REDEFINING LEARNING DISABILITIES: AN ACADEMIC IMPAIRMENT MODEL OF IDENTIFICATION

by

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ABSTRACT

This review of the literature and study attempted to clarify the debate surrounding LD diagnosis by offering a new diagnostic model based on the principles of academic and functional impairment. We first reviewed the strengths and weaknesses of current LD diagnostic approaches. Next, we proposed a method for diagnosing LD that presumes core symptoms of below average academic achievement and associated impairment in other domains of functioning, particularly adaptive functioning, which is modeled on the successful decades old approach to mental retardation diagnosis. Finally, latent class analysis was employed to identify a group of students with low achievement scores associated with a level of functional impairment indicative of the presence of a learning disability. The scores were then transformed to percentile ranks to allow for comparison to other instruments. The learning disability class accounted for 30% of the sample. The implications for classification of children with learning disabilities are discussed and the suggestions for research point in several promising directions.

INDEX WORDS: Learning disabilities, Functional impairment, Diagnosis

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CHAPTER 1

INTRODUCTION

Introduction

Approximately six percent of students in public schools are identified as having a learning disability (U.S. Department of Education, National Center for Education Statistics, 2006). The identification of children with learning disabilities in schools is governed by the Individuals with Disabilities Education Improvement Act (IDEIA, 2004). While most attention is given to learning disabilities in school-age children, the condition persists across the life span. Thus, the conceptual definition and identification procedures set forth by IDEIA are not the only approaches endorsed in the field of learning disabilities.

Overview of Learning Disabilities Definitions

The conceptual definition of learning disabilities presented by IDEIA has not changed since the passage of P.L. 94-142 in 1975. The definition states that, "The term "specific learning disability" means a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which disorder may manifest itself in imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations." The definition continues to specify that several labels previously applied to children with learning disabilities are included, while learning difficulties resulting from visual, hearing, or motor disabilities, mental retardation, emotional disturbance, or environmental, cultural, or economic disadvantage are excluded (IDEA, S.1248, 2003, sec.602(29)).

The National Joint Committee on Learning Disabilities (NJCLD), a committee representing organizations concerned about individuals with disabilities, disagreed with several points in the federal definition and released the following definition in 1990: " Learning disabilities is a general term that refers to a heterogeneous group of disorders manifested by

significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning, or mathematical abilities. These disorders are intrinsic to the individual, presumed to be due to central nervous system dysfunction, and may occur across the life span. Problems in self-regulatory behaviors, social perception, and social interaction may exist with learning disabilities but do not by themselves constitute a learning disability. Although learning disabilities may occur concomitantly with other handicapping conditions (for example, sensory impairment, mental retardation, serious emotional disturbance), or with extrinsic influences (such as cultural differences, insufficient or inappropriate instruction), they are not the result of those conditions or influences." The NJCLD's goal was to eliminate difficult to define terms while highlighting that learning disabilities do not cease to exist after childhood and are intrinsic to the individual.

Overview of Learning Disabilities Identification

While there is some disagreement regarding the appropriate definition of learning disabilities, the more acrimonious debate relates to how learning disabilities are identified. Once again, IDEIA (formerly IDEA) determines what constitutes a learning disability in educational settings. The 1997 reauthorization of IDEA instructed educators to operationalize the definition as failure to achieve commensurate with age and ability as evidenced by a severe discrepancy between academic achievement and intellectual ability in one of seven academic areas. Additionally, the evaluation had to rule-out the exclusionary factors listed in the definition (U.s. Department of Education, 1999, p. 12457). The most recent reauthorization of the special education law also allows states the option of determining whether a child responds to scientific, research-based intervention.

Outside of academic settings the Diagnostic and Statistical Manual of Mental Disorders Fourth Edition (DSM-IV; APA 2000) provides the standard criteria for diagnosing learning disabilities. These criteria also employ the discrepancy approach. More specifically, achievement in reading, math, or written expression as measured by an individually administered standardized achievement test must be substantially below expectation based on chronological age, measured intelligence, and age-appropriate education. Further, the discrepancy must interfere with activities in academics and daily living that require the skill in question.

Purpose of Present Study

Dissatisfaction with currently endorsed classification approaches has prompted the proposal of various identification methods since the advent of the learning disabilities category. The methods have included the standard aptitude-achievement discrepancy, cognitive processing, various intraindividual discrepancies, response to intervention, and low achievement cut scores. As discussed later, strengths and weaknesses have been pointed out and debated for each of these identification procedures.

The purpose of the present study is to describe the rationale for developing a low achievement model of learning disabilities diagnosis based on the definition of learning disabilities and the purposes of classification. To achieve this end, the history of the learning disabilities field is reviewed and currently endorsed approaches to identification are discussed in Chapter 2. Additionally, the concept of functional impairment is introduced to clarify the nature of disability and the potential utility of a low achievement cut point for learning disabilities diagnosis. Finally, person-oriented statistics will be introduced and implemented to identify a meaningful and reliable standardized academic achievement score range to serve as the basis for a new LD diagnostic classification system offered in Chapter 3.

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CHAPTER 2

LITERATURE REVIEW AND A PROPOSAL: AN ACADEMIC IMPAIRMENT MODEL OF LEARNING DISABILITY DIAGNOSIS

Literature Review and a Proposal: An Academic Impairment Model of Learning Disability Diagnosis

The category of specific learning disabilities (LD) accounts for half of the students being served by the Individuals with Disabilities Education Act (IDEA; U.S. Department of Education, 2002). There has been a 28.5 percent increase in LD diagnosis between the 1991-1992 and 2000-2001 school years. A major factor contributing to the large proportion of students receiving the LD label is confusion regarding the appropriate definition and diagnostic procedures for the disorder (Stanovich, 2005). This confusion and resulting high identification rate is likely to continue and become more problematic given the recent changes to IDEA, now IDEIA (Dombrowski, Kamphaus, & Reynolds, 2004).

The 2004 reauthorization of IDEA (now the Individuals with Disabilities Education Improvement Act or IDEIA) allows state education agencies to choose between the standard discrepancy model and response to evidence-based intervention. This latitude will undoubtedly result in differing diagnostic practices, prevalencies, and symptom constellations across geographic locations as has been noted for decades (Shepard, Smith, & Vojir, 1983). More importantly, diagnostic confusion will threaten the viability of the very construct of LD, which would be a disservice to children and adults who genuinely have learning differences that require specialized instruction and services (Stanovich, 2005).

Diagnosis of LD and other disorders is a form of classification that serves five primary purposes: communication, information retrieval, description, prediction, and theory formulation (Blashfield, 1998). In the service of the first purpose, classification provides a common language so that various individuals such as educators, clinicians, and physicians can

communicate with one another. Diagnosis also serves as a method of information retrieval for treatment and the scientific study of specific disorders. Through classification, a short-hand description of co-occurring "symptoms" or problems is established allowing professionals to quickly understand a given situation and formulate hypotheses, leading to the fourth purpose, prediction of course and treatment. The final purpose of classification, concept formation, implies that organization of characteristics of disorders should lead to theories of disorder that guide research. In the case of LD, the lack of a common definition has prevented information organization thus impeding research efforts, and progress in prevention, identification, and remediation.

In addition to the need for accurate diagnosis to meet the purposes of classification, the act of classification itself may produce benefits. For example, the practice of diagnosing individuals with mental retardation and the increased attention paid to diagnostic accuracy contributed to the beginning of the deinstitutionalization movement (Kamphaus, 2001). A more recent example of the necessity for classification is Attention-Deficit/Hyperactivity Disorder (ADHD). Prior to the publication of the Diagnostic and Statistical Manual Third Edition, individuals with the constellation of symptoms characteristic of ADHD (or ADD as it was known at the time) were not recognized as having a disorder. Due to the classification of these individuals as having ADHD, it is now understood that ADHD has a biological basis and great progress is being made in treatment research. If children with learning disabilities are not identified as such it is likely that much-needed advances in prevention and treatment will not be made.

Identifying children as having a learning disability usually involves considerations that differ from other disorders due to its primacy in educational settings. Often clinicians and

educators are presented with a choice to either diagnose the construct of learning disability or to identify a child as having a learning disability so that he or she may receive a desired school placement (Shepard, 1989). Diagnosing the disorder involves the inference of a theoretical construct while school placement is concerned only with the behavioral manifestation of a disorder. While behavior may be enough for pre-referral intervention, the very nature of diagnosis requires that the construct be present, otherwise classification will not serve to enhance communication, prediction, or research.

It is also necessary for educators and psychologists to weigh the benefits of special services with the stigma of a special education label and the cost of assessment. Some individuals lean heavily toward a needs-based definition of LD that would allow any struggling child to receive services without a costly assessment (Shepard, 1989). In addition, labeling a child as having a learning disability is viewed as more desirable than classifying her as suffering from mental retardation (MR) due to the history of ethnic minority overidentification in the latter diagnosis and resulting pressure to avoid disproportionate MR diagnoses. However, by inappropriately classifying students as having a learning disability we fail to reap the beneficial aspects of a classification system and threaten the credibility of the LD construct and the quality of its associated special services.

In a seminal study Shepard, Smith, and Vojir (1983) examined the special education files for a stratified sample of 800 students who had been identified as having learning disabilities. They found that fewer than half of the sample met diagnostic criteria for LD as defined in federal law or the professional literature. Most of the students in the category did have some sort of learning problem, but they were due to other causes such as mental retardation, emotional disturbance, and language interference. The researchers suggested that the over-identification

may have been due to educators' desire to explain their failure to educate students, confusion about definitions, and bureaucratic and parental pressure to identify and provide services for low-achieving students.

If the magnitude of LD misidentification in the Shepard et al. (1983) study is representative of practices across the U.S., research concerning LD will be confounded and the construct will be rendered meaningless in public perception. If the LD label is applied to low achievers, such as non-native English speakers and ethnic minorities who may require services for different reasons than learning disabled students, questions of bias similar to those surrounding mild MR placements are likely to surface. In the most optimistic scenario, labeling a child as having a learning disability will continue to be viewed as more beneficial than harmful allowing it to continue as a catchall category that will ultimately become meaningless and be abolished in public policy (Shepard, 1989).

In this paper we propose that an alternate method for diagnosing learning disabilities based on a premise offered originally by Shepard (1989), one that is based on low achievement test scores may help ameliorate the diagnostic problems plaguing the LD field. To avoid the unreliability associated with cut scores for such methods, we suggest determining what level of achievement is associated with the most functional impairment, which is defined as disability in multiple domains of functioning that are independent of the core symptoms or other symptoms of a disorder (Winters, Collett, & Myers, 2005). The use of impairment criteria in diagnosis has been shown to decrease classification rates to two to three times below rates using only symptom criteria (Bird, 1999). Employing low achievement test scores based on functional impairment levels will result in only students with significantly poor outcomes being classified as having a

learning disability, thus, reducing the variability and overuse of the diagnosis and reserving the diagnosis for children with true need.

We will first briefly review the origins of the LD construct followed by more recent developments. Next, current issues will be discussed, including the arguments surrounding four LD diagnostic approaches (discrepancy, cognitive processing, response to treatment, and low achievement). Finally, the rationale encouraging efforts to determine a level of low achievement that represents functional impairment, and therefore LD, will be presented as well as implications of such a system for children considered "slow learners" and "gifted LD" children.

Origins of LD

The basic concept of learning disability originated with early 19th century European physicians. Joseph Gall is recognized as the first to study disorders that would today be considered language disorders and categorized as learning disabilities (Hammill, 1993). He attributed these problems to specific areas of the brain leading to Pierre Broca and Carl Wernicke's independent observations later in the century that expressive and receptive speech functions reside in the left frontal lobe and superior temporal gyrus, respectively (Hallahan & Mock, 2003). Soon after these developments a German ophthalmologist, Berlin, introduced the term "dyslexia." Inspired by these events, Hinshelwood, a French physician, began to study cases of children who had difficulty acquiring reading skills although they demonstrated average performance in other skill areas (Torgesen, 1991). In 1917, he postulated that reading disability, which he called congenital word-blindness, was a heritable condition caused by faulty visual memory for words and letters that could be remediated through one-to-one training (Hallahan & Mock, 2003).

An American neuropathologist, Samuel Orton (1925), expanded on Hinshelwood's work through his own observations of students referred by teachers as "defective." He found that most of these children actually functioned in the normal range of intelligence and felt they most likely had above average ability that was masked by a reading disability. He further theorized that letter and word images are stored in both hemispheres in beginning readers with one hemisphere becoming dominant to match the customary left-to-right orientation of print. Reading disability, according to Orton, results when one hemisphere fails to become dominant, causing distraction due to the presence of mirror images in one hemisphere and leading to reversals in speech and writing.

Due to the presumed neurological basis for reading difficulties and his fear that word-blindness implicated an acquired disorder, Orton labeled the condition strephosymbalia to emphasize reversals of symbols. He suggested a multisensory method of explicit phonics and sound blending instruction to help educators reach their struggling students (Hallahan & Mock, 2003), but teachers were not receptive to brain dysfunction hypotheses (Torgesen, 1991). Orton's fellow researcher, Marion Monroe, suggested a discrepancy approach that was more acceptable to educators for determining just which students had reading difficulties and required intervention. This procedure involved calculating a reading index based on the difference between actual and expected reading achievement (Hallahan & Mock, 2003) and was the earliest model for the discrepancy method in widespread use today.

The Beginning of the LD Movement

One of Monroe's colleagues, Samuel Kirk, made a lasting contribution to the study of learning difficulties by providing the foundation - a label - that would create a recognized discipline. Kirk coined the term learning disabilities, which he defined as a deficit in a school

subject resulting from a psychological handicap that is not a result of mental retardation, sensory deprivation, or cultural or instructional factors. In 1963, a group of parents formed the Learning Disabilities Association of America based on Kirk's ideas (Hallahan & Mock, 2003), stimulating the formation of other organizations and the beginning of the learning disabilities movement (Hammill, 1993).

At this same time, the 1960s and 1970s, parents became active advocates for their children with learning difficulties and the government began to sponsor research on LD in order to reach a definitional consensus. Medical professionals preferred the term "minimal brain dysfunction" while educators stressed intraindividual differences and discrepancy between ability and achievement, the idea of which was reintroduced by Barbara Bateman despite being absent from Kirk's influential definition. Several researchers aligned with the medical model, focusing on visual and visual-motor disabilities with laterality training as remediation rather than academic intervention (Hammill, 1993). The U.S. government, however, favored the educators' position.

With the passage of the Education for All Handicapped Children Act (EAHCA) in 1975, all disabled students, including those with LD, were guaranteed a free and appropriate public education. In 1977, the U.S. Office of Education updated EAHCA, providing a definition of LD similar to Kirk's from the previous decade and recommending the use of a discrepancy model to determine which students were eligible for services under the LD category (Hallahan & Mock, 2003).

Unfortunately, the discrepancy regulation led to identification problems. Without guidelines for specifying how to determine whether a discrepancy existed, different methods were being employed across states and school districts. Not only were schools identifying

different numbers of children as learning disabled, they were also identifying different children, such that a child could have LD in one district and be problem free in another. Some schools even used grade level discrepancy models, treating ordinal scores as interval data so that resulting calculations were meaningless and "slow learners" without actual disabilities were overidentified (Reynolds, 1984).

Currently Used Methods for Diagnosis

Discrepancy Method

Unfortunately, the learning disability field remains in a similar state to that described above, remarkably resistant to change (Stanovich, 2005). Currently employed diagnostic criteria remain eerily similar to Kirk's 1963 definition focusing on exclusions and Bateman's discrepancy (Dombrowski, Kamphaus, & Reynolds, 2004), with changes reflected in the IDEIA diagnostic regulations threatening to leave the LD field without the consistent and uniform diagnostic approach it has been in need of for over thirty years.

More specifically, a learning disability continues to be defined as "a disorder in one or more of the basic psychological processes involved in understanding or using language, spoken or written, which may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations." The term does not include "a learning problem that is primarily the result of visual, hearing, or motor disabilities, of mental retardation, of emotional disturbance, or of environmental, cultural, or economic disadvantage (Individuals with Disabilities Education Act Amendments of 1997, Sec. 602(26), p. 13). According to the new regulations, a state may not require the use of a discrepancy formula, although schools may still use it, and must permit the use of a process that determines if the child responds to scientific, research-based intervention as part of the evaluation procedures or the use of other alternative

research-based procedures for determining whether a child has a learning disability (IDEA 2004).

Several researchers have pointed out problems with the discrepancy approach and called for new diagnostic methods (Francis, Fletcher, Stuebing, Lyon, Shaywitz, & Shaywitz, 2005; Shepard, Smith, & Vojir, 1983; Siegel, 2003; Stanovich, 2005). Some of the most widely cited shortcomings of the discrepancy model are its lack of reliability and validity, lack of relevance to treatment, and inability to identify children in need of remediation versus those who are not.

As stated previously, there is great variability in the students who are identified because different discrepancy methods are used. For instance, it is not stated whether clinicians should use full-scale scores, verbal composites, or processing composites and it is possible to compare any of these scores to several achievement composites or subtests. Further, more similarities than differences have been found between IQ-discrepant poor readers and low reading achievement test score poor readers (Shaywitz, Fletcher, Holann, & Shaywitz, 1992), suggesting that discrepancy is not a valid indicator of learning (e.g., reading) disability. It also fails to provide relevant treatment information because IQ and reading ability are not linearly related, meaning that low- and high-IQ readers do not require different forms of remediation (Vellutino et al, 1996)

Not only does the discrepancy method fail to reliably identify students or lead to effective treatment, it also delays intervention until a child's achievement scores are low enough to evidence a discrepancy, leading to it's alias - the "wait to fail" model (Stuebing, Fletcher, LeDoux, Lyon, Shaywitz, & Shaywitz, 2002). This delay results because children's achievement scores do not begin to decline until the content of achievement tests becomes increasingly complex and abstract, which generally begins to occur around third grade (Dombrowski et al.,

2004). A similar criticism has been referred to as the Matthew effect (Stanovich, 1986), whereby strong readers gain more knowledge and vocabulary through access to text allowing them to perform better on reading and cognitive tasks. Poor readers do not have access to more information and fall farther behind peers in reading skills, vocabulary, and knowledge, leading to further declines in reading as well as cognitive abilities, making them less likely to exhibit the required discrepancy between achievement and ability (Dombrowski et al., 2004).

Cognitive Processing

Several researchers in the area of learning disabilities have suggested that the methods used to identify LD should be more closely aligned with the definition, i.e. should assess cognitive processes (Mather & Gregg, 2006, Kavale, Kaufman, et al., 2005). However, the concept of processing deficits originated with Kirk's foundational work in LD regarding intraindividual differences and, yet, the concept is no clearer now than it was at the time of its formulation. Before clinicians and educators can determine whether a process deficit is responsible for a student's learning disability, they must have a clear definition of what a process is. According to the Oxford English Dictionary a process is a series of actions or steps towards achieving a particular end, but what the actions and the end consist of is open to interpretation. A brief history of the various hypothetical concepts that have been posited and reified for centuries may help to clarify the lack of clarity inherent in process theories.

Processes have been postulated since at least the sixth century B.C. by Greek philosophers and since that time have had numerous labels and functions bestowed upon them (Mann, 1979). Process theories have experienced shifting tides of favor and disfavor, with the so-called charlatans of psychology, phrenologists, being the earliest modern psychologists to espouse process training beginning in the early nineteenth century. Later in the nineteenth

century and into the beginning of the twentieth century, educators adopted processes, or faculties, with an emphasis on the senses and perception. For example, some of the processes deemed of most importance by theorists were the senses (e.g., smell, taste, touch, etc.), memory, imagination, judgment, and reason, with instruction targeting each of these areas and assumed to strengthen the mind through exercise, resulting in a positive effect on academics and life outcomes.

Interest in the faculties eventually declined in psychology and general education because training the senses without a connection to real world experience was deemed to be of little value. Despite the dip in popularity, process diagnosis and training continued to be used in special education rather than directly targeting academic problems. Despite the ill-defined nature of processes and the lack of support for their use, processes and process training was embraced in special education as a means of revitalizing a model of remedial education that had so far delivered lackluster results (Mann, 1979).

More recent efforts at process assessment have focused specifically on identifying children with learning disabilities. Naglieri has proposed the application of the Planning Attention Simultaneous Successive (PASS) model of intelligence to the diagnosis of LD because the assessed simultaneous, successive, and planning processes have been shown to be related to achievement and are assumed to provide more insight into underlying cognitive processes, thus allowing for targeted strategy training (Naglieri, 1989). In response to Siegel's (1989) claim that pseudoword decoding scores are more accurate diagnostic tools than intelligence tests, Naglieri and Reardon (1993) examined the relationship between PASS components and specific measures of reading ability. They found that pseudoword scores were significantly predicted by successive processing scores and that word recognition scores were significantly predicted by

successive scores as well as a combination of successive and planning scores. Further investigation showed that a group of children with reading disabilities earned a lower mean score than a control group on the successive scale of the Cognitive Assessment System (CAS; Naglieri & Das, 1997), which requires repeating words and sentences in a certain order (Naglieri, Salter, & Edwards, 2004). In effect, Naglieri and colleagues are attempting to measure the cognitive processes underlying reading disabilities so that individuals can be identified based upon their cognitive profile and interventions can be developed to remediate the cognitive deficit thought to result in the disability.

Critics of processing assessment have pointed out that research does not support the validity, reliability, or utility of positing and assessing processes for identification or treatment (Vaughn & Linan-Thompson, 2003; Reschly & Wilson, 1990). While supporters assert the necessity of cognitive processing measures, citing the federal definition, federal LD classification criteria have never required cognitive processing assessment. In terms of identification, profiles do not provide a sound basis for diagnosing learning disabilities because such score differences commonly occur in average populations. Further, process training lacks treatment validity (Reschly & Wilson, 1990) whereas specific instruction in academic skills has received support (Vellutino, Scanlon, Small, & Fanuele, 2006; Swanson, 1999). In acknowledgment of arguments that studies have shown cognitive processes to be correlates of achievement (see Mather & Gregg, 2006), it remains to be seen why clinicians should assess a correlate of achievement for LD diagnosis when achievement can be reliably, validly, and directly measured.

Long ago, Mann (1979) summed up the seductiveness and dangers of processing models when he wrote, “Modern authors seem also to be incapable of abandoning the idea that they can

train the mind and its parts. I must admit, myself, to being prejudiced in this direction. The problem is, as far as I am concerned, that when I am training the mind and its parts, I am not sure of exactly what I am training. And I am always in danger of believing what I do (p. 540)."

Response to Intervention

Response to intervention (RTI) has been touted by several researchers and new regulations as an alternative approach that can overcome these diagnostic shortfalls. Proponents support RTI because it allows for early intervention, does not use IQ as a determinant, and it has the ability to discriminate between poor instruction and individual learning (Fuchs, Fuchs, & Speece, 2002).

RTI basically consists of three steps. First, classwide assessment is conducted using locally-developed curriculum-based measurement to determine the average reading level and growth for the class as a whole. If most students are achieving at a pre-specified level then poor instruction can be ruled out as the cause for individual students' low achievement. Next, students are identified as unresponsive to general instruction based on a comparison of their performance and rate of improvement to those of their normally-achieving peers. Finally, the identified students receive continued assessments with adaptations and referral for special education services if they do not achieve a certain level or amount of growth (Vaughn & Fuchs, 2003).

While this model certainly has the benefit of providing early intervention, there are several problems with the methodology, beyond the obvious amount of time and effort required. The first of these issues is the lack of a common definition for instruction. Some researchers conduct studies based on general education (e.g., Fuchs, Fuchs, & Speece, 2002), while some employ intensive intervention (e.g. Vellutino et al., 1996). The resources required for

implementing these different interventions may determine which are used and may lead to unreliability in who is identified. It is possible that some students will respond to changes in the regular classroom while others may not. Also, the use of more intensive forms of education may allow struggling students to make progress while being served, but upon return to the regular classroom one third of students' gains have been shown to deteriorate (Vaughn, Linan-Thompson, & Hickman, 2003). Thus, students are assumed to not have a learning disability and are returned to the general education classroom where they cannot make progress, leading to another "wait to fail" situation.

In addition to different types of instruction, there are various methods for distinguishing responders from non-responders because responsiveness can be assessed at various times and frequencies and compared to several standards. For instance, responsiveness can be measured by the child's final status, their growth throughout intervention, or a combination of the two, i.e. dual discrepancy. Determining whether a child has responded may be based on comparison to the full distribution of student performance, only other tutored students, or a benchmark associated with a desired outcome. Once method and comparison groups have been chosen, a required outcome level for determining which children have responded must also be decided upon. The use of each of these different methods results in different prevalence rates and different children being identified (Fuchs, Fuchs, & Compton, 2004; Fuchs, 2003). Furthermore, the entire model often rests on the collection of local norms and comparisons to those norms, thus making the diagnosis ungeneralizable across municipalities. An analogous situation would be to adjust the ADHD diagnostic criteria based on local factors.

Some evidence suggests that the group of children identified as LD is the one with greatest cognitive risk, that is, the children with the lowest academic achievement and

intelligence test scores at the outset of schooling. In a three year longitudinal mixed methods investigation of first and second grade children, the group with the lowest reading, intelligence, and phonological processing test scores at the outset of the study were the ones that continued to lag behind their classroom peers, making them the most likely to need involvement in special education (Case, Speece, & Molloy, 2003). This failure to respond to intervention group had mean intelligence test scores, word attack, and letter-word identification scores in the low to mid 80s (using a standard score scale where mean = 100 and standard deviation = 15) for the duration of the study. These results suggest that a group of children with very low, but clearly outside the mental retardation range, academic achievement and other cognitive test scores may need more intensive academic interventions earlier in development, such as those that may be offered in a special education or like environment. It may be more beneficial and humane to identify this group of children with persistent reading problems earlier using standardized academic achievement test results.

In addition to possessing a "wait to fail" component, there is concern that RTI will transform LD into a general learning problem, potentially including all children with below average achievement, thus making the LD category untenable (Kavale, Kaufman, Naglieri, & Hale, 2005). Even in the best case scenario RTI will cause the LD field to remain stagnant because its implementation has not been carefully controlled. Consider, for example, that students whose response is slower than expected will be considered learning disabled (Vaughn, Linan-Thompson, & Hickman, 2003). The expected response is based on other students' level and growth, boiling down to another version of a discrepancy formula with all of the problems of its predecessor. Given all of these issues and the lack of available research addressing promising practices (Burns & Senesac, 2005), it is readily apparent that more research is necessary before

employing RTI as a diagnostic method. Considering the trend in educational intervention research toward fewer and briefer intervention studies, with fewer still focused on children (Hseih, P., et al., 2005), it is not certain that the much-needed research database will be established in the near future.

Low Achievement

Over a decade and a half ago the eminent measurement scientist Lori Shepard concluded that the most effective assessment strategy for learning disabilities is to start with the evidence of inadequate learning and then test for other explanations of the problem (Shepard, 1989, p. 559). Well-respected researchers such as Linda Siegel and Keith Stanovich similarly argued for many years that children should be identified as having learning disabilities based on their achievement scores. Numerous investigations began to use Shepard's and others' simple model of below average reading scores to "diagnose" children in need of reading intervention (Swanson, 1999; Vellutino, Scanlon, Sipay, Small, Pratt, & Chen, 1996). One study conducted in Europe demonstrated that children could be accurately identified as having reading disabilities using word recognition and reading comprehension achievement tests (Rispens, van Yperen, and van Duijn, 1991). Such a low achievement or "academic impairment" approach to LD diagnosis holds great promise and warrants further analysis.

Low achievement methods for identifying students as learning disabled typically require that students score below a certain cut point (e.g., 25^{th} percentile) on an academic achievement measure and have cognitive scores somewhere above the mental retardation range (i.e., IQ > 70). The actual cut scores are arbitrarily chosen by independent researchers or are based on social policy issues, such as resource allocation. Several researchers support this type of method for LD diagnosis because it is parsimonious and reliable across locations. More salient, though, are

findings that groups identified using low achievement and IQ-discrepant definitions do not significantly differ on cognitive characteristics, response to intervention, and other outcomes (Shaywitz et al., 1992; Steubing et al., 2002; Stanovich, 1991).

Opponents of low achievement test score use argue that the use of a cut-point for determining LD lacks research support for the decision that children achieving at certain levels should be included or excluded from eligibility for the diagnosis (Stuebing, Fletcher, LeDoux, Lyon, Shaywitz, & Shaywitz, 2002). A major reason for the arbitrary nature of cut-points used for LD diagnosis is that achievement is normally-distributed. Because there is no natural breaking point in the achievement distribution, setting a cut-point to distinguish between underachievers and individuals with LD is not a straightforward matter (Francis et al., 2005). Thus, LD is distributed along an unobservable dimension and it seems unlikely that a single test score can accurately determine how much of a latent construct, learning disability, an individual actually possesses (Fletcher et al., 2005).

Francis and colleagues (2005) have raised concerns about the use of a low achievement definition for diagnosing LD beyond the argument that cut-points are not inherently related to the construct. They argue that cut-points are not meaningful due to error in measurement and used both real and simulated data to demonstrate that groups formed by cut-points are unstable over time. In this study, LD was defined as scores below the 25^{th} percentile and 32% of children classified as disabled using this criterion at time 1 were classified as non-disabled at time 2.

It is similarly asserted that a low achievement definition of LD is questionable because it depends on a single-indicator, i.e. an achievement score. This argument holds that a single test score cannot "capture perfectly a student's ability on an imperfectly measured latent variable" (Fletcher et al., 2005, pp. 510). This is partly due to measurement error because a score will

fluctuate around a cut point on repeated testing. It is also because LD is a latent construct that must be inferred based on observable data, with more information available for making an inference allowing the inference to be more valid (Fletcher, Denton, et al., 2005). Furthermore, it is believed that academic achievement is influenced by several factors that may be cognitive, behavioral, and social (Francis et al., 2005), and a single test of academic achievement cannot assess all of these factors.

Despite these problems, there is evidence for the validity of low achievement markers for identifying students as having a learning disability. As noted previously, studies have shown that IQ-discrepant and low achieving poor readers do not differ from one another on many outcomes of interest. This finding suggests that the "unexpected" underachievement thought to be captured by the discrepancy approach is not actually a useful concept since students identified with significant learning difficulties based on a low achievement model respond similarly to treatment and evidence difficulties with learning similar to those of children who are considered to demonstrate "unexpected" learning delays. Therefore, there is no need to reject a low achievement model of identification because it does not capture the "unexpected" aspect of learning disabilities, the concept of which has been argued against elsewhere (see Stanovich, 1999). In addition, the low achievement method does not discriminate against individuals whose ability level is below the mean and are therefore less likely to be identified by other approaches. A low achievement definition of learning disabilities, in fact, does not require any comparison within individuals, but simply bases decision-making on comparison to a national norm and evidence of functional impairment.

Other research has demonstrated that groups formed based on the mental retardation exclusion and achievement scores below the 25th percentile result in subgroups of underachievers

that can be validly differentiated from typical achievers based on neurological markers and other external variables (Fletcher, Francis, Morris, & Lyon, 2005; Lyon, Fletcher, & Barnes, 2003). For instance, studies by Vellutino and colleagues (2000; 1996) have demonstrated that level of reading achievement predicts response to intervention, with those children who are lowest-achieving being the slowest responders. It logically follows that students who have received adequate instruction yet remain well below average academically are the students with the greatest learning difficulties and thus the most in need of special services. These students would be quickly and reliably identified through the implementation of low achievement criteria.

A recent review of various diagnostic methods also concluded that the low achievement model is more reliable and valid than aptitude-achievement and intra-individual difference models. The authors suggested that through a combination of RTI to rule-out poor instruction or curricular causes and low achievement criteria, a reliable and unique group of underachievers could be identified (Fletcher, Francis, Morris, & Lyon, 2005; Fletcher, Denton, & Francis, 2005).

Another issue in the use of a low achievement definition of LD retaining the exclusionary clause is whether the cut-point for IQ should simply be the level at which MR is identified or if it should be some higher value. Rispens, van Yperen, and van Duijn (1991) found that the IQ cut-point chosen for inclusion in the category made a greater difference in prevalence than not using IQ in identifying students as learning disabled. For example, with a lower limit of a standard score equal to 85, 3.8% of students were diagnosed as learning disabled versus 5% for a lower limit of 80 and 6.5-7.0% for a lower limit of 70. Stanovich (1999) argues that intelligence should play no role in the diagnosis of LD, but it seems rational to assume that students classified as MR suffer from general inability to learn, not a *specific* learning disability

and based upon the study cited above, the numbers of students identified using an IQ lower-limit of 70 would not be burdensome.

An Academic Impairment Model: Low Achievement and Functional Impairment

We propose an academic impairment definition of LD that retains the exclusion of learning difficulties due to lack of educational opportunity or another disability. This type of approach has been advocated by Dombrowski et al. (2004), Siegel (1999), and Stanovich (1999). Each of these authors has suggested different arbitrary cut-points, which, as mentioned above, is the main argument against this method. Despite this criticism, an academic impairment approach to diagnosis has been demonstrated to work, although it requires further study to determine the optimal cut point for clinical use.

Stanovich (1999) agreed that there is no "magic" point where one does or does not have a disability since most disorders, including LD, appear to be normally-distributed. He suggested that a cut-point reflecting social policy issues, such as the allocation of scarce resources, could prove useful. Vellutino and colleagues' (2000) work revealed that standard scores below 80 to 85 were associated with the lowest rates of reading growth for students receiving intensive intervention. This work and others (Case, Speece, & Molloy, 2003), as shown in Figure 2.1, indicates that a cutoff score at approximately the 15^{th} percentile can be expected to reliably and validly identify students with LD.

The use of the cut-point does not necessarily mean that students scoring near but above that point should not receive services. Instead it may be more reasonable for schools to provide accommodations on a continuum, so that students do not have to be identified as having a learning disability to receive assistance. Regardless, the fact that LD exists on a continuum should not prevent the field from providing a means for educators and clinicians to identify

which students should receive the diagnosis, just as has always been the case for mental retardation (MR) and other diagnoses.

Functional Impairment

Several areas should be considered before determining "caseness," or whether an individual has a particular disorder (Bird, 1999). These considerations include criteria for classification, such as Diagnostic and Statistical Manual of Mental Disorders Fourth Edition (DSM-IV; APA 2000) or IDEA requirements, distress associated with the condition, and the presence of impairment assessed independently of the core symptoms. The last requirement, functional impairment, has been defined as specific deficits in multiple domains of functioning developing subsequent to a disorder and includes the concept of adaptive functioning, or adjustment to life's demands across multiple domains (Winters, Collett, & Myers, 2005).

On the surface functional impairment may appear analogous to severity; however, they are two distinct concepts. Severity indicates the extent to which the disorder is manifested or the seriousness of the disorder itself. Thus, severity can be measured by considering the quality and quantity of the symptoms, making it a characteristic of the disorder. Functional impairment, on the other hand, is a more global construct and a characteristic of the individual (Bird, 1999). It is much broader and can be conceptualized as poor outcomes that may have been avoided if the individual did not suffer from a particular disorder. In the case of LD, functional impairment may be hypothesized to include internalizing or externalizing behavior problems as well as deficits in adaptive behavior.

Traditionally, LD diagnosis has not incorporated functional impairment, yet the field of psychiatry has placed increasing importance on its presence in determining psychopathology and on cut points for the number of symptoms to make a diagnosis. The growing interest in

functional impairment has been a result of the emphasis given in the DSM, healthcare providers' and parents' focus on improvement in functioning as a treatment outcome, and outcome research demonstrating that the resolution of symptoms does not always correlate with psychosocial improvement (Winters, Collett, & Myers, 2005). The DSM's inclusion of distress or impairment and the Global Assessment of Functioning is probably the most salient evidence of this trend distinguishing between symptom severity and level of functioning. The assessment of impairment is a better fit with clinicians' inclination to evaluate and make treatment decisions in a dimensional, rather than categorical, manner (Bird, 1999).

The Children's Global Assessment Scale (CGAS; Shaffer et al., 1983) provides an example of how functional impairment can be determined. It is a "single unidimensional global measure" of severity of a disorder as well as social functioning (Shaffer et al., 1983). It is completed in the context of a broader evaluation of a child, taking clinical information, history, symptoms, behavior, and social relations into account allowing all of these inputs to be synthesized into a single meaningful index. Ratings on the CGAS range from 1 to 100 with lower numbers representing poorer functioning and a description corresponding to each decile (Bird, 1999; see Figure 2.2).

The use of the CGAS as a measure of functional impairment has been shown to improve the ability to determine whether a child has responded to treatment. Shaffer et al. (1983) used both the CGAS and the Conners' 10-item abbreviated Parent Checklist to assign children diagnosed with Attention Deficit/Hyperactivity Disorder to either an improved or unimproved group. The Conners' criteria simply consists of how many symptoms a child exhibits, while the CGAS is a global description based on how the symptoms are impacting the child's ability to interact in his or her environment. In this instance, Shaffer et al. (1983) found that the Conners'

identified many more children as improved than were identified using the CGAS. This illustrates that while the core symptoms of the disorder may have decreased in the number being exhibited, the effect on the child's daily functioning may still be problematic and necessitate further treatment. It is reasonable to assume that a global indicator of functioning will result in more accurate identification at initial evaluation as well as at reevaluation.

Another example of functional impairment requirements for diagnosis is the DSM-IV and AAMR criteria for mental retardation. The *Diagnostic and Statistical Manual of Mental Disorders* (American Psychiatric Association, 2000; Dombrowski et al., 2004) requires subaverage intellectual functioning as illustrated by an IQ of 70 or below with concurrent deficits in adaptive functioning in 2 out of 11 areas, with an onset prior to 18 years of age. The current AAMR definition states that "mental retardation is a disability characterized by significant limitations both in intellectual functioning and in adaptive behavior as expressed in conceptual, social, and practical adaptive skills. This disability originates before age 18" (AAMR Ad Hoc Committee on Terminology and Classification, 2002, p. 1). Shepard's perspective regarding LD diagnosis with an emphasis on functional impairment is similarly parsimonious and useful.

The incorporation of functional impairment in diagnostic decisions shows promise in allowing educators and clinicians to conserve limited resources while still identifying the students who are most in need of services. Many of the children who currently meet diagnostic criteria are not severely impaired and services are not deemed to be necessary (Bird, 1999). A related phenomenon in LD diagnosis is the growth in "relative" compared to "absolute" poor achievers allowing high-functioning students with achievement discrepancies to receive already scarce services (Gordon, Lewandowski, & Keiser, 1999). The Americans with Disabilities Act has already addressed this problem with their "average person" standard, i.e. individuals are only

disabled if their functional impairment limits them relative to most people. Stanovich (1999) assailed the irrationality of the LD diagnosis for individuals with average achievement and high IQ scores as a peculiar practice that make LD the only disorder where "average" persons can have a disability.

By including functional impairment with low achievement test performance in the diagnostic criteria for LD, we would be ensuring that the average person standard is met. According to Bird (1999), inclusion of impairment in such decisions results in two to three times fewer cases being identified compared to meeting the diagnostic criteria alone. Of course, what the level of functional impairment an individual experiences may differ according to the disorder in question.

In the field of learning disabilities, the purpose of diagnosis is to identify children who are struggling in the educational setting. Bird (1999) has identified three domains of functioning for individuals with mental health disorders. The first domain, interpersonal relations, includes how a child relates to peers, family members, and other adults in their environment. The second domain, performance in school, refers to the ability of a child to perform comfortably and without undue anxiety at an expected level based on the child's potential. The third and final domain, self-care and fulfillment, is an individual's ability to enjoy life and use leisure time through different recreational activities, interests, or hobbies. However, because LD is by definition an inability to learn and assessment and treatment for the disorder are mainly addressed in the school, we propose that mental health be substituted for "performance in school" as one of the three areas of functional impairment. The importance of functioning in school constitutes the core "symptom" of the disorder as highlighted by IDEA's emphasis on significant interference with *educational* performance.

Defining Functional Impairment for Learning Disabilities

Fortunately, the major latent constructs underlying child mental health problems have been well articulated by Quay, Peterson, Achenbach, Edelbrock and others and now codified as the internalizing and externalizing dimensions of child psychopathology. When using a broader item pool and an assessment of academic problems in school a third factor emerges in studies using the Teacher Rating Scale of the BASC-2 (Reynolds & Kamphaus, 2004). This factor is characterized by attention problems, long known to be a behavior problem that impairs school functioning. Thus is possible that attention, internalizing, and externalizing problems may be used to assess functional impairment of behavior and emotion that may be associated with a case of LD.

McKinney (1989) found seven subtypes of children with LD using cluster analysis. These groups included attention deficit, conduct problems, withdrawn and dependent, lack of positive behavior, global behavior problems, and two groups of normal behavior. Further, McKinney (1989) followed these students for three years and discovered that LD children with attention and conduct problems had poorer academic outcomes than those in other groups. Based on this research, it may be hypothesized that functional impairment associated with LD may consist of a certain constellation of behavior problems such as overactivity, conduct problems, and lack of social interaction.

In this context, however, we do not use the terms “mental health” or “psychopathology” because we do not think that impairment in behavior or emotion in cases of LD may be impairing and yet not severe enough to warrant a psychiatric classification. This point of view is analogous to considering intelligence test standard scores in the 70s and 80s but yet not meeting the criteria for an MR diagnosis. According to a review of studies investigating the social-

emotional functioning of students with LD (Rourke & Fuerst, 1991), there do appear to be distinct types of social-emotional and behavior disturbances found more frequently in students with LD than among their average peers. Despite these disturbances, children with LD do achieve "adequate" psychosocial adaptation (Rourke & Fuerst, 1991, p. 85). Thus, we would expect that students with LD would demonstrate more mild adaptive and behavioral difficulties than students classified as having a behavior disorder as is illustrated by the data presented in Table 2.1.

In a large scale study of children classified as possessing LD, with the known caveat of the current problems associated with the diagnosis, Reynolds and Kamphaus (2004) found LD cases to have externalizing (mean T = 54 for ages 6-11 and 56 for 12-18), internalizing (mean T = 54 for ages 6-11 and 57 for 12-18), and attention problems (mean T = 58 for ages 6-11 and 57 for 12-18) of between one-half and one standard deviation from the normative mean, in the deviant direction, on teacher rating scales. The means for the BASC-2 parent rating scales were virtually identical. These results indicate that T scores that are at about a half standard deviation or higher on clinical scales could be used as evidence of behavioral or emotional functional impairment that could be associated with possessing an LD.

While the above conceptualization of learning disabilities may prove fruitful it is also likely that not all students with learning disabilities demonstrate social and emotional disturbances. Thus, it would be unfair to limit the learning disabilities diagnosis to individuals who have social-emotional symptoms, yet it is still the case that an individual must have some functional impairment in order to be considered to have a disorder. Furthermore, functional impairment is required for diagnosis across disorders and the definition of functional impairment should not be greatly changed to accommodate certain disorders. In other words, if functional

impairment consists of social-emotional impairment for LD diagnosis, it should consists of social-emotional impairment for ADHD, depression, anxiety, and other DSM disorders. This conception of functional impairment is unacceptable, though, since social-emotional difficulties are explicit symptom requirements for depression and other disorders, preventing functional impairment so defined from being measured independently of symptomatology.

More recent research applying the concept of functional impairment to the diagnosis of ADHD has helped to clarify this dilemma. In an attempt to determine what is meant by DSM's impairment requirement, Lewandowski, Lovett, Gordon, and Antshel (2006) referenced various instruments used to measure impairment. The review of seven measures suggested that functional impairment is actually roughly equivalent to adaptive functioning, including areas such as academic and social functioning. For example, the Impairment Rating Scale (Fabiano et al., 2006), which correlated with other impairment ratings, consists of the following six domains: relationships with peers, relationships with teachers, academic progress, self-esteem, influence on classroom functioning, and overall impairment. Based on the accepted definition of functional impairment as adaptive functioning in the field of ADHD where most impairment research has been conducted, it follows that impairment for other disorders, including LD, can reasonably be considered synonymous with adaptive skills.

A functional impairment approach to classification of children with learning disabilities will prevent the LD category from becoming a meaningless repository for all struggling students. To do so, it must effectively eliminate the continuance of placement decisions and only identify those students who are truly struggling in an academic subject, which raises issues concerning students who previously would have been considered in need of services. The two most

contentious groups to no longer be considered learning disabled are likely to be slow learners and gifted students.

Differentiation of LD from "slow learner"

In order to avoid confounding the LD construct, students who are "slow learners" must not be identified as having a learning disability. Kaznowski (2004) defined slow learners as students with IQs ranging from 70 to 85 and achievement scores in the same range, which thus does not represent a severe discrepancy between predicted and actual achievement. The National Association of School Psychologists (Carroll, 1998) describes slow learners as "students with below average cognitive abilities who are not disabled, but who struggle to cope with the traditional academic demands of the regular classroom" (p. 205) and estimate that they comprise at least 15% of school populations.

According to Forness (1985) slow learners are stuck in a special education "no man's land" (p. 39) due to a lack of consistent terminology, competing definitions, and differing prevalence rates. In one study conducted to determine the effectiveness of special education services for slow learners by comparing achievement of those receiving services as learning disabled and those who were not, it was discovered that few differences existed between the groups (Kaznowski, 2004). In fact, the group of slow learners receiving special education were actually passing their academic classes and failing standardized achievement tests. The group not receiving services performed better on the Iowa Test of Basic Skills (ITBS) suggesting that the slow learners labeled learning disabled were receiving a watered-down curriculum and lower expectations (Kaznowski, 2004). These findings may indicate that neither special education nor regular education are adequately meeting the needs of slow learners and special education may actually be detrimental for these students' achievement. This is consistent with Kavale's (2005)

position that the concept of LD should not be threatened by the designation of slow learners as learning disabled despite the desire to see all students succeed academically.

While it is important that schools meet the needs of slow learners, as mentioned above, serving such students through classification as having a learning disability threatens the construct of LD and likely would not meet their needs (Kaznowski, 2004). It is the authors' opinion that schools should develop programs independent of LD services to provide assistance for these slow learners. The discussion of such programs is beyond the scope of this review.

Differentiation of LD from Learning Differences

Lewis Terman (1931), often considered the father of gifted education and research, stated that "superiority of one kind does not *necessarily* imply superiority in everything" (p. 568). Yet, it is not uncommon for gifted students who achieve only in the average range in one academic area to be identified as learning disabled. Reluctance to part with the notion of gifted LD stems in part from the idea of an "unexpected" academic failure, yet research has shown that in reading an idea of some type of unexplained reading failure being different from reading failure with an explanation is simply "folk psychology" (Stanovich, 1999). As Stanovich (1999) pointed out, reading difficulties in a gifted individual would be expected if the person has deficits in phonological awareness.

The conceptualization of gifted LD is also based on the idea that measures of cognitive functioning actually tell us how much potential an individual possesses, which is also a holdout from the aptitude-achievement discrepancy model. If we have conceded that the discrepancy model is not a valid indicator of LD for average and below-average achievers, then we must also surrender the rationale of discrepancy as applied to gifted children. Even if one accepts the discrepancy model, Kavale (2005) points out that discrepancy indicates the *possibility* of a

disability, but only significantly below average achievement should be considered a learning disability.

Instead of referring to gifted students who do not perform as well as expected but have average or above-average achievement in one or more academic areas as having a learning disability, we propose that they be considered to have a "learning difference." This new terminology acknowledges that a gifted student displays a difference between achievement in various areas but does not imply that they suffer from an actual disability, thus reserving LD for students who display significantly below average achievement despite average or better cognitive functioning.

Conclusion and Research Agenda

It is obvious that the confusion and variation surrounding LD diagnosis, both now and throughout history, have done a great disservice to children in need of remediation and to research aiming to serve these students. The IDEIA regulations further threaten the LD construct and make resolution of identification debates both timely and crucial. It is obvious that progress toward this goal involves abandoning the entrenched practice of employing familiar discrepancy methods, but we must first have a tried and true alternative to replace former practice. That is why we propose a new approach for identifying students with LD based on low achievement test scores determined by levels of functional impairment, or an academic impairment model.

The use of low achievement scores will preclude comparison of children to local norm groups and to their own performance in other domains in addition to preventing students who are do not have significantly below average achievement from being mislabeled as having a learning disability. This method will also provide a reliable identification procedure that is uniform

across locations and serves the purposes of classification. Instead of a simple cut point, a confidence band around the selected score would help to increase this utility.

The cut point would also not be based on some arbitrary number or only consider one indicator. The inclusion of functional impairment in the diagnostic procedure would identify students for whom actual distress is associated with their LD and consider more than just their achievement level, making it a more meaningful criterion. Through methods such as latent class analysis, the achievement score associated with substantial functional impairment could be identified. Thus, the cut score used would represent both poor academic achievement and problems functioning in the school environment. This will help to guarantee that special services are available to those students who are most in need.

More specifically we plan to identify the level of low achievement most associated with functional impairment using latent class analysis in a similar manner to that used by Hudziak and colleagues (1999) to demonstrate the continuous nature of ADHD represented by several classes of severity. The goal of latent class analysis is to classify cases into groups where members within a group are similar to each other and different from members of other groups (Vermunt & Magidson, 2002). Latent class methods identify cases using a model-based method, meaning an underlying statistical model is assumed to underlie the population. This model is used to identify groups of individuals similar with respect to a categorical latent variable (Muthén & Muthén, 2000, 2004). The objective is to identify classes that differ with respect to their mean values for selected variables.

In our study, we will use both academic indicators and adaptive functioning indicators as variables in the latent class model to determine the low achievement score associated with significant levels of functional impairment. Academic indicators to be used include Iowa Test of

Basic Skills (ITBS) reading scores and ITBS math scores. Functional impairment indicators will include the Behavior Assessment System for Children Teacher Report Scale (BASC-TRS; Reynolds and Kamphaus, 1992) Adaptive Skills composite scales, i.e. Adaptability, Leadership, Social Skills, Study Skills. Once the classes have been obtained and the class representing students with possible learning disabilities has been identified, other variables such as gender, special education placement, and pre-referral intervention history can be used to determine if the class is accurately identified.

While the learning disability diagnostic criteria would benefit from the above revision, it is still necessary to retain the exclusionary clause, i.e. a student's disability may not be the result of visual, hearing, or motor disabilities, of mental retardation, of emotional disturbance, or of environmental, cultural, or economic disadvantage. Without these exclusions, students whose academic difficulties are the result of other causes may receive the LD label, reducing available resources for those whose learning difficulties are caused by a learning disability and making the category meaningless.

In supporting the use of a low achievement test score based on functional impairment for the diagnosis of LD, we are not condemning the use of response-to-intervention. While RTI does not provide a reliable means of diagnosis, it seems optimal to use some form of RTI as a means of guaranteeing quality pre-referral intervention. It would provide help for students without requiring the LD label, resulting in reduced need for educators to rely on a placement diagnosis rather than a construct diagnosis so students can receive services. In this situation, only those students who fail to respond to intervention would require evaluation for special education programs. This is in line with research showing that the use of pre-referral intervention services results in fewer children being tested for placement, and of the children

who are tested using the pre-referral model, more are actually in need of services (Gutkin, Henning-Stout, & Piersel, 1988).

In addition to providing an efficient means of pre-referral intervention, RTI would also allow educators and clinicians to rule out ineffective instruction or lack of opportunity to learn as explanations for low achievement when performance of a group of students is in question. After a student is identified as having a learning disability, the curriculum based measurement component of RTI may be used for teachers and special educators to monitor treatment progress (Dombrowski, Kamphaus, & Reynolds, 2004). Hence, while RTI is not useful as a defining feature of LD because it lacks norm-referenced scores that allow for professional communication, it is ideal for pre-referral intervention, hypothesis-testing, and treatment monitoring.

In conclusion, in creating a diagnostic definition of LD, it is important to ensure that it serves the purposes of classification and represents a meaningful construct (Shepard, 1989). That is why we propose the use of low achievement test scores; an approach that can be reliably applied across locations, providing both a common language for description and a more consistent diagnostic picture (Blashfield, 1998). The incorporation of functional impairment, which Bird (1999) describes as poor outcomes associated with a disorder, will increase the likelihood that identified students actually suffer from "LD-ness." Our emphasis on the documentation of sub-average academic achievement is hardly new, as the eminent measurement scientist Shepard concluded in her widely cited 1989 chapter, "If LD is an inexplicable inability to learn, an effective assessment strategy is to start with the evidence of inadequate learning and test for other explanations for the problem (p. 559)."

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Table 2.1 *Mean BASC T scores for children identified as LD and BD.*

	Learning Disability				Behavior Disorder			
	Parent Rating Scale		Teacher Rating Scale		Parent Rating Scale		Teacher Rating Scale	
	Child	Adolescent	Child	Adolescent	Child	Adolescent	Child	Adolescent
Scale								
Hyperactivity	56.4	58.4	55.7	54.9	62.2	64.0	61.1	60.3
Aggression	54.3	56.9	55.0	54.2	63.9	62.0	63.5	63.3
Conduct Problems	52.2	56.3	52.7	53.2	67.6	74.6	62.9	65.8
Anxiety	51.1	53.2	54.1	55.0	48.4	52.9	56.5	55.3
Depression	54.4	55.6	54.5	51.6	61.6	58.3	62.2	55.8
Somatization	49.7	49.9	51.1	52.6	49.6	49.6	52.4	55.9
Attention Problems	57.9	62.7	57.0	57.0	61.2	63.0	59.4	60.6
Learning Problems	--	--	60.2	61.5	--	--	57.4	59.9
Atypicality	54.0	54.0	52.9	51.7	58.4	58.3	58.6	57.4
Withdrawal	51.3	54.7	55.6	52.4	51.8	55.2	60.4	56.9
Adaptability	46.2	--	44.1	--	37.3	--	38.4	--
Social Skills	46.6	45.7	48.5	46.1	41.2	38.8	44.6	41.8
Leadership	45.3	44.7	46.6	45.3	40.8	39.2	42.1	41.9
Study Skills	--	--	43.9	43.5	--	--	40.7	38.9
Composite								
Externalizing Problems	55.0	58.5	54.9	54.6	67.0	69.9	63.7	64.7
Internalizing Problems	52.3	53.4	53.9	53.7	54.2	54.3	58.5	56.8
School Problems	--	--	59.0	59.9	--	--	58.8	60.9
Adaptive Skills	45.4	44.7	45.2	44.6	38.2	38.1	40.3	40.1
Behavioral Symptoms Index	56.8	59.3	56.1	55.1	63.3	63.3	62.7	61.0

Study	Achievement Measure	Responsiveness Description and Standard Score			
Vellutino, Scanlon, & Lyon (2000)		Very Low	Low	Good	Very Good
Grade 1	Word Attack	74.58	77.5	76.89	80.05
	Word Identification	80.89	86.22	93.17	93.74
Vellutino, Scanlon, Small, & Fanuele (2006)		Difficult to Remediate	Less Difficult to Remediate	No Longer at Risk	
Grade 1	Word Attack	93.32	102.23	102.15	
	Word Identification	94.63	105.73	109.24	
Grade 2	Word Attack	84.68	101.54	102.26	
	Word Identification	83.94	102.73	107.47	
Berninger, et al (2002)		Slower	Faster		
Grade 1	Word Attack	80.8	86.3		
	Word Identification	75.9	85.8		

Figure 2.1 *Mean standard scores of students identified as at-risk and grouped by responsiveness to intervention.*

CHILDREN'S GLOBAL ASSESSMENT SCALE
For children 4-16 years of age

David Shaffer, MD, Madelyn S. Gould, PhD,
Hector Bird, MD, Prudence Fisher, MA

Adaptation of the Adult Global Assessment Scale
(Robert L. Spitzer, MD, Miriam Gibbon, MSW, Jean Endicott, PhD)

Rate the subject's most impaired level of general functioning for the specified time period by selecting the *lowest* level which describes his/her functioning on a hypothetical continuum of health-illness. Use intermediary levels (e.g., 35, 58, 62).

Rate actual functioning regardless of treatment or prognosis. The examples of behavior provided are only illustrative and are not required for a particular rating.

Specified time period: 1 month

100-91	**Superior functioning** in all areas (at home, at school, and with peers), involved in a range of activities and has many interests (e.g., has hobbies or participates in extracurricular activities or belongs to an organized group such as Scouts, etc.). Likeable, confident, "everyday" worries never get out of hand. Doing well in school. No symptoms.
90-81	**Good functioning in all areas.** Secure in family, school, and with peers. There may be transient difficulties and "everyday worries that occasionally get out of hand (e.g., mild anxiety associated with an imporatn exam, occasional "blow-ups" with siblings, parents, or peers).
80-71	**No more than slight impairment in functioning** at home, at school, or with peers. Some disturbance of behavior or emotional distress may be present in response to life stresses (e.g., parental separations, deaths, birth of a sibling) but these are brief and interference with functioning is transient. Such children are only minimally disturbing to others and are not considered deviant by those who know them.
70-61	**Some difficulty in a single area, but generally functioning pretty well** (e.g., sporadic or isolated antisocial acts, such as occasionally playing hooky or petty theft; consistent minor difficulties with schoolwork, mood changes of brief duration; fears and anxieties, which do not lead to gross avoidance behavior; self-doubts). Has some meaningful interpersonal relationships. Most people who do not know the child well would not consider him/her deviant but those who do know him/her well might express concern.
60-51	**Variable functioning with sporadic difficulties or symptoms in several but not all social areas.** Disturbance would not be apparent to those who encounter the child in a dysfunctional setting or time but not to those who see the child in other settings.
50-41	**Moderate degree of interference in functioning in most social areas or severe impairment of functioning in one area,** such as might result from, for example, suicidal preoccupations and ruminations, school refusal and other forms of anxiety, obsessive rituals, major conversion symptoms, frequent anxiety attacks, frequent episodes of aggressive or other antisocial behavior with some preservation of meaningful social relationships.
40-31	**Major impairment in functioning in several areas and unable to function in one of these areas,** that is, disturbed at home, at school with peers, or in the society at large (e.g., persistent aggression without clear instigation; markedly withdrawn and isolated behavior due to either mood or thought disturbance, suicidal attempt with clear lethal intent). Such children are likely to require special schooling and/ore hospitalization or withdrawal from school (but this is not a sufficient criterion for inclusion in this category).
30-21	**Unable to function in almost all areas,** for example, stays at home, in ward or in bed all day without taking part in social activities OR severe impairment in reality testing OR serious impairment in communication (e.g., sometimes incoherent or inappropriate).
20-11	**Needs considerable supervision** to prevent hurting others or self, for example, frequently violen, repeated suicide attempts OR to maintain personal hygiene OR gross impairment in all forms of communication, for example, sever abnormalities in verbal and gestural communication, marked social aloofness, stupor, etc.
10-1	**Needs constant supervision** (24-hour car) due to severely aggressive or self-destructive behavior or gross impairment in reality testing, communication, cognition, affect, or personal hygiene.

Figure 2.2 *Example of functional impairment as defined by The Children's Global Assessment Scale.*

CHAPTER 3

QUANTIFYING LEARNING DISABILITIES: LATENT CLASS ANALYSIS OF FUNCTIONAL IMPAIRMENT AND ACHIEVEMENT

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Abstract

There is a lack of consensus regarding best practices in LD diagnosis. Some learning disabilities (LD) researchers have proposed that an alternate method for diagnosing learning disabilities that is based on low achievement test scores may help ameliorate the diagnostic problems plaguing the LD field. The purpose of the current study was to determine what level of achievement is associated with the most functional impairment in order to avoid the unreliability associated with cut scores. The study used MPlus software to identify latent classes of achievement and adaptive functioning for students in grades 1 through 5. The groups with low achievement scores associated with the most functional impairment were considered learning disability classes and achievement score ranges for these groups were considered indicative of the presence of a learning disability. The learning disability class accounted for 30% of the sample and was characterized by below average achievement scores and associated deficits in adaptive skills. The implications for classification of children with learning disabilities are preliminary and numerous caveats apply, but implications for research point in several promising directions.

Introduction

Disagreement regarding optimal diagnostic practices in the field of learning disabilities has existed for decades. The debate has been stimulated by concerns regarding overidentification as well as misidentification of students as having LD in schools. In response to these concerns, researchers have proposed various classification techniques, each with its own strengths and weaknesses.

The argument surrounding LD diagnosis has intensified due to recent regulations allowing states and school districts to choose between the standard discrepancy model and response to intervention. The relevant literature has focused on the reliability and validity of the various proposed models, yet underlying the debate is an often unmentioned preoccupation with the classification methods' ability to capture the essence of what it is to have a learning disability. This complicates matters when the core of a learning disability is not completely agreed upon. For instance, some may feel that substantial underachievement is the defining characteristic of LD while others may believe that it is an "unexplained" failure in a certain type of academic pursuit.

Stanovich (1999) has pointed out that the concept of "unexplained" underachievement is unfounded, since students with learning disabilities have deficits, such as poor phonological awareness, that do in fact explain their academic performance. Based on this logic, academic underachievement must be the unifying distinction in learning disabilities. However, as with most constructs, achievement exists on a continuum. Therefore it is necessary to distinguish low achievement from severe underachievement that is indicative of disorder.

In the field of psychiatry, the presence of functional impairment has traditionally been a requirement for an individual to meet criteria for any type of disorder. Functional impairment has been defined as specific deficits in multiple domains of functioning developing subsequent to a disorder and includes the concept of adaptive functioning, or adjustment to life's demands across multiple domains (Winters, Collett, & Myers, 2005). In fact, the most commonly accepted measures of functional impairment assess adaptive skills such as interpersonal relations, academic progress, and participation in leisure and other activities (Fabiano et al., 2006; Lewandowski, Lovett, Gordon, & Antshel, 2006). It is important to note that functional impairment is not analogous to severity, which is the number of symptoms manifested or the seriousness of the disorder itself. Perhaps, this distinction is best illustrated by the Diagnostic and Statistical Manual's (American Psychiatric Association, 2000) inclusion of distress or impairment as well as the Global Assessment of Functioning in addition to requiring that a certain number of symptoms, i.e. severity, be present for diagnosis.

Another example of functional impairment is the DSM-IV and the AAMR criteria for mental retardation (MR) requirements of subaverage intellectual functioning (IQ below 70) with concurrent deficits in adaptive functioning (AAMR Ad Hoc Committee on Terminology and Classification, 2002, p.1; American Psychiatric Association, 2000). Studies of individuals with MR have demonstrated high rates of comorbid emotional and behavioral disorders (Hodapp & Dykens, 2003) indicating that the cut-score does identify individuals for whom the disorder is associated with significant impairment. It would be expected that the use of a cut score based on meaningful level of low achievement for learning disability diagnosis would also result in identification of individuals who experience functional impairment associated with their learning disability.

By assessing for "the essence of" learning disability, i.e., a level of underachievement that causes marked impairment, "absolute" poor achievers would be identified rather than "relative" poor achievers allowing educators and clinicians to conserve limited resources while still identifying the students who are most in need of services (Gordon, Lewandowski, & Keiser, 1999). In addition, LD diagnosis would meet the requirements of the Americans with Disabilities Act by complying with the "average person" standard, i.e. individuals are only disabled if their functional impairment limits them relative to most people. Thus, LD would no longer be the only disorder that questionably allows "average" persons to have a disability (Stanovich, 1999).

Person-oriented methods have shown promise in identifying groups of behavioral adjustment ((DiStefano, Kamphaus, Horne, & Windsor, 2003; Kamphaus, Huberty, DiStefano, & Petoskey, 1997; Huberty, DiStefano, & Kamphaus, 1997). Person-oriented methods include multivariate techniques such as cluster analysis (CA) and latent class analysis (LCA) that can be used to construct homogeneous groups of individuals from an underlying data set (Anderberg, 1973; Aldenderfer & Blashfield, 1984; Blashfield & Aldenderfer, 1988; Milligan & Cooper, 1987). Multivariate behavior typologies are gaining wider acceptance as a model of classification (Achenbach & Edelbrock, 1978; Hudziak, Wadsworth, Heath, & Achenbach, 1999) and research evidence suggests that typologies created through these person-oriented techniques show evidence of external replication (DiStefano, Kamphaus, Horne, & Winsor, 2003), stability (Mattison & Spitznagel, 1999), replication across samples (Kamphaus et al., 1997; DiStefano, et al., 2003, Kamphaus & DiStefano, 2001) and predictive validity (Flanagan, Bierman, & Kam, 2003; Fergusson & Horwood, 1995).

Person-oriented methods may be used to capture quantitative differences in the symptom presentation of low achieving students through dimensional scales with the goal of creating a profile of traits that underlie true learning disability. The profiles created based on academic achievement and behavioral adjustment can then be used as a categorical classification tool to identify individuals with learning disabilities. More specifically, for the group with the most functional impairment associated with low achievement, their pattern of low achievement and impairment would be hypothesized to have been caused by their membership in the learning disability group. In other words, learning disability is the latent variable causing their pattern of impairment and achievement. Thus, the cut score used in a low achievement model of learning disability diagnosis would be based on the mean score of this group. In order to accurately represent the members of the possible learning disability class, however, it will be necessary to select an achievement score range that will not exclude the half of class members who have scores above the average.

The purpose of the current study is to identify the achievement score range associated with substantial functional impairment using the method of latent class analysis. This approach would capture the essence of the learning disability construct while allowing LD to meet the requirements of disorder. Thus, the cut score used would represent both poor academic achievement and problems functioning in the school and other environments. This approach holds the potential to help guarantee that special services are available to those students who are most in need.

Hypotheses

In a previous study employing cluster analysis, Speece and Cooper (1990) obtained six clusters of school adjustment for at-risk and control children using achievement, intelligence,

interpersonal, behavioral, and language measures. At-risk status was determined by prereferral intervention nomination and comprised over half of the sample. The derived clusters included an LD group, a language impaired group, a slow learner group, and three groups that were variations of normal profiles. Based on an analysis of the mean scores for the variables in the Speece and Cooper (1990) study, one normal group could be considered above average based on cognitive characteristics and a second normal group could be considered above average based on achievement results. Given the variables to be used in the current study and the smaller proportion of at-risk students defined by prereferral intervention, we would expect to find at least one learning disability class, an above average class, a below average class, and at least one normal class.

Research regarding subtypes of learning disabilities suggests that we should expect to find more than one LD class when using math and reading achievement scores as academic indicators. According to Rourke's (1989) subtyping studies, there are three groups of learning disabled students; a group with uniform deficiencies in reading, spelling, and math, a group with significant reading but not arithmetic difficulties, and a group with impaired arithmetic performance and average reading ability. Barberesi and colleagues (2005) conducted a large population-based cohort study of the incidence of learning disabilities and also interpreted their findings as representing three types of students with learning disabilities; those with reading LD, those with math LD, and those with comorbid math and reading LD. Thus, we anticipate that there will be three learning disability classes. These classes will represent reading disability, math disability, and combined math and reading disability. Further, based on findings that students with achievement scores below about the 15th percentile do not respond to intervention

(Vellutino et al., 2000, 2006; Berninger, Abbot, & Vermeulen, 2002) we expect that these groups will have scores below this percentile rank.

Therefore, based on the prior review of the literature, we hypothesize that at least six latent classes will be present. These classes, as shown in Figure 3.1, are expected to include two representing normal and optimal academic development, another representing significantly poor academic development with percentile rank scores at or near the mental retardation range, one cluster with below average reading, one cluster with below average mathematics scores at or below the 15th percentile, and at least one cluster with achievement test scores at about the 15th percentile rank in reading and mathematics based on the findings of Vellutino and others. The latter three groups will be indicators of the presence of a learning disability consistent with the low achievement model.

Methods

Participants

Data for this study were collected as part of the federally funded Project A.C.T. Early.[1] The participating school district is composed of a large population of "at-risk" students, with approximately 70% of the student body participating in the free or reduced cost lunch program, a large percentage of each school coming from public housing units, and a less than 50% on-time graduation rate from high school. The sample included 523 kindergarten through fifth-grade children from three schools participating in the Project A.C.T. Early study during the 1999-2000

[1] Author note: Data collection was funded by Field-Initiated Studies grants (R306F60158, R305T990330) from the Institute for At-Risk Children of the Office of Educational Research and Improvement, United States Department of Education awarded to R. W. Kamphaus, J. A. Baker, & A. M. Horne.

school year. The sample was approximately half male (N = 240) and half female (N = 283). The ethnic group representation of the sample was 55% African American, 33% Caucasian, 7% Hispanic, 2 % Asian American, and 3% Multiracial, which parallels the school district's ethnic distribution.

In order to approximate adherence to the definition of learning disabilities, students who would be ruled-out based on the exclusionary clause were omitted from the analyses. According to this clause, learning disabilities may not be primarily due to visual, hearing, or motor disabilities, mental retardation, emotional disturbance, or environmental, cultural, or economic disadvantage (Individuals with Disabilities Education Act Amendments of 1997, Sec. 602(26), p. 13). Thus, students classified as having an intellectual disability, emotional-behavioral disorder, traumatic brain injury, autism, other health impairment, or a native language other than English were removed from the sample. Additionally, three older students were omitted from the analyses because their teachers had completed the adolescent rather than child form. This resulted in a remaining sample of 488. Table 3.1 illustrates how many children from each category were excluded. The sex distribution of the remaining sample was also approximately half male (N=228) and half female (N=260). The resulting ethnic makeup was 57% African American, 35% Caucasian, 4% Hispanic, 2% Asian American, and 3% multi-racial.

Instruments

The Behavior Assessment System for Children, Teacher Rating Scale-Child (BASC-TRS-C; Reynolds & Kamphaus, 1992), which is used for children ages 6 to 11, is a 148-item, nationally standardized measure that yields nine problem behavior scales (Aggression, Conduct Problems, Hyperactivity, Anxiety, Depression, Somatization, Attention Problems, Learning Problems, and Atypicality) and four adaptive skills scales (Adaptability, Leadership, Social

Skills, and Study Skills) as well as composite, or summary, scores. The 148 items are rated using a four-point Likert scale, ranging from 1 (never) to 4 (almost always). The TRS-C composites with associated subscales are : (1) Adaptive Skills (how students develop socially and interact with peers and authority figures; Adaptability, Social Skills, Leadership, and Study Skills), (2) Externalizing Problems (tendencies for students to display aggressive or hyperactive behaviors; Aggression, Hyperactivity, and Conduct Problems), (3) Internalizing Problems (tendencies for students to show feelings of anxiety, worry, or stress; Anxiety, Depression, and Somatization), and (4) School Problems (presence of problems with learning and school work; Attention Problems, Learning Problems) (Reynolds & Kamphaus, 1992).

All TRS-C subscale scores are nationally-normed T-scores with a mean of 50 and a standard deviation of 10. Both external reviews (Sandoval & Echandia, 1994) and data presented in the BASC manual (Reynolds & Kamphaus, 1992) provide evidence of strong reliability and validity of scores to support its use for many assessment purposes including diagnosis.

The Iowa Test of Basic Skills (ITBS) is a battery of norm-referenced standardized achievement tests designed to assist teachers in determining what students in grades kindergarten through ninth are able to accomplish across four broad academic domains, including reading, math, language, and vocabulary. A complete battery containing listening, vocabulary, language, mathematics, reading, and word analysis is intended for use with students in grades K-1. Students in first through third grade may be given one of three forms containing subtests including listening, vocabulary, reading, language, mathematics concepts, mathematics problems, word analysis, mathematics computation, social studies, and science. The three forms for grades 3-9 include vocabulary, reading comprehension, spelling, capitalization, punctuation,

usage and expression, math concepts and estimation, math problem solving and data interpretation, math computation, social studies, science, maps and diagrams, and reference materials. For the purposes of this analysis, only the math and reading composite scaled scores are used. At grade 1, the reading composite is composed of reading words and reading comprehension, while the reading composite consists of vocabulary and comprehension for grades 2 through 5. The math composite for grade 1 consists of only one mathematics subtest and for grades 2 through 5 consists of concepts, problems and data interpretation, and computation subtests. Refer to Table 3.2 for the ITBS math and reading composites means and standard deviations for the Spring 2000 administration.

Procedure

As part of Project ACT Early, parents were given the opportunity to give consent for their children to participate in the study at the beginning of the school year. A Spanish language consent form was distributed as needed. Student participation rates across the schools were 70%, 71%, and 68%. In the fall and spring of the project, teachers completed questionnaires and behavioral ratings scales. The Behavior Assessment System for Children (BASC) Teacher Rating Scale child version (TRS-C; Reynolds & Kamphaus, 1992) was completed for each participating child in a teacher's classroom. The BASC-TRS is widely used in the school district for the assessment of emotional and behavior problems in students, so no special instruction for teachers was necessary.

At the end of the school year, demographic information, such as age, gender, ethnicity, standardized test scores, etc., was gathered from students' cumulative files. The current study utilized both academic and behavioral variables obtained in the spring of the 1999-2000 school year. The academic indicators included standardized ITBS reading standard scores and ITBS

math standard scores. Behavioral indicators include the BASC-TRS-C scales composing the Adaptive Skills component (Adaptability, Leadership, Social Skills, Study Skills).

Statistical Design

The purpose of latent class analysis (LCA) is to create smaller, more homogenous subgroups from a larger, ungrouped dataset based on individuals' response patterns on a set of indicators (Muthén & Muthén, 2000, 2004; Vermunt & Magidson, 2002). The ultimate goal is to classify cases into groups where members within a group are similar to each other and different from members of other groups on variables of interest (Vermunt & Magidson, 2002). Latent class analysis can be used with categorical or continuous metrics, with the latter more commonly known as latent profile analysis (Muthén & Muthén, 2000).

Latent class analysis has the goal of creating smaller homogeneous groups in common with the more widely used cluster analysis, but these methods differ in several important ways. First, latent class methods identify cases using a model-based procedure, meaning that all cases in the population are assumed to follow a basic underlying model. Second, latent class analysis is robust to different types of scaling, making it ideal for the current study. Finally, latent class analysis takes uncertainty of a case's membership in a certain class into account (Yang, Shaftel, Glasnapp, & Poggio, 2005). A study conducted by DiStefano and Kamphaus (2006) showed a high degree of overlap between the subgroups produced by both methods, making each a viable alternative depending on the specific research goal and available data.

Latent class analysis requires two main assumptions. First, latent classes are assumed to be homogeneous. In other words, each case is classified as belonging in only one class. Second, there is local independence meaning that correlations between observed variables within each class are zero. This is important because the key underlying assumption in LCA is that the

relationship among variables is due to the latent class membership.

As referred to previously, latent class analysis is a model-based procedure. The model is used to identify groups of individuals similar with respect to a categorical latent variable, with the number of latent groups unknown a priori (Muthén & Muthén, 2000, 2004). The parameters in LCA include the prevalence of cases in each latent class and the conditional response probabilities of belonging to a certain class for each case. The primary goal is to identify classes that differ with respect to the mean (i.e., centroid) values, but other parameters such as variances and covariances are also estimated based on the profile of the individual's values across the set of observed variables (DiStefano & Kamphaus, 2006).

More than one analysis can be specified by relaxing constraints on the variance-covariance matrix (DiStefano & Kamphaus, 2006). Then for each analysis, cases are assigned to a class by estimating the probability of a case demonstrating a specific pattern of observed variables. This is an iterative procedure, meaning that one or two classes are extracted and then successive classes are added until no more can be derived. This estimation is accomplished using either the maximum likelihood (ML) method or the maximum-posterior method (MAP). As classes are added, the fit of various models are compared with the best solution being that with the fewest classes while still achieving acceptable model fit (DiStefano & Kamphaus, 2006).

There are multiple criteria for assessing fit, including statistical indices, classification quality, ease of interpretability, and match to theory (Muthén, 2001). The most often used goodness-of-fit indices are the Akaike Information Criteria (AIC) and the Bayesian Information Criteria (BIC). These indices test how well the solution fits the model while taking parsimony into account. Lower values of the information criteria indicate better fit. When the fit indices

are contradictory, the more consistent BIC should be used (Yang, Shaftel, Glasnapp, & Poggio, 2005). Also, differences between fit index values may be investigated to determine how much model fit improves by adding a class. Additionally, entropy values indicating how well the model predicts class membership may be assessed to indicate model fit (DiStefano & Kamphaus, 2006).

The quality of classification can be determined by examining the posterior probability information. Probabilities are provided for the individual cases as well as averaged across the entire class. At the individual level, higher probability values mean that an individual is more likely to have been correctly assigned to a group. At the class level, higher probability values are interpreted as greater certainty of classification because it is based on the number of difficult to classify cases in the class. Perfect classification would be illustrated by probability values of 1 for each class. Finally, to determine interpretability, centroid information and descriptive information may be evaluated for each of the classes. This procedure also allows the assessment of fit with theory and ensures that the obtained classes are meaningful (DiStefano & Kamphaus, 2006). Muthén (2004, 2003) stresses the importance of considering substantive theory, auxiliary information, and practical usefulness as the ultimate guide in choosing the appropriate number of latent classes.

Latent class analysis provides many advantages, with possibly the most valuable being the ability to mix continuous and categorical variables without any estimation problems. Latent class methods also allow for a more flexible framework by letting researchers relax restrictions to allow evaluation of different solutions to determine which provides optimal fit to the data in terms of parsimony, fit indices, and relevance. Additionally, more data can be incorporated to further investigate differences among classes. For example, latent class methodology may

incorporate background information (e.g., covariates), directional relationships among variables (e.g. causal models), or studies of class membership over time (e.g., latent transition analysis, latent growth curve analysis) (Muthén & Muthén, 2004). Unfortunately, as additional parameters are added, it is harder to find a solution and the criteria for assessing fit are largely heuristic (DiStefano & Kamphaus, 2006).

Statistical Analyses

MPlus Version 3.0 (Muthén, & Muthén, 2004) was used to perform latent class analysis. Only continuous latent class indicators were used in the analyses. Automatic starting values were determined using maximum likelihood optimization. Prior to completing the LCA, the ITBS math and reading scaled scores were converted to standardized *z* scores so that the achievement scores would be on a common metric across grades. This was necessary due to the ITBS's use of scaled scores, which are developmental norms that allow students' growth to be tracked within a given subtest or composite score as they progress through grades (Kamphaus, 2001). Thus, scores cannot be compared between students in different grades, as age would be expected to be associated with score levels, with older students having higher scores.

Once the scaled scores had been transformed, we fitted three-, four-, five-, six-, and seven class models. Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), entropy, and the Vuong-Lo-Mendell-Rubin (VLMR) likelihood ratio test were obtained and examined for each model. Based on research indicating the relative usefulness of using a likelihood ratio test in combination with the BIC to identify the appropriate number of classes, we used the VLMR likelihood ratio test and the BIC to select the class model that seemed to provide the best fit, with the BIC being the best indicator (Nylund, Asparouhov, & Muthén, 2006). Other fit indices were consulted when the BIC and VLMR likelihood ratio test conflicted. Most importantly, each

model was also compared to the hypotheses to ensure correspondence with theory. Hence, because the goal of the study was to identify a group representing students with learning disabilities, the most parsimonious solution that contained the classes hypothesized based upon prior research and theory was chosen as the "best" solution. In addition, descriptive data including gender, race, age, special education status, and gifted program participation was considered for each class to provide more information about the class make-up. Finally, based on mean values for the six latent indicators (BASC scales: adaptability, leadership, social skills, study skills; ITBS composites: reading, math) with reference to descriptive data, the class most likely to represent students who possibly have learning disabilities was identified.

In order to determine the cut score range that should be used to inform future research, the mean ITBS reading composite scores and the mean ITBS math composite scores were identified. Scatterplots of scores for cases within the possible class indicating presence of a learning disability were examined for a visual indication of scatter among scores to guide the determination of the best method to obtain the cut score. The options for obtaining such a score included simply using the mean, adding one standard deviation to the mean, adding two standard deviations to the mean, or using the maximum score in the class. All of these options involve possible drawbacks. For instance, the use of the mean would exclude half of the class from which it was obtained; adding one standard deviation may still exclude some class members; and, adding two standard deviations or using the maximum score would likely lead to overlap with other classes. Taking all of these considerations into account, adding one standard deviation to the mean was deemed to be the most appropriate option and resulted in the exclusion of 16% of students in the suspected LD class on average. After adding a standard deviation to

the mean, the obtained scaled score was converted to a percentile rank to allow for meaningful comparison to other norm-referenced instruments.

Results

The three-class model resulted in a BIC value of 16169.785. The four-class model BIC was 139 points lower than the three-class model, the five-class model was 109 points lower than the four-class model, and the six-class model was 82 points lower than the five-class model. Adding another class resulted in a further decrease of 8 points. The BIC, therefore, indicates that the 7-class solution provides the best fit. The VLMR likelihood ratio test provided conflicting results. The VLMR was not significant for 2 versus 3 classes indicating that we cannot reject the conclusion that 2 classes is sufficient, however, the VLMR was also not significant for 4 versus 5 classes and 6 versus 7 classes. These results imply that 2 classes, 4 classes, and 6 classes are appropriate. The other fit statistics (see Table 3.3) were no more useful in determining the optimal number of classes. Thus, the fit statistics were not a factor in the selection of the most useful solution, so each class solution was assessed for interpretability and fit with theory as recommended by Muthén (2003, 2004).

In determining which solution was most interpretable, the goal of the current study was considered to be of utmost importance. In other words, we were most concerned with identifying a solution that contained at least one class of children with below average achievement and slightly impaired adaptive functioning. Based on research, we would expect there to be three classes with this pattern that are distinguished by achievement in math and reading, e.g. poor math and reading scores, poor math scores and average or above reading, or poor reading scores and average or above math scores. Additionally, as mentioned previously, we would expect a class of students who perform well above average across indicators, a group

of students with average scores, and a group of students that is well-below average. In order to comply with the exclusionary criteria in the LD definition, students who had been classified as having mental retardation were not included in the analyses. Thus, we would no longer expect to identify a group of well-below average students, suggesting a five class solution.

The three-class solution provided three nearly evenly distributed classes representing below average, average, and above average achievement with similar levels of associated adaptive skills and was rejected due to its oversimplification of students. Adding an additional class resulted in classes with below average, slightly below average, slightly above average, and above average achievement scores also with similarly increasing adaptive indicators, resulting in the rejection of the four-class solution as well. The five class solution resulted in a group with well-below average achievement and adaptive scores, a somewhat impaired group, a class with average achievement and slightly above average adaptive skills, a group with slightly above average achievement and adaptive indicators, and a group with well-above average scores. The six- and seven-class solutions provided similar low achieving groups but also included additional variations of groups with above average achievement scores (see Tables 3.4-3.7).

The six- and seven-class solutions were rejected because they did not provide additional information regarding a unique group of students that demonstrates a pattern of academic and functional performance that would be considered a marker of possible learning disability. Thus, the five-class solution was chosen as the best fit to data and theory across the five grades examined. Class sensitivity for the five-class solution, which is the average class membership probability after classification of all cases, was high (.860-.934), indicating that students were well-classified.

The class specific probabilities, which in the case of latent profile analysis are means

obtained for the variables of interest, are illustrated in Figure 3.2. Ninety-five (19%) cases were assigned to class 1, 148 (30%) to class 2, 85 (17%) to class 3, 62 (13%) to class 4, and 98 (20%) to class 5. Class 1 evidenced the lowest scores across the adaptive scales as well as the lowest reading and math scores as can be seen in Table 3.6. This class was composed primarily of males and 38% of class members had been recommended for pre-referral intervention. Students in class 2 were below the mean but within one standard deviation for both impairment and academic indicators and contained nearly equal number of males (46%) and females (54%). Class 3 students demonstrated above average adaptive skills and average achievement. Children in Class 4 had nearly average adaptive skills and above average achievement with 24% of group members participating in the gifted program. Forty-nine percent of class 5 members were placed in the gifted program. This class had above average adaptive and academic indicators. Table 3.9 provides information regarding gender, race, and age and Table 3.10 provides information regarding special education and gifted program status.

Careful review of the results described above led us to conclude that class 2 was most likely to represent students with possible learning disabilities. We, therefore, took the class 2 reading composite mean z score of -.5887 and added the within class standard deviation (0.5313) to arrive at a reading cut score of -.0570. In a similar manner, a math cut score of 0.0762 (mean = -0.5486, std. dev. = .6248) was calculated. Single-sided cut scores were obtained in order to exclude as few cases as possible. These scores did result in the exclusion of 20 cases for the reading cut-point and 25 cases for the math cut-point, which as can be seen in Figures 3.3 and 3.4, excluded the class members who had high achievement scores that would be considered outliers. Conversion to percentile ranks resulted in cut scores at the 48th percentile rank for reading and the 53rd percentile rank for math performance.

Discussion

This study represents an incremental improvement toward Stanovich's (2005) goal of making LD a defensible category of disability. The derived cut scores, though, are far from Stanovich's recommendation of using the 10^{th} to 15^{th} percentile rank and closer to Siegel's (1999) suggested cut score at the 25^{th} percentile. The current study indicates that within an academic impairment framework educators should focus their attention on children with academic achievement scores somewhere below the 25^{th} to 50^{th} percentile rank as being at-risk of having learning disabilities.

The results of the study imply that the use of subtyping and profiling with psychological and educational tests will not easily simplify the diagnostic approaches for identifying those with learning disabilities. It highlights the fact that diagnosis of LD and other disabilities is not a statistically simple procedure. Additionally, this study focuses on one approach to developing LD diagnostic criteria. The study does, however, narrow down the group of students who should be considered at risk of having a learning disability by providing a broad cut score for use in an academic impairment model of identification. It is also likely that more gifted students may be diagnosed as having a LD than previously expected, since their achievement scores may fall closer to this upper limit. Thus, the academic impairment model of identification does not completely exclude gifted children from the LD category as some critics have suggested low achievement models would do.

In fact, one student who had been classified as gifted was included in the class representing the presence of a possible learning disability. This student was rated as demonstrating slightly above average adaptability, average leadership, and slightly below average social and study skills. Her reading and math scores, however, were actually somewhat

above average. Thus, this student demonstrated expected deficits in some areas of adaptive functioning, yet performed quite well on the school-wide standardized achievement test. It is not known whether she received accommodations during testing, capitalized on her ability to make the best of situations, or was served for a learning disability in an area other than reading or math. Regardless of this child's particular pattern of achievement, this case and the relatively generous cut point suggested by this study indicate that gifted students will not be automatically excluded from the LD diagnosis, but that the overidentification of gifted individuals with relative rather than absolute academic difficulties may be remedied.

The relatively high cut score for the class hypothesized to be organized around the latent construct of LD may indicate the need to consider the smaller and lower achieving Class 1 as possibly being the most likely representative of an LD class. Upon further analysis this does not seem to be the case. This option was explored by comparing the adaptive score patterns to those of the LD clinical sample in the BASC (Reynolds & Kamphaus, 1992) and BASC-2 (Reynolds & Kamphaus, 2004) manuals. This investigation revealed that Class 1's adaptive functioning was most similar to the mild mental retardation (MMR) and autism clinical groups in the BASC studies, while Class 2's adaptive functioning was similar to that of the LD group (see Table 3.11). The BASC studies also revealed that the distinguishing factors between the LD and MMR group appeared to be scores on the Atypicality and Withdrawal scales. One-way ANOVAs were performed and confirmed that Class 1 was rated as displaying significantly more atypical ($F(4, 483)=48.809$, $p<.01$) and withdrawal ($F(4, 483)=38.644$, $p<.01$) behaviors than Class 2, indicating that Class 1 is more likely composed of individuals with intellectual and adaptive functioning near the mild mental retardation range.

The lower adaptive functioning and higher rates of SST referral in Class 1 also suggest

that some members of the class may demonstrate a below average pattern of performance across indicators due to an emotional or behavioral disorder. In order to test this possibility one-way ANOVAs were conducted and confirmed that Class 1 does in fact display more internalizing ($F(4, 483)=20.213$, $p<.01$) and externalizing ($F(4, 483)=64.821$, $p<.01$) behaviors in the school setting than Class 2 members.

Overall, results of BASC studies and analyses utilizing BASC scales and composites indicate that Class 1 is most likely composed of students with intellectual disabilities and emotional or behavioral disturbances that cause the pattern of high functional impairment and low academic achievement. This information also lends support to the credibility of Class 2 as representing a group of students with possible learning disabilities. Additional support is provided by the assignment of 64% of the students in the sample with learning disabilities to Class 2, which is more than in any other class. While this difference is not statistically significant ($F(4, 483) = 2.169$, $p > .05$), the lack of significance is likely due to only 11 students in the sample being identified as having a learning disability.

Examination of the proportion of males versus females in Class 2 is another method of ensuring the defensibility of labeling this class as representing potential LD. Several researchers have assumed that boys are about twice as likely to be identified as having a math or reading LD than are girls (American Psychiatric Association, 2004; Wagner, Marden, Blackorby, & Cardoso, 2002). Epidemiological and neurological studies, however, have found that the incidence of learning disabilities in the population does not differ according to child sex (Shaywitz, Shaywitz, Fletcher, & Escobar, 1990; Alexander, Gray, & Lyon, 1993). Shaywitz et al. (1990) discovered that schools identified boys as having learning disabilities four times more often than girls, but when the school's role was deleted from the identification equation boys and girls were

identified at equivalent rates. This epidemiological sex proportion is similar to that of our possibly LD class.

The high proportion of students identified as having a possible learning disability in the current study may also be a result of the type of test used. Specifically, the ITBS, which was the only achievement measure available in the existing database used for this study, does not measure discrete skills so those skills most associated with the presence of a learning disability are not the only constructs being measured. For instance the reading composite, includes the vocabulary and comprehension subtests and the math composite includes the concepts, problems and data interpretation, and computation subtests for students in grades 2 through 5. Most research concerning the best measures for identifying reading and math disabilities have employed tests that measure discrete skills, such as single word decoding or math calculation. A test that measures multiple skills is more likely to identify students who may be struggling academically for a number of reasons.

Additionally, this study was conducted using an "at-risk" sample. For instance, in the school district attended by the children in this study 70% of students received a free or reduced lunch rate and a large percentage lived in public housing (Baker, Kamphaus, Horne, & Winsor, 2006). The sample used was mainly composed of minority students and 4% of the sample used in the data analysis was served by special education after eliminating students served in all but the learning disability and speech impairment categories. There was also a high rate of children served through pre-referral intervention. Given the sample demographics, the high rate of LD eligibility identified in this study is not unexpected. It is also likely that some children who are included in the possible LD class demonstrate concomitant functional impairment and low achievement due to other factors such as unidentified social-emotional disorders, ADHD, etc.

Review of Vellutino and colleagues' (1996, 2000, 2006) work with at-risk readers reveals another possibility: the percentile ranks identified in the current study may identify students with learning disabilities as well as students who are at-risk of developing a reading disability. Vellutino et al. (1996) found that the largest percentage of poor readers in their intervention program scored in the average or above average range after being provided with remediation. In other words, these students appeared to have reading disabilities, but after intervention were able to read as well as average.

The scores for different skill level groups of readers from another intervention study (Vellutino, Scanlon, Small, & Fanuele, 2006) are actually quite similar to those found in the current study. From first through third grade, students labeled as difficult to remediate scored between the 8^{th}-38^{th} percentile ranks on word identification, nonword decoding, and reading comprehension tests. Students considered less difficult to remediate received scores in the 40^{th} to 65^{th} percentile rank range. Those students who responded to intervention and were labeled as no longer being at risk of reading difficulties scored in the 52^{nd} to 73^{rd} percentile rank range. Thus, it would appear that the ITBS percentile ranks arrived at through latent class analysis may be identifying some students whose academic ability would improve with intensive intervention.

Yet another likely possibility is that the students in the sample would have benefited from intensive interventions, not simply because they had received inadequate instruction, but because they are an at-risk population. This possibility was examined by converting the mean z score for the learning disability class to scaled scores for each grade and comparing the obtained scores to the normative sample for the ITBS to determine the associated percentile rank. As expected, adding one standard deviation to the scaled score means resulted in achievement percentile ranks similar to those found for students who persistently failed to respond to intervention in previous

studies (Case, Speece, & Molloy, 2003; Vellutino et al, 2006). Based on these scores, it appears that Stanovich's (1999) suggested cut score at the 15th percentile may be appropriate for grades one through three. The obtained scores also suggest that a more lenient cut score, such as the 25th percentile recommended by Siegel (1999), may be more appropriate for students in fourth through fifth grade since these students are beginning to use other strategies to compensate for their weaknesses (see Table 3.12).

The proportion of the students in this study with below average achievement indicative of a learning disability combined with results of intervention research speaks to the need for implementation of response to intervention (RTI), as well as application of other exclusionary factors, to rule out other causes of learning difficulties, particularly ineffective instruction or lack of opportunity to learn. The use of RTI as a prevention strategy would eliminate the need for children to be labeled as having an LD to receive remediation. Those students who do not respond to intervention could receive an evaluation for special education so that more intensive remediation and accommodations could be made available. On the other hand, for children with the lowest achievement scores that are nevertheless outside the mental retardation range, however, RTI should not be implemented on a multiyear basis so that it too becomes a wait to fail model (Case, Speece, & Molloy, 2003).

Despite the advantages provided within an RTI framework, it is not appropriate as the sole means of diagnosis. Unresolved issues in RTI implementation include whether to use general education intervention (e.g., Fuchs et al., 2002) or intensive individual interventions (e.g. Vellutino et al., 1996) and how to define and measure responsiveness. The use of different interventions, definitions, and measures can lead to different prevalence rates and different children being identified (Fuchs, Fuchs, & Compton, 2004). Further, it has been suggested that

gains may not be maintained upon return to the regular classroom (Vaughn, Linan-Thompson, & Hickman, 2003). In addition, RTI is unreliable across locations because it often relies on the collection of local norms and comparisons to those norms. Thus, the search for a meaningful and reliable diagnostic method must continue.

It is important to note that the current study possessed several limitations. As mentioned previously, this sample consisted of an at-risk population and a less than ideal test was used as the measure of academic achievement. In addition to consisting of composites and subtests that assess multiple skills, the ITBS also only reports results as raw scores, scaled scores, and percentile ranks. Raw scores are meaningless and cannot be compared to other scores so scaled scores had to be used for the analyses. Scaled scores, though, are developmental scores that cannot be compared across grades. Due to this limitation, the achievement scores had to be converted to z scores and subsequently transformed to percentile ranks to make the results applicable to other achievement measures. Additionally, the interpretation of latent class analysis results relies heavily on individual judgment, thus other researchers using different theories and hypotheses may have reached differing conclusions.

We were also unable to identify all of the hypothesized classes of learning and adjustment. Specifically, we did not find three different types of LD as expected and instead only identified one class of students in each grade that was characterized by below average achievement in reading and math. One possible reason for the absence of a class of students with below average achievement in solely math or solely reading may be due to the demands of the ITBS. If the math subtests require reading skill, then students with reading disabilities would perform poorly on the math and reading tests. Similarly, studies have suggested that students' math disabilities are often the result of difficulty with phonological representation, so these

students would have low math and reading achievement scores as well (Robinson, Menchetti, & Torgesen, 2002). Since math and reading disabilities influence other academic domains in addition to being comorbid, the majority of students with LD would likely manifest low achievement in more than just one academic subject. Those students who may have one type of LD that does not affect performance in other domains would represent a very small proportion of students with LD. This small proportion would likely not be sufficient for forming an independent class using latent class analysis with a small to moderate sample size and would have been assigned to larger class with a similar pattern of probabilities.

Future research should employ a large community-sample-based dataset with multiple measures of functional impairment in different settings and individually-administered, nationally-normed measures of academic achievement across time. The academic tests should include at least two nationally-normed tests of phonological processing, such as single word recognition and nonword decoding, to identify the core symptom of reading disability (Siegel, 1999). In addition, because research has not yet yielded ideal measures for identifying mathematics disabilities, several types of arithmetic measures such as computation, fact retrieval, concepts and applications, and story problems tests should be included (Fuchs et al., 2005). Furthermore, in order to rule out competing explanations for low achievement, the sample should have research-based academic interventions like those found in RTI programs. Latent class analysis and similar statistical methodology could then be applied to better define cut points associated with the presence of a learning disability.

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Table 3.1 *Number and percent of children omitted based on exclusionary criteria by category.*

Category	Frequency	Percent of Sample
Autism	1	.2%
Behavior Disorder	10	2%
English as Second Language	15	3%
Intellectual Disability	5	1%
Other Health Impaired	1	.2%
Traumatic Brain Injury	0	0%

Table 3.2 *Spring 2000 ITBS normative means and standard deviations by grade.*

Grade	Composite	Mean	Standard Deviation
1	Reading	151.5	13.5
	Math	150.2	11.2
2	Reading	169.9	19.1
	Math	168.6	16.9
3	Reading	186.4	21.7
	Math	185.9	20.5
4	Reading	201.2	24.4
	Math	200.7	20.5
5	Reading	214.8	27.3
	Math	215.8	27.9

Table 3.3 *Fit statistics.*

Fit Criteria	3 Classes	4 Classes	5 Classes	6 Classes	7 Classes
Akaike (AIC)	16060.837	15892.415	15753.615	15642.773	15605.350
Bayesian (BIC)	16169.785	16030.696	15921.228	15839.718	15831.627
Entropy	0.849	0.853	0.848	0.861	0.856
Vuong-Lo-Mendell-Rubin LRT (p-value)	.3187	.0057	.1463	.0003	.3961

Table 3.4 *Latent class indicator means for 3 class solution.*

	Class 1	Class 2	Class 3
Adaptability	39.35	49.24	58.78
Leadership	38.71	49.75	63.93
Social Skills	41.59	51.15	62.38
Study Skills	38.19	49.79	61.85
Reading	-.720	-.035	.919
Math	-.732	-.016	.907

Table 3.5 *Latent class indicator means for 4 class solution.*

	Class 1	Class 2	Class 3	Class 4
Adaptability	37.40	44.66	53.67	60.20
Leadership	35.77	45.21	54.97	66.52
Social Skills	39.07	47.47	55.16	64.34
Study Skills	35.44	44.73	55.30	63.41
Reading	-0.791	-0.357	0.269	1.097
Math	-0.851	-0.343	0.347	1.030

Table 3.6 *Latent class indicator means for model solution chosen as best fit.*

	Class 1	Class 2	Class 3	Class 4	Class 5
Adaptability	36.50	45.64	55.93	45.46	60.43
Leadership	35.93	44.48	55.13	52.85	66.04
Social Skills	38.57	48.04	58.60	46.37	64.35
Study Skills	35.71	44.25	55.27	52.22	63.11
Reading	-0.758	-0.589	-0.144	0.993	1.127
Math	-0.805	-0.549	-0.068	0.969	1.066

Table 3.7 *Latent class indicator means for 6 class solution.*

	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6
Adaptability	36.52	46.55	53.61	41.00	55.35	61.92
Leadership	35.67	44.39	58.98	47.01	55.05	67.90
Social Skills	38.90	48.72	53.14	43.14	58.38	67.10
Study Skills	35.50	44.30	58.72	45.92	54.95	64.30
Reading	-0.834	-0.692	1.391	0.542	-0.132	0.953
Math	-0.899	-0.719	1.381	0.632	-0.061	0.922

Table 3.8 *Latent class indicator means for 7 class solution.*

	Class 1	Class 2	Class 4	Class 4	Class 5	Class 6	Class 7
Adaptability	36.84	46.51	43.88	37.71	55.84	55.05	62.01
Leadership	35.31	44.57	50.83	41.36	55.40	60.01	68.36
Social Skills	39.20	48.80	45.47	38.84	58.88	55.37	67.42
Study Skills	35.26	44.47	49.75	40.70	55.37	59.38	64.55
Reading	-0.904	-0.681	0.765	0.150	-0.154	1.454	0.935
Math	-0.974	-0.704	0.723	0.439	-0.073	1.419	0.897

Table 3.9 *Gender, race, grade, and age statistics by mean/frequency and percentage.*

		Class 1		Class 2		Class 3		Class 4		Class 5	
		Mean/ Freq.	%	Mean/ Freq.	%	Mean/ Freq.	%	Mean/ Freq.	%	Mean/ Freq.	%
Gender	Male	59	62%	68	46%	33	39%	38	61%	33	34%
	Female	36	38%	80	54%	52	61%	24	39%	65	66%
Race	White	12	13%	26	18%	25	29%	41	66%	65	66%
	African American	79	83%	103	70%	52	61%	18	29%	24	25%
	Hispanic	0	0%	11	7%	6	7%	2	3%	1	1%
	Asian	0	0%	4	3%	1	1%	0	0%	5	5%
	Multi-racial	4	4%	4	3%	1	1%	1	2%	3	3%
Grade	1	12	13%	30	20%	24	28%	9	15%	23	24%
	2	20	21%	32	22%	18	21%	15	24%	24	25%
	3	22	23%	30	20%	21	25%	9	15%	17	17%
	4	15	16%	24	16%	8	9%	11	18%	16	16%
	5	26	27%	32	22%	14	17%	18	29%	18	18%
Age		9.57	--	9.1	--	8.85	--	9.37	--	8.92	--

Table 3.10 S*pecial education and gifted program status.*

		Class 1		Class 2		Class 3		Class 4		Class 5	
		Mean/ Freq.	%	Mean/ Freq.	%	Mean/ Freq.	%	Mean/ Freq.	%	Mean/ Freq.	%
Special Education Status	Prereferral	36	38%	21	14%	6	7%	6	10%	2	2%
	SPED placement	10	11%	9	6%	2	2%	0	0%	0	0%
	SPED refer	10	11%	7	5%	1	1%	2	3%	1	1%
	Eligib-ility	2	2%	7	5%	1	1%	2	3%	0	0%
	LD	2	2%	7	5%	0	0%	2	3%	0	0%
	SI	1	1%	4	3%	1	1%	0	0%	1	1%
Gifted Status	Placement	2	2%	1	1%	6	7%	15	24%	48	49 %
	Referral	3	3%	0	0%	1	1%	5	8%	5	5%
	Eligibility	3	3%	0	0%	1	1%	4	7%	6	6%

Note: Cells refer to, in order, recommendation to prereferral intervention, currently placed in special education, referred to special education, found eligible for special education, classified as having learning disability, classified as having speech impairment, placed in gifted program, referred to gifted program, and found eligible for gifted program, respectively. SPED = Special Education. SI = Speech Impairment.

Table 3.11 *BASC data.*

	Behavior Disorder (child)		Learning Disability (child)		Mild Mental Retardation (child)		Autism (combined)		Current Study (BASC)	
	BASC	BASC2	BASC	BASC2	BASC	BASC2	BASC	BASC2	Class 1	Class 2
Scale										
Atypicality	58.6	63.6	52.9	56.4	60.4	70.0	69.8	70.9	56.3	48.7
Withdrawal	60.4	61.9	55.6	55.3	61.7	62.8	74.9	71.4	58.7	49.0
Adaptability	38.4	37.9	44.1	44.9	40.7	39.5	43.7	35.9	36.2	45.9
Social Skills	44.6	41.7	48.5	44.4	43.0	39.3	36.9	37.9	38.2	48.1
Leadership	42.1	41.8	46.6	42.5	38.7	37.5	35.1	39.3	35.6	44.5
Study Skills	40.7	39.6	43.9	40.5	36.9	35.3	42.2	42.2	35.6	44.2
Composite										
Externalizing	66.9	64.4	54.9	54.2	52.8	60.7	52.8	57.9	62.4	53.1
Internalizing	61.1	62.3	53.9	53.8	56.7	58.3	50.7	59.9	55.1	51.0

Table 3.12 *Scaled score conversions by grade with associated ITBS percentile rank.*

		Z Score Conversions for Class 2		Corresponding ITBS Percentile Ranks	
		Scaled Score Mean	Mean plus 1 Standard Deviation	Scaled Score Mean	Mean plus 1 Standard Deviation
Grade 1	Reading	135.99	142.68	1	13
	Math	137.00	144.35	2	16
Grade 2	Reading	144.15	155.72	1	10
	Math	152.50	164.29	4	30
Grade 3	Reading	158.13	172.47	1	15
	Math	168.67	180.10	7	29
Grade 4	Reading	178.52	191.54	6	26
	Math	188.77	198.32	18	40
Grade 5	Reading	186.39	199.97	2	17
	Math	190.95	210.80	4	39

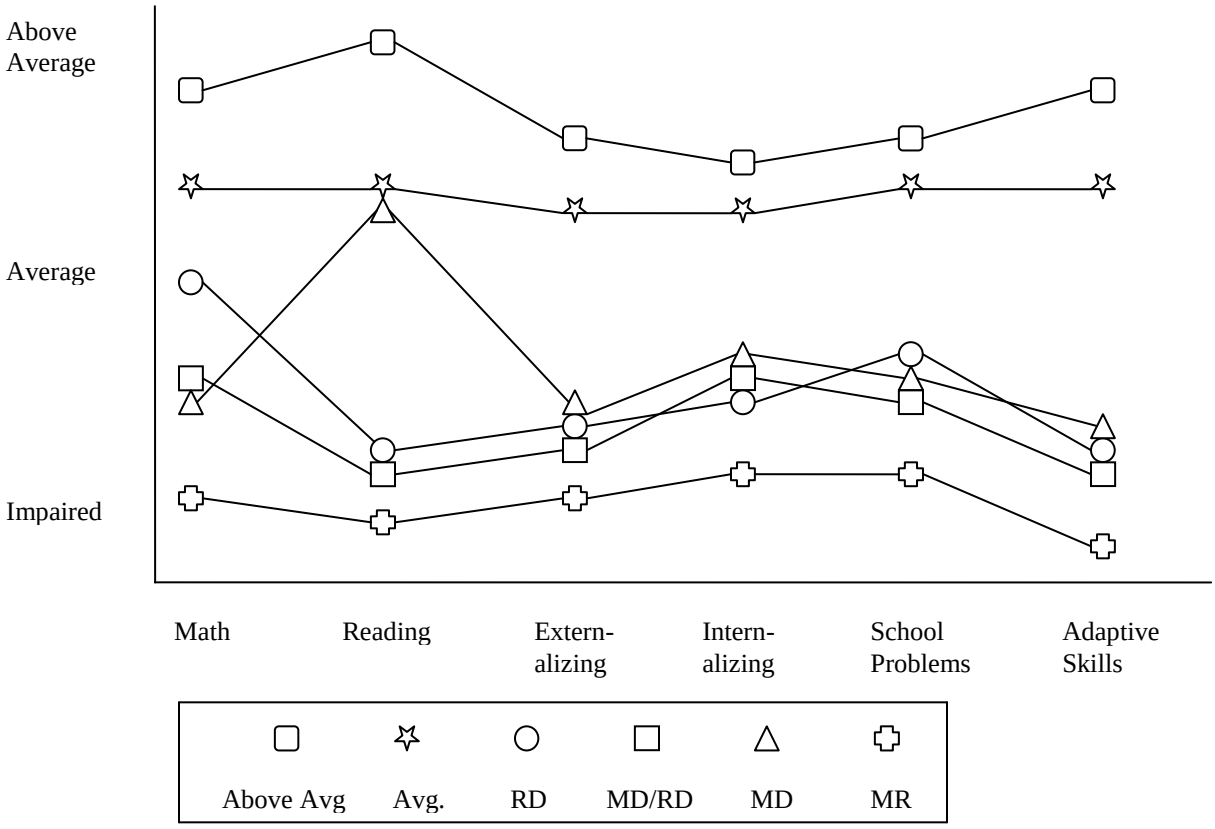

Figure 3.1 *Profile of hypothesized latent classes.*

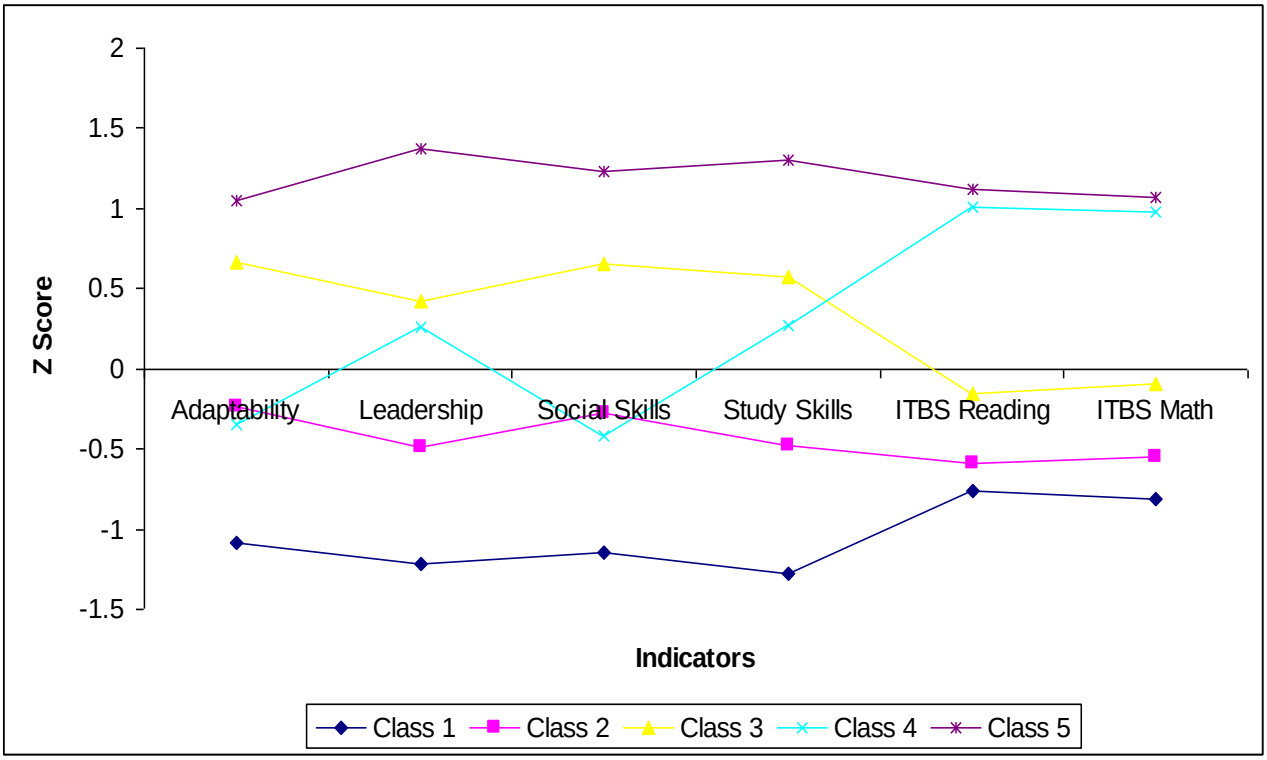

Figure 3.2 *Obtained latent class probabilities/means.*

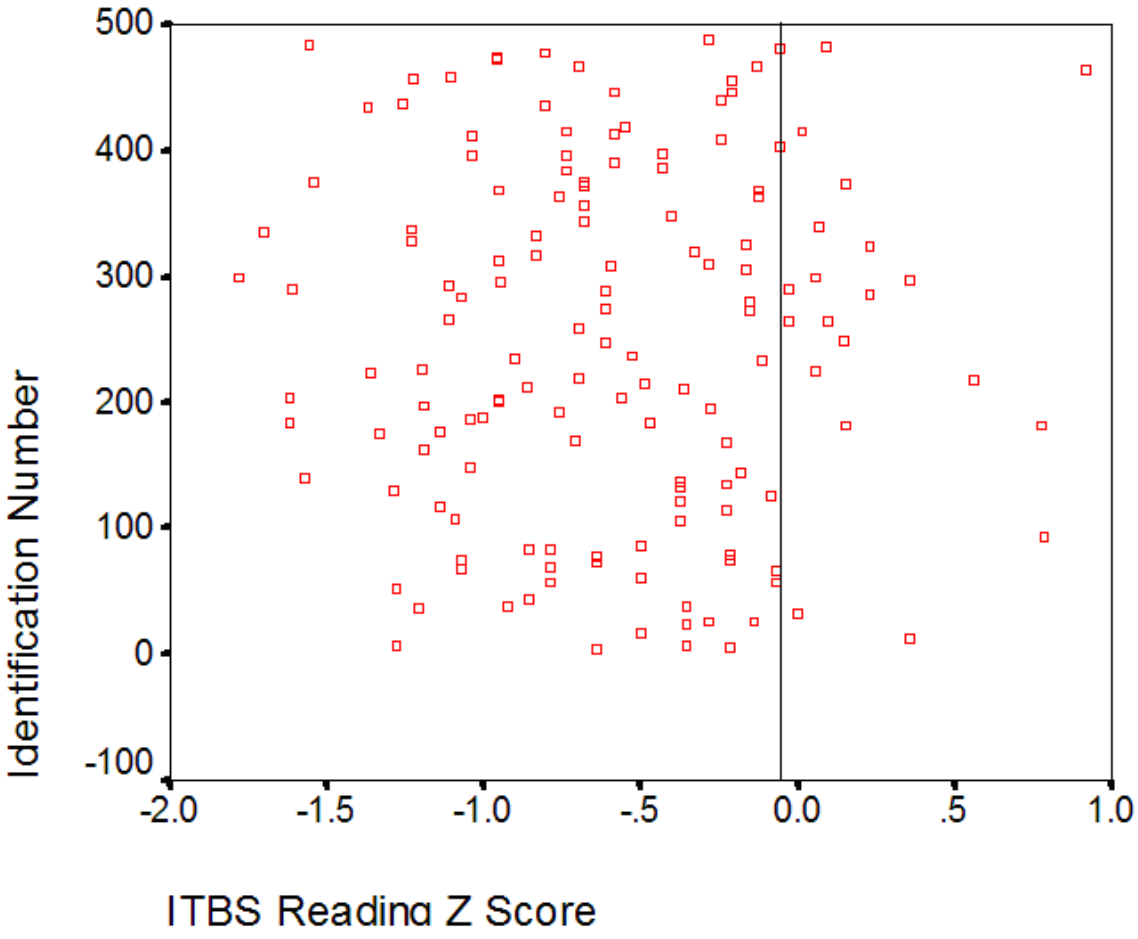

Figure 3.3 *Scatterplot of ITBS reading composite scores for Class 2 demonstrating which cases were excluded.*

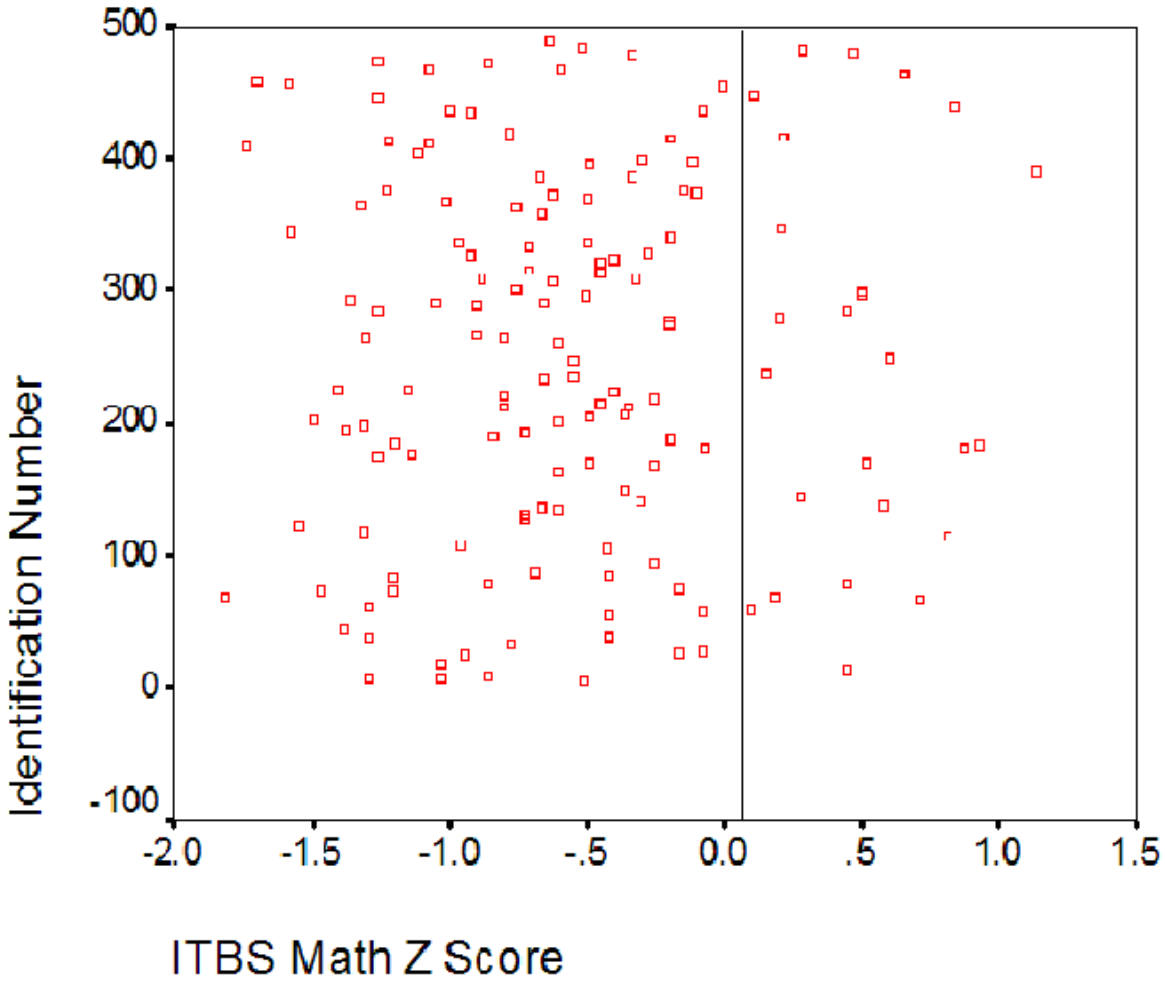

Figure 3.4 S*catterplot of ITBS math composite scores by case for Class 2 demonstrating which cases were excluded.*

CHAPTER 4

CONCLUSION

Conclusion

The recent reauthorization of the Individuals with Disabilities Act (IDEIA) has brought the learning disabilities (LD) diagnosis controversy that has existed for decades to the forefront in special education research. The majority of the debate focuses on the inclusion of response to intervention in the options for identifying students as having a learning disability. Some researchers, however, have taken the opportunity provided by the alternate evaluation criteria allowing for use of another research-based method for identification of learning disabilities to explore the utility of a low achievement approach to learning disabilities.

While several researchers have highlighted both the strengths and weaknesses of a low achievement approach, such a method has not been explicitly operationalized. More specifically, research has not been conducted to identify a meaningful cut score for use in a low achievement approach to LD diagnosis. The study presented above attempted to fill the research gap through latent class analysis. A class of students was identified that is most likely to represent students with learning disabilities based on a pattern of functional impairment and below average achievement scores. The inclusion of adaptive functioning ensured that students would be identified based not only on achievement scores, but also impaired functioning in other domains, which is a requirement of having a disorder. Once this group of possibly LD students was identified, the mean achievement scores were used to determine what percentile rank is associated with the presence of the characteristics of a learning disability.

The results of the study imply that the latent classes obtained simply reduced the error variance in the diagnostic decision-making by eliminating some cases that would have been considered eligible with the discrepancy or RTI methods. This is similar to the diagnosis of

other disorders, such as ADHD, in which clinicians first look high attention problem scores or symptoms and then decide if these indicators are explained by the presence of ADHD. The latent classes in effect reduce the specificity rate in a ROCC framework incrementally. Thus, the study provided a step toward determining the appropriate cut score for deciding if an individual has a learning disability, but further studies are necessary to arrive at the more specific cut score range associated with having a learning disability.