = .008$.

Therefore, a univariate GLM with BASC-2 TRS clinical and adaptive scales as repeated dependent measures and the six cognitive SLD subtypes as the between-subjects factor was undertaken. The assumption of sphericity as tested by Mauchly's Test of

Tests of within-subjects contrasts demonstrated a linear effect for the BASC-2

TRS clinical and adaptive scales $F(1, 107) = 140.728$, $p < .001$, $\eta^2 = .568$ and a quadratic

Table 9

BASC-2 TRS Internalizing and Externalizing Variables and Cognitive SLD Subtypes

		V/S (n = 14)	Fluid (n = 10)	C/L (n = 15)	PS (n = 30)	E/WM (n = 19)	HF/I (n = 25)	F^1
Hyp	*M*	53.29	61.70	61.20	52.63	68.16[a,d]	59.56	3.46**
	SD	12.70	13.60	15.24	10.89	12.65	17.94	
Agg	*M*	52.50	58.10	63.27[d]	50.33	61.32	55.80	2.70*
	SD	12.48	14.82	16.48	10.48	14.50	14.49	
Con	*M*	51.79	59.80	61.13	50.77	62.89[d]	55.64	3.27**
	SD	10.48	12.09	11.67	8.48	14.76	15.49	
EP	*M*	52.64	60.40	62.73	51.37	65.11[d]	57.56	3.49**
	SD	11.64	13.63	14.67	9.84	13.71	15.84	
Anx	*M*	49.93	52.60	55.40	52.00	56.74	52.32	.79
	SD	10.08	8.99	11.56	12.22	14.98	8.72	
Dep	*M*	53.36	61.40	66.73	58.10	69.58[a,f]	56.56	3.47**
	SD	8.75	13.68	18.88	11.10	17.26	13.68	
Som	*M*	52.93	61.30	54.53	52.70	60.74	51.80	1.55
	SD	13.48	17.82	16.73	12.10	16.16	10.27	
IP	*M*	52.57	60.40	61.13	55.30	65.21[a,d,f]	54.32	2.59*
	SD	11.28	14.23	16.00	11.15	16.05	10.04	

Note. Hyp = Hyperactivity; Agg = Aggression; Con = Conduct Problems; EP =

Externalizing Problems; Anx = Anxiety; Dep = Depression; Som = Somatization; IP = Internalizing Problems. V/S = Visual/Spatial SLD; Fluid = Fluid Reasoning SLD; C/L =Crystallized/Language SLD; PS = Processing Speed SLD; Executive/Working Memory SLD; HF/I = High Functioning/Inattentive SLD.

[a]Higher than V/S subtype.

[b]Higher than Fluid Reasoning subtype.

[c]Higher than Crystallized/Language subtype.

[d]Higher than Processing Speed subtype.

[e]Higher than Executive/Working Memory subtype.

[f]Higher than High Functioning/Inattentive subtype.

$^{*}p < .05$, $^{**}p < .01$

Table 10

BASC-2 TRS School Problems and Behavioral Symptoms Index and Cognitive SLD Subtypes

		V/S (n = 14)	Fluid (n = 10)	C/L (n = 15)	PS (n = 30)	E/WM (n = 19)	HF/I (n = 25)	*F*[1]
AP	*M*	60.43	60.40	61.93	61.33	65.58	60.12	.90
	SD	8.94	11.39	6.46	9.00	7.90	11.15	
LP	*M*	60.57	61.70	66.93	62.50	67.89[f]	57.04	3.00*
	SD	9.71	10.37	9.46	10.24	11.29	11.12	

Table 10 (continued)

		V/S (n = 14)	Fluid (n = 10)	C/L (n = 15)	PS (n = 30)	E/WM (n = 19)	HF/I (n = 25)	F^1
SP	*M*	60.57	62.00	65.00	63.00	68.21[f]	59.56	2.15*
	SD	8.23	10.87	8.45	9.09	10.05	9.98	
Aty	*M*	54.71	62.80	64.20	61.27	70.47	58.04	1.81
	SD	12.28	22.93	15.09	15.27	20.10	16.53	
With	*M*	52.79	60.20	58.80	58.60	63.89[f]	52.52	2.63*
	SD	8.46	14.18	12.59	11.81	14.38	9.59	
BSI	*M*	56.36	63.60	65.80	58.73	70.79[a,d,f]	59.00	3.34**
	SD	10.33	14.66	13.87	9.91	15.17	13.36	

Note. AP = Attention Problems; LP = Learning Problems; SP = School Problems; Aty = Atypicality; With = Withdrawal; BSI = Behavioral Symptoms Index. V/S = Visual/Spatial SLD; Fluid = Fluid Reasoning SLD; C/L = Crystallized/Language SLD; PS = Processing Speed SLD; Executive/Working Memory SLD; HF/I = High Functioning/Inattentive SLD.

[a]Higher than V/S subtype.

[b]Higher than Fluid Reasoning subtype.

[c]Higher than Crystallized/Language subtype.

[d]Higher than Processing Speed subtype.

[e]Higher than Executive/Working Memory subtype.

[f]Higher than High Functioning/Inattentive subtype.

$^{*}p < .05$, $^{**}p < .01$

Table 11

BASC-2 TRS Adaptive Scales and Cognitive SLD Subtypes

		VS (n = 14)	Fluid (n = 10)	C/L (n = 15)	PS (n = 30)	E/WM (n = 19)	HF/I (n = 25)	F^1
Adapt	*M*	43.14	41.20	42.13	42.10	40.47	44.56	.48
	SD	10.81	8.74	7.39	9.03	10.73	8.93	
Social	*M*	42.93	41.50	40.67	39.50	43.00	43.56	.54
	SD	10.65	6.60	6.56	12.58	10.20	10.85	
Leader	*M*	40.00	44.50	38.00	39.27	40.42	43.56	2.22
	SD	6.92	5.70	4.61	7.02	7.18	7.86	
Study	*M*	40.00	39.50	36.27	37.50	36.84	42.52	2.17
	SD	7.30	8.61	5.71	6.74	8.05	7.92	
FC	*M*	38.14	40.40	35.53	39.00	37.32	42.92	1.94
	SD	6.88	8.94	5.85	7.17	8.90	9.92	
AS	*M*	39.64	40.30	37.13	38.33	38.21	42.72	1.58
	SD	6.89	6.68	4.37	7.39	8.72	7.77	

Note. Adapt = Adaptability; Social = Social Skills; Leader = Leadership; Study = Study Skills; FC = Functional Communication; AS = Adaptive Skills. V/S = Visual/Spatial SLD; Fluid = Fluid Reasoning SLD; C/L =

Crystallized/Language SLD; PS = Processing Speed SLD; Executive/Working Memory SLD; HF/I = High Functioning/Inattentive SLD.

[1]All F ratios not significant at $p < .05$

Chapter Five

Discussion

The heterogeneity evident in the SLD population has limited the exploration into specific subtypes of SLD examined across cognitive, academic, and psychosocial factors, despite evidence suggesting that SLD subtypes can be discriminated through exploration of these multiple factors (D'Amato et al., 1998; Fiorello et al., 2006; Forrest, 2004; Fuerst et al., 1989, 1990; Geary et al., 1999; Hale et al., 2003; Hendriksen et al., 2007; Mayes & Calhoun, 2008; Rourke, 2008; Speece et al., 1985). Outcomes studies of children with SLD have highlighted the debilitating nature of SLD on educational and psychosocial development; this includes serious academic deficits and higher drop rate rates (Bender & Wall, 1994), overrepresentation in the juvenile justice system (Quinn et al., 2005), and heightened possibility of comorbid SLD and mental illness in adulthood (Bouras & Drummond, 1992). It is clear that researchers need to engage in studies involving subtypes (of both patterns of neurocognitive functioning on the one hand, and patterns of psychosocial functioning on the other) if relevant conclusions and implications are to be specified for children with SLD (Rourke, 2008). The current study was undertaken to explore homogeneous subtypes of children with SLD and differentiate these subtypes based on cognitive, achievement, and emotional/behavioral variables.

A major facet of this study was to obtain an SLD sample that met C-DM requirements for SLD (Hale & Fiorello, 2004; Hale et al., 2008). This was advantageous in determining cognitive strengths and weaknesses and in linking these factors to achievement areas. This method helped to minimize SLD heterogeneity by examining a more rigid classification scheme than one based on simple ability-achievement discrepancies as conducted by the respective school districts.

The initial aim of this study was to cluster analyze the WISC-IV subtest variables to examine if meaningful subtypes would emerge. These subtypes were discerned by utilizing a subtest approach to subtype membership instead of utilizing the FSIQ and the Index scores in the cluster analysis, because these global scores can obfuscate meaningful individual differences (Hale et al., 2008). Therefore, based on examining specific "basic psychological processes", the cluster analysis yielded six cognitive SLD subtypes. These subtypes were differentiated, based on neuropsychological and cognitive processes underlying the tasks presented on the subtests. In this manner, psychological processing patterns of functioning were examined from the processing demands of the subtests instead of examining input or output demands (Hale & Fiorello, 2004).

Subtype Differentiation and Clinical Implications

Several meaningful subtype differences across the cognitive variables emerged in this study. Two of the subtypes, Fluid Reasoning and Visual/Spatial, appear to be aligned with a NVLD or a right hemisphere learning disability (RHLD), suggesting subtype differences in the NVLD construct commensurate with current research (Forrest, 2004; Hendriksen et al., 2007; Mammarella et al., 2006). Two subtypes, the Processing Speed and Executive/Working Memory groups, appeared to have difficulties with frontal-subcortical functioning as evidenced by poor performances on the PSI and WMI, which is also in line with most subtype research and related to the SCAD and ACID profile (Fiorello et al., 2006; Hanna-Pladdy, 2007; Kaufman, 1994; Mayes & Calhoun, 2004;

Prifitera & Dersh, 1993). Two other subtypes emerged with opposite patterns, a High Functioning/Inattentive subtype, characterized by higher mean scores across most cognitive areas, and a Crystallized/Language subtype who demonstrated global cognitive deficits. However, significant differences were also noted across academic and psychosocial factors among these subtypes, suggesting both clear and subtle differences warranting careful clinical examination and differentiated instructional programs.

Table 12 depicts the six SLD subtypes differentiated across cognitive, academic, and emotional/behavioral variables.

Table 12

Differentiation of SLD Subtype Deficits across Study Variables

Subtypes	Cognitive	Academic	Emotional/Behavioral
	Block Design	Math Calculation	Attention Problems
V/S	Symbol Search	Math Reasoning	Learning Problems
	Digit Span	Written Language	School Problems
	Picture Concepts	Math Calculation	Internalizing Probs.
FR	Matrix Reasoning	Math Reasoning	Externalizing Probs.
	Comprehension	Reading Comp	BSI
	VCI	Word Reading	Internalizing Probs.
C/L	WMI	Reading Comp.	Externalizing Probs.
	PSI	Math Calculation	School Problems
		Math Reasoning	BSI
		Written Language	Adaptive Skills

Table 12 (continued)

Subtypes	Cognitive	Academic	Emotional/Behavioral
	Coding	Reading Comp.	Depression
PS	Symbol Search	Written Expression	Attention Problems
			Learning Problems
			School Problems
			Atypicality
			Adaptive Skills
	Digit Span	Reading Comp.	Internalizing Probs.
E/WM	LNS	Math Calculation	Externalizing Probs.
	Coding	Math Reasoning	School Problems
	Symbol Search	Spelling	BSI
		Written Expression	Adaptive Skills
HF/I	Digit Span	Word Reading	Hyperactivity
		Written Expression	Attention Problems

V/S= Visual/Spatial; FR = Fluid Reasoning SLD; C/L =Crystallized/Language; PS = Processing Speed; Executive/Working Memory; HF/I = High Functioning/Inattentive.

The Visual/Spatial learning disability subtype was characterized by a relatively consistent cognitive profile across the WISC-IV composites, with difficulties noted by a relatively lower PRI and WMI mean score. Although the PRI score was within the average range, a subtest analysis approach revealed marked deviations across the subtests that constitute this domain. On the Block Design subtest, this group appeared to demonstrate deficiencies in visual and spatial processing, in visual analysis and synthesis, and in understanding of part-whole relationships (Groth-Marnat & Teal, 2000), receiving the lowest BD subtest mean of the six SLD subtypes. Their overall average PRI was inflated by a high mean score on the PC subtest and low average performance on MR, similar to the pattern described in Hale et al. (2006). The overall WMI was the lowest scored composite area, reflecting poor DS performance and an average LNS performance. Therefore, the difficulties associated with the lowered WMI appeared to be most closely related to the lowered DS mean score. The DS subtest does consist both of Digits Forward and of Digits Backward tasks; however, in this study, these separate areas were not further examined. Therefore, it is difficult to determine if the DS score was due to a lowered performance on the forward or backward condition, or if both conditions were relatively comparable. Although it appears that because the LNS mean score was average, that the DS lowered mean performance could have been influenced more by the digits forward performance, suggesting difficulties with passive sequential working memory rather than an active working memory deficit per se (Mammarella et al., 2006). The inattention can also be attributed to the right posterior attention activation system (Posner & Raichle, 1994). Although the PSI fell in the average range, a subtest approach validated the need for closer inspection because the SS mean score was lower than the CD mean score, indicating more difficulty with spatial processing (Gs) as measured by SS and BD (Keith et al., 2006). This subtype appears to be best described as having difficulties with visual/spatial processing and poor awareness and attention of self and of the environment, characteristics often found in children with right hemisphere parietal processing difficulties, indicating dorsal stream deficiencies involving posterior regions rather than frontal regions (Hale & Fiorello, 2004; Hale et al., 2006).

Examination of achievement for this SLD subtype revealed poor performance on Math Calculation and Math Reasoning. The means for these subtests were in the low average range and were the lowest subtest means across all areas of academics within this group. This math SLD subtype appears most frequently characterized by right hemisphere weaknesses with problems in math evident in column alignment, determining place values, and attention to operands (Mazzocco, 2004), again suggestive of dorsal stream difficulties (Hale et al., 2008). This subtype is also suggestive of Rourke's (1995) nonverbal learning disability syndrome with a visual-spatial subtype of math disability because of white matter dysfunction presumably due to right hemisphere SLD. This subtype is also in line with the visual/spatial SLD subtype found by Forrest (2004).

Likewise, these same processes may also be affecting written language ability. If this area is responsible for providing visual-spatial sensory feedback to the motor system, difficulties may be associated with constructional apraxia as seen on BD and perhaps on the Written Expression subtest that requires a coordination of graphomotor skills, spatial visualization and organization in space (Hale & Fiorello, 2004). Attention problems due to a right parietal deficit are also evident in this subtype; their performance on the DS subtest fell below average levels. This is similar to other findings suggesting that children with MD have attention problems (Semrud-Clikeman & Hynd, 1990). This subtype was primarily characterized by attention problems and learning problems on the BASC-2. Although prior studies have substantiated internalizing disorders and heightened psychosocial disturbances in children with NVLD (Rourke & Fuerst, 1991), this particular subtype had lower levels of depression and anxiety than the other subtypes. In addition, externalizing disorders were not evident, suggesting overall low levels of psychopathology, consistent with recent research suggesting lower rates of psychopathology in children with NVLD when compared to controls and children with VLD (Forrest, 2004).

The Fluid Reasoning subtype also appears to be a subtype of a right hemisphere learning disability. Fluid, novel problem solving and categorical inductive reasoning was impaired, both suggestive of right hemisphere processes (Bryan & Hale, 2001; Hale & Fiorello, 2004). This group is differentiated from the other NVLD subtype because they appear to have relatively strong rote and working memory. This group also scored lower on the socially-relevant Comprehension subtest, perhaps indicating difficulties with pragmatic language and inferential reasoning processes tapped by the right temporal lobe (Bryan & Hale, 2001). This subtype is congruent with certain aspects of Rourke's (1989) NVLD type, but does not appear to have the visual-spatial deficits consistent with more posterior dysfunction.

Examination of achievement indicated primary problems with Reading Comprehension, Math Reasoning, and Math Calculation. Because of the lowered Comprehension subtest performance, inferential divergent reasoning skills such as that required in comprehension of reading passages and math reasoning problem solving may be hindered by poor fluid reasoning abilities for this SLD subtype (Keith et al., 2006). More comfortable with explicit, rote comprehension, this subtype is especially prone to struggle in higher academic grades as the content and curricula become more demanding (Hale & Fiorello, 2004).

Although the Visual/Spatial SLD subtype may likely demonstrate posterior right hemisphere dysfunction, the Fluid Reasoning subtype appears to have more anterior right hemisphere (temporal lobe) deficits affecting fluid reasoning, novel problem-solving skills, and right hemisphere language processes (Berniner & Richards, 2002; Bryan & Hale, 2001; Lindell, 2006). This fits nicely with the deficits in Math Reasoning and Reading Comprehension both of which require problem-solving skills and divergent thought processes utilizing the right hemisphere prefrontal cortex in looking for patterns of information to obtain the bigger picture needed in discordant-related tasks (Hale & Fiorello, 2004). In line with Rourke and Fuerst (1991) NVLD subtype, this group did have heightened scores on the BASC-2 across both internalizing and externalizing areas, suggesting increased risk for psychopathology. Coupled with the Fluid Reasoning SLD profile, this subtype has many comorbid difficulties across academic and emotional/behavioral domains. The right frontal lobe is critical for sustained attention and self-control (Hale et al., 2005), because of reciprocal interactions with the frontal-subcortical circuits (e.g., Lichter & Cummings, 2001), so it is not surprising this subtype would be more likely to experience behavioral problems and greater overall psychopathology.

The Crystallized/Language subtype had a FSIQ mean score in the borderline range; however, a severe amount of variability was evident in this group. This group evidently experiences deficiencies in the areas of language processing and most notably has significant expressive and receptive language difficulties, all subsumed under crystallized knowledge or Gc (Berninger & Richards, 2002; Fiorello et al., 2006; Keith et al., 2006). It is very likely that this subtype constitutes the VLD or the verbal learning disability subtype that is discussed in prior research (Forrest, 2004; Hendrikesen et al., 2007). The difficulty with language most likely hinders these children in school and on formal assessment because understanding and processing language either by ear, by mouth, or by hand is difficult (Berninger & Richards, 2002). In combination with the executive deficits and working memory problems experienced by this group, it is not surprising that the achievement and levels of psychosocial functioning were well beneath their peers because this difficulty with language appears to relate directly to global deficits in functioning.

Children with left hemisphere deficits will likely demonstrate poor crystallized and language skills and will most probably experience continuous difficulty with automaticity and routinization of academic skills (Hale & Fiorello, 2004). Both posterior and anterior quadrants of the left hemisphere are likely deficient, because this subtype appears to have difficulty encoding new language-based information and making it routinized or automatic so that the executive system can lessen its involvement and the left hemisphere can produce information fluently. According to Goldberg (2001), a gradual shift in right to left hemisphere processes occurs as tasks become learned and demonstrated. These deficient processes, resulting in global academic deficits for this subtype, are a common cause of learning disability (Hale & Fiorello, 2004).

This subtype had high means for the areas of Hyperactivity, Aggression, and Conduct Problems on the BASC-2. The mean score for the area of Aggression was the highest mean for all subtypes. Children with crystallized and language deficits have been found to display withdrawn, anxious, and depressed symptoms (Boetsch et al., 1996), but this subtype, likely found in juvenile delinquency centers, may likely be emergent, conduct-disordered children due possibly to neuropsychological deficits or to continual school and social failures (Hale & Fiorello, 2004). These results are also congruent with the Forrest (2004) study in which children with VLD had higher rates of psychopathology than did children with NVLD. Perhaps the presence of intact right hemisphere emotion-processing leads to higher rates of socialized delinquency in this subtype because these children may be socially aware, yet alienated because of their continuous academic failure (Hale & Fiorello, 2004).

The Processing Speed subtype was characterized by a lower PSI mean score which was markedly different from the other mean scores across the composites and subtests within this subtype. Lowered mean scores for the SS and CD subtests revealed difficulties with processing speed, with automaticity of simple cognitive processing when under time constraints, and with psychomotor speed. These abilities are most closely aligned with the CHC factor of Gs (Keith et al., 2006). These cognitive deficits likely led to difficulties with quick automatic performance, such as the reading fluency skills needed for effective Reading Comprehension.

A psychomotor speed difficulty may affect new learning and automaticity of learned skills, which in the classroom may suggest that these students need additional instruction time at the beginning, but will then be able to retain and express this material. According to Goldberg (2001), a difficulty in automaticity of learned skills may also hinder new learning as the brain tries to put forth enough resources to learn new material while it is still processing skills that should be automatic. Automaticity probably frees additional resources for processing. Deficient graphomotor skills may likely be involved because both the CD and SS tasks require these processes, which could account for problems with Written Expression.

This subtype may likely be displaying deficits in the anterior cingulate circuit, which is primarily involved in motivation to perform well, persistence on tasks, and online monitoring of performance (Hale & Fiorello, 2004). Because this subtype demonstrated difficulties with the tasks requiring sustained performance and balancing speed and accuracy which require persistence on the timed tasks of CD and SS, cingulate dysfunction is likely because it serves to regulate communication between the anterior and posterior regions (Hale & Fiorello, 2004). The cerebellum has also been named as being involved in timing and implicit learning with difficulties processing reading due to "poor timing secondary to cerebellar dysfunction" (Hale & Fiorello, 2004, p. 192). In addition to the cingulate and cerebellum, the oculomotor circuit with its relationship to motor control and visual attention and scanning may also be related to the difficulties on the CD and SS subtests; this would also be related to word reading and written language difficulties (Hale & Fiorello, 2004), yet cognitive hypothesis testing of these possibilities could further elucidate the nature of the processing speed problem, and therefore lead to more specific interventions as a result.

For the Processing Speed subtype, emotional and behavioral areas of most concern were found for Attention Problems, Learning Problems, and Atypicality scales. Depression and Withdrawal appeared to be borderline clinically significant. This subtype appears again to suffer from cortical-subcortical circuit dysfunction such as that of the anterior cingulated, with problems evident in online monitoring of motivational behavior and persistence on sustained tasks (Hale & Fiorello, 2004). In the classroom, these children may appear "slow" because psychomotor speed is diminished, resulting in depressive like symptoms due to cingulate dysfunction, not unlike individuals who experience apathy due to abulia (Mayberg, 2001).

The Executive/Working Memory subtype was most frequently characterized by deficits on the WMI and PSI. This group evidenced difficulty in DS and LNS, with the mean score being the lowest across all groups on LNS. This group had the second lowest mean score on DS. Within the PSI, this group had the lowest mean score for CD and the second lowest mean score for SS across all SLD subtypes. The greatest areas of deficit were found in working memory and psychomotor speed, suggesting global frontal-subcortical circuit dysfunction, leading to probable deficits in multiple executive functions (Hale & Fiorello, 2004).

This subtype evidently has difficulty with several of the cortical-subcortical circuits. First, the difficulty with CD could be related to anterior cingulate deficits in relation to the online monitoring of performance or to the oculomotor circuit, suggesting difficulties with visual attention and scanning (Hale & Fiorello, 2004). The anterior cingulate is responsible for "executive-attention" functions which help the communication from posterior to anterior areas (Posner & Raichle, 1994). The dorsolateral prefrontal circuit could likely be deficient in terms of motor planning, sustained attention, and regulation of performance needed for CD and SS (Hale & Fiorello, 2004). Furthermore, the deficits noticeable on DS and LNS suggest difficulties with bilateral frontal activity (encoding and retrieval) and with working memory processes that must operate in concert with executive functions to carry out higher level processing (Hale & Fiorello, 2004). This type appears to be related to the SCAD profile (Kaufman, 1994) in which students with SLD often performed poorly on the SS, CD, DS, and Arithmetic subtests. Because the frontal functions serve as a checks and balance between the hemispheres of the brain and the posterior to anterior axis, this subtype may appear to be the most impaired because the frontal lobe is responsible for higher level cognition (Hale & Fiorello, 2004).

This group had the most frequent global emotional and behavioral functioning difficulties, evidenced by the highest means for the BASC-2 clinical scales of all SLD subtypes on Hyperactivity, Conduct Problems, Anxiety, Depression, Attention Problems, Learning Problems, Atypicality, and Withdrawal. Overall, this subtype had clinically significant mean scores both for Internalizing and for Externalizing Problems. This pattern is highly suggestive of overall executive dysfunction and deficient working memory processing (Hanna-Pladdy, 2007). The seat of psychopathology is thought to lie in the prefrontal cortex and it is not surprising that this subtype evidenced the most disabling emotional and behavioral functioning (Kazdin, 1985; Powell & Voeller, 2004). This subtype evidenced difficulties with the dorsolateral prefrontal circuit and the orbital prefrontal circuit, evidencing problems with emotional lability, disinhibition, and poor impulse control (Hale & Fiorello, 2004) both higher level executive functioning and emotional regulation. When working with the dorsolateral region, the orbital region determines initiation, maintenance of performance, and modulates emotional responses (Elliott, Rees, & Dolan, 1999). This subtype is most likely displaying dysexecutive syndromes that impair cognitive, academic, and psychosocial functioning.

The High Functioning/Inattentive subtype was the highest functioning group across all areas of the WISC-IV with the exception of the WMI Index. WMI variability was noted, with the mean score for DS being much lower than the mean score for LNS. Therefore the WMI appeared to be reduced mainly by the DS subtest performance because the LNS mean score fell into the average range. This group appears to have mild difficulty with basic encoding of auditory information into short-term memory, which also suggests difficulties with immediate attention and possible auditory processing problems (Berninger & Richards, 2002). Limited auditory attention and processing may be related to lowered performances on the Word Reading and Written Expression subtests.

This subtype, as with some of the others, has a frontal-subcortical aspect to the profile. In light of adequate LNS performance, the lowered DS score suggests a possible difficulty with the frontal aspects of attention and encoding. For this subtype a possible deficit in the sequential processing of auditory information is also likely, implicating the left hemisphere frontal regions with encoding sensory information into the working memory realm (Berninger & Richards, 2002; Hale & Fiorello, 2004; Hale et al., 2002). Because the LNS performance was average, it appears that the deficit lies before working memory involvement, more noticeably at the level of sensory information and attention to the stimulus, perhaps pointing to auditory processing deficits in language by ear (Berninger & Richards, 2002). Academic weaknesses for this group were mild but did appear to affect those areas involved with language; however, this group did not have difficulties with Decoding, which may suggest the likelihood of a phonological processing disorder and left superior temporal lobe dysfunction (Hale & Fiorello, 2004). If the frontal subcortical circuits are implicated, the problems may possibly lie in the oculomotor circuit for reading words and visual and auditory attention (Hale & Fiorello, 2004). Despite the confusion regarding the locus of the problem, the cognitive deficit lies in orienting attention to an auditory stimulus, perhaps highlighting an inattention aspect to this subtype. The inattention aspect suggests the involvement of frontal-subcortical regions rather than a left hemisphere deficit in phonological processing.

This subtype was characterized by heightened means for the area of Hyperactivity and Attention Problems, with means in those areas within clinical limits. This is also highly congruent with their cognitive profile weaknesses in attention. This group appears to have characteristics of mild ADHD. The difficulties may lie in bilateral frontal regions including the dorsolateral region for the executive functions and the orbital frontal regions for regulating impulses, suggesting hypoactivity of these circuits (Hale & Fiorello, 2004).

Academic Subtype Differences

Additional aims of the study sought to examine whether or not significant differences would be found between the subtypes on measures of cognitive and academic variables. Indeed, significant group differences occurred across all cognitive and achievement measures, with the Crystallized/Language and the Executive/Working Memory subtypes demonstrating significantly lower performance across the achievement variables. Reading difficulties were pronounced for the Crystallized/Language subtype as well as for the Executive/Working Memory subtype, suggesting left hemisphere and frontal aspects involved in successful reading, a left-frontal combination (Hale & Fiorello, 2004; Shaywitz et al., 2002). The Crystallized/Language subtype had deficits across all areas of reading perhaps suggesting that these children are experiencing double or triple deficit reading disabilities and are at greatest risk for reading failure (Lovett, Steinbach, & Frijters, 2000; Wolf & Bowers, 1999). They appear congruent with the Global subtype of reading disability found in the Fiorello et al., (2006) study. The Executive/Working Memory subtype demonstrated more difficulty in Word Reading and Reading Comprehension suggesting possible deficient rapid naming ability and fluency, leading to comprehension deficits (Bowers, 2001), which is also aligned with the Fluency-Comprehension subtype reported by Fiorello et al., (2006). Reading

Comprehension concerns were evident for the Fluid Reasoning subtype perhaps due to difficulties with divergent/discordant reasoning, further stipulating right hemisphere language-based disabilities (Bryan & Hale, 2001).

The Executive/Working Memory subtype evidenced difficulties with the math areas, suggesting frontal aspects involved in Math Calculation and Math Reasoning (Mazzocco, 2001); this also suggests that math difficulties can stem from many reasons, not only from right hemisphere processes (Forrest, 2004; Hale & Fiorello, 2004). This subtype may represent a procedural type of math disability characterized by poor strategy usage and working memory difficulties (Geary et al., 1999). This math subtype appears congruent with the Mild Executive/Working Memory math disability subtype reported by Hale and colleagues (2008). Both RHLD groups experienced difficulty with Math Calculation and Math Reasoning. These two subtypes were differentiated by posterior or anterior deficits, indicating that visual-spatial and fluid reasoning novel problem solving processes are related to math achievement (Hale & Fiorello, 2004; Langdon & Warrington, 1997). The Fluid Reasoning subtype appears aligned with the Fluid/Quantitative subtype in the Hale et al., (2008) study, whereas, the Visual/Spatial subtype appears to be aligned with the Right Hemisphere/NVLD math disability subtype. The Crystallized/Language subtype evidenced difficulty with the math areas as well indicating that math disabilities appears to be the result both of left and of right hemisphere bilateral processes (Benbow & Lubinski, 1997; Hale et al., 2003; Hale & Fiorello, 2004). The Crystallized/Language subtype may represent a semantic type of math disability, with difficulties noted in number association and math fact automaticity

(Geary, 1993) or they may represent the Dyscalculia-Gerstmann Syndrome math disability subtype documented by Hale et al., (2008).

Written expression difficulties were apparent for the Crystallized/Language, the Executive/Working Memory, and the two RHLD subtypes. These results suggest that linguistic processes, executive impairments, visual-spatial deficits, and difficulties with divergent thought processes may be related to written expression disabilities. The difficulties with written language in the Crystallized/Language subtype may very well relate to language by hand difficulties (see Berninger & Richards, 2002). The Executive/Working Memory subtype probably has written language disabilities due to the constraint placed upon the executive system and the increase in working memory involvement in creating and revising a written product (Wilson & Proctor, 2000). The difficulties noted in the RHLD groups could likely be due to visual/spatial deficits, fine motor deficits, or possible right hemisphere linguistic deficits (see Berninger & Richards, 2002; Sandler et al., 1992). This alludes to the fact that intervention aimed at remediating written expression disabilities will need to be geared to the specific, underlying cognitive process that is deficient in order to make any real progress (Berninger & Abbott, 1992).

Psychosocial Subtype Differences

The ultimate aim of this study was to examine further the contribution of emotional and behavioral variables in the description of the SLD subtypes and to examine psychopathology comorbidity between the subtypes. As Rourke suggests, there is no single psychosocial profile of children with SLD, although there are reliable subtypes of psychosocial functioning in children with SLD which ranges on a continuum from normal to severe (Rourke, 2008). Overall, each subtype had a differential profile for emotional and behavioral functioning suggesting that children with SLD do indeed have significant issues with psychosocial functioning and psychopathology.

The Crystallized/Language and Executive/Working Memory subtypes had the highest scores for the areas on the BASC-2 TRS of all the subtypes. This suggests comorbidity between externalizing and internalizing disorders and comorbidity between SLD subtypes and these forms of psychopathology (Willcutt & Pennington, 2000). The poor crystallized/language skills most notably lead to a host of academic and social difficulties in the school setting (Bryan et al., 2002). These children are often viewed as aggressive and more likely to engage in acts of conduct disorder. Furthermore, this subtype evidenced higher levels of internalizing disorders. This subtype may appear to have psychopathology due to consistent school failures or to deficient processing of emotional and social information (Bryan et al., 2004; Hale & Fiorello, 2004). This subtype is also aligned with previous cluster analytic studies in which verbal deficits led to a moderate degree of behavioral impairment (Nussbaum & Bigler, 1986; Nussbaum et al., 1986).

The Executive/Working Memory subtype evidenced the highest overall levels of psychopathology in internalizing, externalizing, and school-related problems. This is aligned with research stipulating that difficulties with the frontal-subcortical circuits could very well be indicative of dysexecutive syndromes in some children with SLD, affecting cognitive, academic, and emotional/behavioral functioning (Hanna-Pladdy, 2007). This subtype has been frequently reported in other cluster analytic studies (see McKinney & Speece, 1986; Nussbaum & Bigler, 1986; Speece et al., 1985)

Remarkably, the Visual/Spatial, Processing Speed, and High Functioning/Inattentive subtypes demonstrated low levels of psychopathology, displaying mainly attention and learning problems, with reduced adaptive skills. However, the High Functioning/Inattentive subtype demonstrated heightened Attention Problems and Hyperactivity, perhaps suggesting characteristics of mild ADHD. This could be due to dorsolateral and orbital circuit dysfunction such as that seen in children with ADHD (Hale & Fiorello, 2004). This is also aligned with previous cluster analytic studies in which a subtype emerged, characterized by inattention and high distractibility (Speece et al., 1985). The inattention observed in the Visual/Spatial subtype could be due to posterior attentional processes and neglect (Posner & Raichle, 1994). Consistent with these findings, Nussbaum & Bigler (1986) also found a subtype with deficits in visual/spatial/motor functioning; this subtype demonstrated the least amount of behavioral impairment. All the SLD groups had relatively higher scores for the area of Attention Problems and Learning Problems, although the subtypes did not appear anxious because lower scores were found for all subtypes on Anxiety. Based in part on the findings of this study and on previous research, it may be helpful for diagnostic and treatment purposes to reserve the term NVLD for children whose visual-spatial deficits are primary and severe enough to affect written mathematics (Forrest, 2004; Mammarella et al., 2006). Given the integral nature of social relationships in children's lives, a social processing disorder category could be created for children whose social skills deficits are primary (Forrest, 2004).

The Fluid Reasoning subtype demonstrated characteristics similar to Rourke's NVLD syndrome, resulting in higher levels of psychosocial disturbance and psychopathology in Hyperactivity, Aggression, Conduct Problems, Depression, Somatization, Atypicality, and Withdrawal. This subtype demonstrated less severe problems than the crystallized/language subtype which is not in line with Rourke's finding that children with BPPD did not display any significant signs of psychopathology (Rourke, 2008). However, in the Rourke studies, a heterogeneous group of NVLD children may raise the potential for finding more significant psychopathology; however, in this study, the NVLD subtypes were formed on the basis of anterior or posterior right hemisphere deficiencies leading to specific academic and emotional/behavioral functioning deficits. As Mammarella et al., (2006) determined that specific subtypes such as the visuospatial subtype of NVLD should be further explored especially because the right hemisphere is not seen as purely "nonverbal" and can be better differentiated by concordant/convergent (left hemisphere) and discordant/divergent (right hemisphere) functions (Bryan & Hale, 2001; Lindell, 2006).

Limitations

This study utilized a small sample size of archival data and data were collected only on those students who had recent completion of the WISC-IV standard battery and the BASC-2 TRS; this may have had implications for this study. The generalization of the results is limited to other educational settings with similar demographics. Likewise, the sample consisted of differing numbers of males and females in the overall sample and within the subtypes, which was expected. This higher percentage of males within the subtypes may have factored into the results obtained and these results may not generalize to a strictly female population. In addition, the children in the Crystallized/Language and Executive/Working Memory subtypes were generally younger in age and had the highest ratio of males to females. These groups also appeared to have more global deficits in cognitive, academic, and emotional/behavioral realms and may suggest that the younger age and the higher incidence of males led to these findings. Therefore age and gender may be differentially related to the subtypes and future research may want to explore these outcomes especially because gender differences on the BASC-2 are found (Reynolds & Kamphaus, 2004).

This study utilized a behavior rating scale which is considered a subjective appraisal of children's emotional and behavioral functioning. Although teacher ratings are considered more accurate than parent ratings (Hale et al., 2002), identification of EBD is usually performed both with parent input and with clinical assessment in the diagnosis of such disabilities. However, in this study behavior ratings were used as the sole criterion for determining emotional/behavioral characteristics. Furthermore, the BASC-2 is but one type of behavior rating scale and different scales may produce different results. The WISC-IV is also one representation of instruments that assess cognitive functioning. Different results may be found with different instruments such as the WJ-III which utilizes CHC theory or even examination of the WISC-IV through a different factorial methodology such as in the Keith et al., (2006) study. Future research may want to explore these avenues. Data used in this study were from instruments that informally measure cognitive functions and behavioral observations, so that testing causal hypotheses was not possible; therefore, the neuropsychological implications are hypothesized relationships because this study did not use direct measurements of neuropsychological functioning, nor did it utilize *f*MRI data for comparisons.

This study also used only the WISC-IV standard subtests and did not include the Digit Span Forward (DSF) and Digit Span Backward (DSB) subtests. Therefore, because these subtests are thought to measure different cognitive processes; DSF measures rote memory and DSB measures working memory (Hale et al., 2002), the direct contribution of DS was difficult to tease out in the subtypes.

Implications and Future Direction

Specific learning disability identification and eligibility procedures are undergoing dramatic changes, including the likely removal of the ability-achievement discrepancy approach and the implementation of an RtI approach in determining entitlement. However, both of these methodologies fall short in identifying the underlying basic psychological processes underlying specific subtypes of SLD, thereby neglecting the vast literature on SLD subtypes and brain-behavior relationships (Fiorello et al., 2006; Hale et al., 2006; Mather & Gregg, 2006; Semrund-Clikeman, 2005). This study and others similar to it imply that children with SLD are not a heterogeneous group when further classified into cognitive, academic, and emotional/behavioral characteristics and that these more homogeneous groups can be differentiated based on basic psychological processes, academic deficits, and pattern of psychosocial disturbance. The assessment of the basic psychological processes in determining SLD is aligned with the statutory and regulatory definition of what it is that constitutes SLD, warranting comprehensive cognitive assessment in connection with RtI approaches (Hale et al., 2006; Hale, 2008). Given the fact that SLD subtypes can be extrapolated from the heterogeneous mix, the "third method" of determining SLD may be warranted as proper assessment of cognitive, academic, and psychosocial functioning is critical to proper intervention (Hale et al., 2006).

Furthermore, SLD can be further differentiated not only when examining cognitive factors, but also when examining achievement and emotional/behavioral factors. The neuropsychological literature supports subtype delineation through examination of patterns of functioning across learning and emotional/behavioral systems (Forest, 2004; Fuerst et al., 1989, 1990; Mayes & Calhoun, 2004; Nussbaum & Bigler, 1986; Nussbaum et al., 1986; Speece et al., 1985). Improvement of educational and life outcomes for children with SLD will likely be improved if comprehensive evaluation and treatment includes assessment of cognitive, academic, and emotional/behavioral needs because children with SLD demonstrate emotional/behavioral deficits that are likely related to the neurocognitive deficits in much the same way as are academic deficits (Rourke, 2008). Future studies are warranted to demonstrate the usefulness of subtype analysis to broaden the knowledge base of the homogeneity evident as well as increase the knowledge of emotional/behavioral comorbidity in SLD. Practitioners must address neurocognitive, academic, and psychosocial functioning of children with SLD in order to provide scientific, research-based interventions for specific learning and psychosocial needs.

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Appendix A

Request for Data Letter

Dear School Psychologist,

We would appreciate your participation in a study entitled *Do Cognitive Variables Discriminate Emotional/Behavioral Subtypes of Children with Learning Disabilities?* The research is being conducted by Lisa A. Hain, Psy. D. Candidate, as a partial requirement for the Doctor of Psychology degree, and the principal investigator and supervisor of the research project is James B. Hale, Ph.D.

The purpose of this project is to examine cognitive functioning and emotional/behavioral functioning in children with specific learning disabilities (SLD). The archival data sought includes scores from the Wechsler Intelligence Test for Children – Fourth Edition (WISC-IV) and the Behavior Assessment System for Children – Second Edition, Teacher Rating Scales (BASC-2). In addition, achievement scores are requested that were part of the evaluation to aid in verifying the SLD. The achievement test scores can derive from any standardized, individually-administered, achievement test.

We are asking you to provide raw scores and standard scores/scaled scores of the WISC-IV, the raw scores and standard scores/scaled scores from the test of achievement and the T-scores from the BASC-2 teacher form. As this is an *archival record review*, there will be *no contact* between myself or Dr. Hale and the child, family, or team members. In fact, we ask you to only report the WISC-IV, BASC-2, achievement scores, age, grade, gender, and disability label, not the child's name or any identifying information. There is no harm to the students or 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 Lisa A. Hain at lisahai@pcom.edu or James B. Hale at jamesha@pcom.edu.

Lisa A. Hain, MS, NCSP

James B. Hale, Ph. D.

Appendix B

School Psychologist Agreement

School Psychologist Name: ____________________________

School: ____________________________

Date: ____________________________

I, ________________________________, hereby allow the use of my archival WISC-IV, standardized achievement, and BASC-2 Teacher Rating scores in the research project entitled *Do Cognitive Variables Discriminate Emotional/Behavioral Subtypes of Children with Learning Disabilities?* 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.

______ WISC-IV Subtests Scaled Scores, Standard Scores

______ BASC-2 TRS T-scores

______ Achievement Measure (Name:____________________________)

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

Age: _________________ LD Subtype(s): ____________

Grade: ________________ Gender: _______________

Date Concordance-Discordance Statistics Completed:

Determination (Include if LD is present and in what achievement domain):

Check if data included in study: (All Criteria Met)

______Yes

______ No

WISC-IV Scores

Measures	Raw	Scaled/Standard
Similarities		
Comprehension		
Vocabulary		
Block Design		
Picture Concepts		
Matrix Reasoning		
Digit Span Forward (if computed)		
Digit Span Backward (if computed)		
Digit Span		
Letter-Number Sequencing		
Coding		
Symbol Search		
Verbal Comprehension Index		
Perceptual Reasoning Index		
Working Memory Index		
Processing Speed Index		
Full Scale IQ		

Notes:

BASC-2 Scores

Areas	T-Scores
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:

Concordance/Discordance Statistics Worksheet

Achievement Measure (Name) –

Area (fill in)	Raw	Standard Score
Reading		
Math		
Written Language		

Statistics: