

6-19-2011

Malingering by College Students on Evaluations for Mathematics Learning Disabilities

Andrea L. Sanders

Indiana University of Pennsylvania

Follow this and additional works at: <http://knowledge.library.iup.edu/etd>

Recommended Citation

Sanders, Andrea L., "Malingering by College Students on Evaluations for Mathematics Learning Disabilities" (2011). *Theses and Dissertations (All)*. 42.

<http://knowledge.library.iup.edu/etd/42>

This Dissertation is brought to you for free and open access by Knowledge Repository @ IUP. It has been accepted for inclusion in Theses and Dissertations (All) by an authorized administrator of Knowledge Repository @ IUP. For more information, please contact cclouser@iup.edu, sara.parme@iup.edu.

MALINGERING BY COLLEGE STUDENTS
ON EVALUATIONS FOR MATHEMATICS LEARNING DISABILITIES

A Dissertation

Submitted to the School of Graduate Studies and Research in Partial Fulfillment of the
Requirements for the Degree of Doctor of Psychology

Andrea L. Sanders

Indiana University of Pennsylvania

May, 2011

Indiana University of Pennsylvania
The School of Graduate Studies and Research
Department of Clinical Psychology

We hereby approve the dissertation of

Andrea L. Sanders

Candidate for the degree of Doctor of Psychology

Signature on File

David J. LaPorte, Ph.D.
Professor of Psychology, Advisor

Signature on File

Donald Robertson, Ph.D.
Professor of Psychology

Signature on File

Susan T. Zimny, Ph.D.
Professor of Psychology

ACCEPTED

Signature on File

Timothy P. Mack, Ph.D.

Dean

The School of Graduate Studies and Research

Abstract

Title: Malingering by College Students on Evaluations for Mathematics Learning Disabilities

Author: Andrea L. Sanders

Dissertation Chair: David LaPorte, Ph.D.

Dissertation Committee Members: Donald Robertson, Ph.D.

Susan Zimny, Ph.D.

Academic accommodations for college students with learning disabilities are intended to ensure equal access to education, yet some accommodations, such as course waivers, are potentially advantageous to all students, with or without disabilities. This study sought to develop a method to detect malingering by college students on learning disability evaluations. A total of 57 volunteer students were divided into three groups: uncoached malingerers, coached malingerers and controls. They were administered a battery of tests commonly included in comprehensive learning disability evaluations, including embedded and free-standing measures of malingering. Data from the three experimental groups were compared to 23 archival cases of students diagnosed with a mathematics learning disability. Participants who were coached on how to malingere a mathematics learning disability did not perform significantly different from naïve malingerers. Both malingering groups were able to produce performance profiles very similar to those of students with an actual diagnosis of math LD, which highlights the need for further research of malingering of learning disabilities. Optimal cut-off scores were derived for

each measure, maintaining specificity of 90% or better. None of the measures in this study were individually highly sensitive to the presence of malingering, with more than half of malingerers going undetected. Failure on any combination of two or more cut-offs resulted in near perfect specificities ranging from 96 to 100%, indicating an extremely high probability of malingering. While measures in this study cannot be used to rule out the presence of malingering, failure on these cut-offs can serve as a cautionary flag to raise the suspicion of probable malingering.

Table of Contents

Chapter	Page
I	INTRODUCTION1
II	LITERATURE REVIEW3
	Learning Disabilities3
	The Increased Prevalence of Learning Disabilities3
	Accommodating Students with Disabilities.....5
	Documentation of Disabilities9
	Potential Malingering of Learning Disabilities.....11
	Definitional Issues and the Diagnosis of Learning Disability13
	Discrepancy Models.....17
	Learning Disabilities in College Populations24
	Mathematics Disability27
	Definition of Mathematics Disability27
	Diagnosing Mathematics Disability.....33
	Mathematics Disability and College Students34
	Malingering.....38
	Definition of Malingering38
	Techniques for Detection of Malingering43
	Conducting Research on Malingering50
	Summary of Literature54
	Hypotheses55

III	METHOD AND DESIGN	57
	Participant Characteristics, Sampling Procedures, and Participant	
	Instructions.....	57
	Assessment Measures	63
	Debriefing Questionnaire.....	67
	Debriefing Form.....	68
IV	RESULTS	69
	Manipulation Checks	69
	Analysis of Categorical/Binary Measures	70
	Analysis of Continuous Measures	71
	Assumptions of Multivariate Parametric Statistics.....	75
	Hypothesis 1: Coached vs. Uncoached Malingering	79
	Hypothesis 2: Malingering vs. Learning Disability	81
	Hypothesis 3: Malingering vs. Control.....	86
	Hypothesis 4: Malingering vs. Non-Malingering	92
V	DISCUSSION.....	99
	Summary of Findings.....	99
	Hypothesis 1.....	101
	Hypothesis 2.....	103
	Hypothesis 3.....	105
	Hypothesis 4.....	107

Limitations	109
Implications for Further Research and Theoretical Considerations	110
Conclusions.....	112
REFERENCES	114
APPENDICES	126
Appendix A – Informed Consent.....	126
Appendix B – Demographic Questionnaire	127
Appendix C – Debriefing Questionnaire	128
Appendix D – Debriefing Form.....	129
Appendix E – Participant Instructions	130
Appendix F – Drawing Entry Form	134
Appendix G – Indiana University of Pennsylvania – Center for Applied Psychology – Client Consent Form	135
Appendix H – Harcourt Assessment Fee Permission Agreement	136

List of Tables

Table	Page
1 Participant Demographics by Group.....	58
2 Strategies Used by Malingering Groups	70
3 Binary Variable Frequencies by Group	71
4 Continuous Measures Descriptives by Group.....	72
5 Pearson Correlations for Dependent Variables.....	78
6 ANOVA Results for Four Groups	80
7 Helmert Planned Contrasts Significance Levels.....	81
8 Malinge r vs. LD: Forced Entry Logistic Regression Parameter Estimates.....	82
9 Malinge r vs. LD: Logistic Regression Classification Table.....	83
10 ANOVA Results for Malinge r vs. Control	86
11 Malinge r vs. Control: Forced Entry Logistic Regression Parameter Estimates.....	88
12 Ability of Single Cut-Offs to Differentiate Between Malingering and Control Groups	91
13 Comparison of Single, Pairwise, and 3-Way Cut-Off Models in Differentiating Between Malingering and Control Groups	92
14 ANOVA Results for Malinge r vs. Non-Malinge r.....	93
15 Malinge r vs. Non-Malinge r: Forced Entry Logistic Regression Parameter Estimates	94

16	Ability of Single Cut-Offs to Differentiate Between Malingering and Non-Malingering Groups	97
17	Comparison of Single, Pairwise, and 3-Way Cut-off Models in Differentiating Between Malingering and Non-Malingering Groups	98

List of Figures

Figure		Page
1	WJ-III mean standard scores by group	73
2	WMS-III mean standard scores by group	73
3	Rey-Osterrieth mean raw scores by group.....	74
4	Rey Dot Counting Test mean time by group	74
5	ROC curve for malingers vs. LD.....	84
6	ROC curve for malingers vs. control.....	89
7	ROC curve for malingers vs. non-malingers	95

CHAPTER I

INTRODUCTION

In the early 1990s, Boston University marketed itself as a leading institution in the education of college students with learning disabilities. In response, the number of students self-identified as having a learning disability increased nearly ten-fold from 1991 to 1995 (Wolinsky & Whelan, 1999). As more and more students requested academic accommodations to compensate for their disability, the University's Provost began to question the school's policies regarding accommodations for students with learning disabilities, and proposed that many of these students were receiving accommodations based on misdiagnoses or misrepresentation of their impairments. As a result, he immediately implemented drastic changes to the process by which students were granted accommodations and specifically terminated the school's prior policy of granting course substitutions for foreign language and mathematics degree requirements.

A group of Boston University students filed suit against the school, alleging discrimination against students with learning disabilities (*Guckenberger, et. al., v. Boston University, 1997*). The court did not question the school's authority to deny requests for accommodations, but ultimately ruled that its actions were discriminatory based on an inability to provide *sufficient evidence* of students' misdiagnosis and/or misrepresentation of their disabilities. The court also ruled that the abruptness of the policy changes was unfair, as it prevented students from complying with the new requirements for documentation of a disability. The ruling was considered a triumph for advocates of disability rights and particularly for students with learning disabilities; however, it also highlighted the need for more accurate methods of diagnosing learning disabilities and a

way to screen out those students who may be misdiagnosed or misrepresenting their learning difficulties.

Today, many of the school's proposed policy changes that were once considered highly controversial are now widely accepted among disability determination offices at postsecondary institutions. For example, it is now common practice to require *recent* documentation of a disability, generally requiring re-evaluation within the past five years. It is also common practice to require that the evaluation be conducted by a licensed or certified psychologist or learning disability specialist (Educational Testing Service [ETS], 2007). This evolution in documentation of learning disabilities has helped to reduce the number misdiagnosed students erroneously receiving accommodations, but the field still lacks a universally accepted means of screening out students who may be misrepresenting their disabilities. This study seeks to establish a reliable method of identifying intentional exaggeration or feigning of a mathematics learning disability.

CHAPTER II

LITERATURE REVIEW

Learning Disabilities

The Increased Prevalence of Learning Disabilities

The percentage of postsecondary students reporting disabilities has steadily increased over the past few decades. Between 2000 and 2008, the number of college students reporting some form of disability grew from 9% to 11% (U.S. Government Accountability Office [GAO], 2009). California postsecondary institutions reported a 20% increase in the number of undergraduates claiming disabilities from 1999 to 2007, while New York colleges and universities reported an approximate 40% increase in students reporting disabilities across this same time period (GAO, 2009).

Disabilities can take various forms. Hearing or visual impairment, serious emotional disturbance, autism and orthopedic impairments represent some of the disability categories. According to the National Center for Education Statistics (NCES), specific learning disabilities accounted for approximately 5% of all disabilities reported by postsecondary students in 2000. In 2008, specific learning disabilities accounted for 8.9% of reported disabilities among college students (GAO, 2009). There is considerable variability among reported prevalence rates of learning disability in college, and the reported rates are believed to significantly underestimate the true number of students with learning disability (Cortiella, 2009). This is partly attributable to a lack of consistency in the methods utilized to identify these students. Prevalence rates are most often based on student self-report, which may be an unreliable method of measurement. According to the

National Center for Learning Disabilities, over half of students who received special education services in high school denied having a disability when surveyed at the time of their transition to college. The prevalence rates have also been affected by differing definitions of learning disability utilized by various surveys. Prior to 1999, Attention Deficit Disorder and Attention Deficit Hyperactivity Disorder were often included in estimates of learning disability. These disorders now account for a substantial percentage of students identified as having a disability. The separation of these students into their own disability category has resulted in a decline in the number of college students considered to have specific learning disabilities, creating the false impression that the rate of learning disabilities is declining.

The increasing incidence of learning disabilities among college students mirrors a marked increase in the prevalence of learning disabilities among elementary and secondary students. The rate of learning disability diagnosis is estimated to have increased by approximately 300% between 1976 and 2000, among school age students (Cortiella, 2009). According to statistics from the U.S. Department of Education, more public elementary and secondary students were receiving special education services for learning disabilities during the 2007-2008 school year, than for any other type of disability (Aud et al., 2010). Learning disabilities (LD) accounted for 39% of students involved in special education. This is in comparison to 21.5% of students receiving services for specific learning disabilities in 1976.

Accommodating Students with Disabilities

The increased prevalence of postsecondary students with learning disabilities is believed to be heavily tied to two legislative items that ultimately served to increase access to disability support services in postsecondary education and improve the quality of academic preparation for higher education through access to special education at the school-age and high school levels. Increasing societal awareness of learning disabilities, increasing popularity of legal recourse in cases of alleged discrimination, and probable overdiagnosis of learning disability have all contributed to the increased prevalence of learning disability in postsecondary populations.

In 1975, the Education for All Handicapped Children Act (Public Law 94-142) ensured elementary and secondary education for all children with disabilities, including specific learning disabilities. The definition of specific learning disability provided in this law, based upon the 1968 definition from the National Advisory Committee on Handicapped Children, became the standard upon which later definitions of learning disability were founded. The issue of definition is one of the most controversial topics in the field of learning disabilities and will be discussed in more detail in a later section. Federal funding was promised to all states that complied with P.L. 94-142 and greatly increased the accessibility and quality of special education for students with learning disabilities.

The Education for All Handicapped Children Act was renamed the Individuals with Disabilities Education Act (IDEA) in 1990. IDEA has been amended several times: in 1991, 1997 and again in 2004. The 2004 amendments constituted the Individuals with Disabilities Education Improvement Act and aligned IDEA with the No Child Left

Behind Act (NCLB) of 2001. This is significant, as No Child Left Behind outlines financial incentives for states that are able to demonstrate improvements in special education services, which may have important consequences with regard to the prevalence and characteristics of students being identified as learning disabled by school districts who stand to gain or lose money based on the breadth and success of programs designed to educate these students. A report from the Manhattan Institute (Winters & Greene, 2009), reiterates that schools receive state and federal subsidies for students with disabilities. The authors argue that schools face several incentives for classifying low performing students (including those who do not meet criteria for learning disability), as requiring special education services. For example, not only do schools gain extra funding for students with learning disability, but in some cases they are able to exempt their disabled students from taking state and national standardized academic tests. Exemption of disabled students (who are often low performing), from standardized tests results in higher mean test scores for the school or district. Winters and Greene argue that that creates yet another incentive for elementary and secondary schools to over-classify students as having a learning disability.

Students who entered the educational system after 1975 were able to benefit from improved special education services and thus were better able to overcome or compensate for their learning disabilities, making them more prepared and better qualified for postsecondary education. These students began enrolling college in the 1990s, which coincides with the large increase in the number of learning disabled students over the past few decades. However, the provisions of IDEA apply only to children ages 3 through 21, who are enrolled in public elementary and secondary schools. This legislation does not

apply to students entering or enrolled in postsecondary institutions. College students with disabilities are protected by the Rehabilitation Act of 1973, and the Americans with Disabilities Act (ADA) of 1990 and its 2008 amendments.

Section 504 of the Rehabilitation Act of 1973, guarantees equal access to postsecondary education for all students with disabilities. It requires all institutions receiving federal funds to provide appropriate accommodations to facilitate academic equality for “otherwise qualified” students. Failure to provide appropriate accommodations is considered discrimination and institutions risk losing their funding from the federal government, which includes money received through student financial aid awards.

The ADA states that individuals (including students) qualify as disabled if they have a mental or physical impairment that substantially limits his or her major life activities in comparison to the general public or “most people.” Life activities include, but are not limited to: performance of schoolwork, learning, thinking and communicating. Simply having a diagnosis of impairment is insufficient for a diagnosis of disability. The individual must have *functional* deficits or impairment. “Otherwise qualified” disabled students in postsecondary settings must meet the academic and technical standards required for admission to the school. Postsecondary institutions are required to provide reasonable accommodations that compensate for the student’s disability and therefore make his or her opportunity for academic success equal to that of their non-disabled peers. These accommodations may take the form of modified academic requirements, modification of testing requirements, or the use of computer-assistive devices or other assistive technology.

Accommodations are intended to correct for any suppression of scores due to a student's disability and should not alter the nature of the ability or skill being measured. Accommodations are meant to level the playing field between students with and without disabilities. According to The College Board (2010), 2% of college-bound high school seniors from the class of 2010, received accommodations on the Scholastic Aptitude Test (SAT). The College Board does not provide details about the specific types of disabilities being accommodated.

Elliott and Roach (2002), report that the most commonly granted accommodations during standardized testing are: individual administration of tests, dictation of responses, small group administration, use of large print or Braille, and extended time on assignments/tests. However, accommodations are often altered to meet students' individual needs, which introduces significant variability into standardized procedures. The authors report that use of accommodations had a medium to large positive effect size for 78.1% of students with disabilities, and for 54.5% of students without disabilities. The fact that accommodations also produced a significant positive effect for students who were not disabled, raised concern that the accommodations were not equalizing scores between those with and without disabilities, but were actually altering the measured construct and therefore compromising the validity and reliability of scores. This viewpoint is also supported by Stanovich (1999), who proposes that granting accommodations to students with learning disabilities is akin to penalizing the academic success of students without a learning disability.

A meta-analysis by Johnstone, Altman, Thurlow and Thompson (2006) found that accommodations did not consistently have positive or negative effects on state

assessment scores of school-age students; however, some accommodations were found to alter the item difficulty or construct being measured, undermining the comparability of scores between students who took the assessment with and without accommodations.

Colleges and universities are required to incur the costs of providing these accommodations to students, though they are not required to provide accommodations that would fundamentally alter or waive the essential academic requirements, or cause excessive financial hardship to the school (GAO, 2009). According to a report from NCES (Lewis & Farris, 1999), the most common accommodations granted at the postsecondary level include alternate examination formats, extended time on assignments and examinations, and tutors. Sixty-nine percent of surveyed public four-year colleges/universities offered course substitutions or waivers to students with disabilities.

Documentation of Disabilities

Federal Law mandates that it is the responsibility of the student to inform postsecondary institutions of his or her disability, and to request or apply for appropriate accommodations. Accommodations cannot be obtained without supplying appropriate documentation of the disability to the institution. Although institutions vary on the type of documentation required, recommendations or guidelines have been published by multiple entities, including the Association on Higher Education and Disability (AHEAD) and the Educational Testing Service. Mapou (2009) summarizes that, generally, documentation must be provided by a qualified professional with the assessment taking place sometime in the last three to five years, and consist of a diagnostic interview and assessment of: 1) ability, 2) achievement, and 3) information

processing (memory, processing speed, auditory and visual perception, executive functioning, and/or motor ability). Documentation must include a specific diagnosis of learning disability and rule out alternative explanations for the observed deficit(s). Percentiles or standard scores must be included and must be related to specific functional limitations that would require accommodation. There must be evidence that the disability has been present since childhood, even if previously undiagnosed (Mapou, 2009). Recommendations and rationale for specific accommodations should also be included.

A study by McGuire, Madaus, Litt, & Ramirez (1996) demonstrated that the majority of documentation provided by college students requesting accommodations does not comply with the AHEAD guidelines. Documentation collected at a large public university over a period of five years demonstrated that almost 50% of reports supposedly documenting a learning disability assessed only ability, which was most often measured in terms of IQ. Assessment of achievement (inherent in most definitions of learning disability) was included in only 49.3% of reports, and information processing was assessed in a mere 19.1% of evaluations. Regardless of whether accommodations were granted based upon this documentation, the majority of these students were inappropriately labeled as having a learning disorder due to inadequate assessment techniques.

Sparks, Philips and Jarovsky (2003), specifically studied college students diagnosed with a learning disability in the area of foreign language. They report that over half of the students already diagnosed with LD did not meet diagnostic criteria, and that most of them had no history of language difficulties prior to college. The authors recommend that evaluators be extremely vigilant when assessing students who did not

have an LD diagnosis prior to entering college, and that postsecondary schools require a verifiable, longstanding history of learning difficulties. They stress the need for a better definition of learning disability and more valid classification criteria, as well as new research focusing on the motivation of students classified as having a learning disability.

Potential Malingering of Learning Disabilities

Not all students requesting accommodations have a true learning disability. The potential accommodations available to students with learning disabilities represent a significant incentive. Malingering is a very real possibility in any situation involving substantial internal or external incentive. It is reasonable to assume that some non-disabled students who are struggling with the academic and social challenges of higher education due to generalized low ability, low motivation/effort, or a psychological disorder, may also be seeking a diagnosis of learning disability in order to receive accommodations. Alfano and Boone (2007) suggest that some non-disabled students may seek a diagnosis of attention deficit hyperactivity disorder or LD, in order to obtain stimulant medications.

Brinckerhoff, Shaw, and McGuire (1993) cite examples of postsecondary institutions that found the majority of students seeking accommodations for learning disabilities were not eligible. The University of Georgia reviewed documentation submitted from 1986 to 1990 and found that 53.6% of these students did not meet diagnostic criteria. The University of Wisconsin-Madison reported similar results when evaluating students with a previous diagnosis of learning disability, as well as students seeking an initial diagnosis of learning disability. It was reported that 82.5% of these

students did not meet criteria for a learning disability. Ohio State University reported that only one-third of students applying for accommodations due to a learning disability were found eligible.

In a study by Wierzbicki and Tyson (2007), out of 92 college students seeking a diagnosis of learning disability (LD), attention deficit-hyperactivity disorder (ADHD), or both, 43.5% did not qualify for any diagnosis. Only three out of the ten students previously diagnosed with LD had their diagnosis confirmed after administration of an objective test battery. The authors found that diagnosis based upon their objective testing was not significantly correlated with prior diagnoses of LD, ADHD or both. Rather than actual learning disability, the students' academic difficulties were attributed to poor study skills, decreased cognitive ability, poor academic preparation, insufficient studying and decreased motivation.

Alfano and Boone (2007) cite an ABC News report, which alleges that of the 300,000 students taking the Scholastic Aptitude Test (SAT) in 2006, 10% were given special accommodations, though it was estimated that only 2% of all high school students at that time had learning disabilities. This suggests that the majority of students earning accommodations on the SAT did not have a formal diagnosis of learning disability during their high school years. The authors also note that accommodations are disproportionately granted to affluent, Caucasian, private school students, which is incongruent with the demographics of students receiving special education services, who presumably have been diagnosed with a learning disability.

These statistics contradict the commonly held belief that students are hesitant to seek diagnosis and accommodations due to the social stigma attached to learning

disabilities. Stigma may be more of an issue in elementary and secondary education, where accommodations and support services tend to interrupt the normal school routine and are much more conspicuous to other students. In a postsecondary setting, accommodations are much less visible and each individual student can decide whether or not to disclose a diagnosis of learning disability to employers or future educational institutions. In essence, students can exert a fair amount of control over the disclosure of this potentially stigmatizing information.

In 1999, NCES reported that, among college students who earned a bachelor's degree in the 1992-1993 school year, students with and without disabilities (including learning disabilities) demonstrated minimal difference in employment and graduate education outcomes (Horn, Berkthold & Bobbitt, 1999). Comparable numbers of students with and without disabilities were employed full-time, making comparable salaries, and with no significant differences in their fields of occupation. There were also no significant differences in the number of students with and without disabilities that applied to, and were accepted to graduate school.

Definitional Issues and the Diagnosis of Learning Disability

Students seeking accommodations in postsecondary education may have a prior diagnosis of learning disability and are hoping to extend accommodations that they received in primary and secondary schools. In contrast, students may be seeking a first-time diagnosis of learning disability as an explanation for poor academic performance in college, with the hope of being granted accommodations that will lead to an improved grade point average. Unquestionably, there are many college students who could benefit

from accommodations due to a learning disability, and is possible that a learning disability might go unnoticed in earlier years of education. It is not uncommon for students to be able to compensate adequately for their learning disabilities throughout primary and secondary school, but begin to struggle when they are confronted with the more rigorous demands of postsecondary education, prompting them to present for an initial learning disability evaluation at this late age (Shapiro & Rich, 1999). Due to the extensive time and effort required of personnel who complete learning disability assessments at postsecondary institutions, as well as the long wait-list that inevitably accrues for such evaluations, Brinckerhoff et al. warn that it is necessary to carefully assess the need for each evaluation.

There have been several U.S. Supreme Court cases concerning the alleged failure of institutions to provide reasonable accommodations to students with disabilities (Scott, 1994). While the risk to institutions for failing to comply is quite serious, the legislation protecting students with disabilities was written in vague terms with little to no guidance regarding implementation. The terms “otherwise qualified student” and “appropriate accommodations” have been interpreted and operationalized in very different ways. The government provided implementation guidelines in 1977, and the 2008 amendment to the Americans with Disabilities Act sought to clarify these terms. This has resulted in the establishment of new admission policies and support services for students with disabilities to help prevent intentional and unintentional discrimination. However postsecondary institutions continue to utilize a wide variety of definitions and diagnostic criteria for learning disability.

It is reasonable to question the validity of the recent upsurge in students diagnosed with learning disabilities at all age levels. Brinckerhoff, et al. (1993) note that the diagnosis of learning disability has drastically increased while the diagnosis of other types of disabilities, particularly mild mental retardation, has significantly decreased. This suggests that students with conditions such as low cognitive ability, ADHD or psychological disorder may be inappropriately receiving a diagnosis of learning disability. Misdiagnosis may be partly attributable to lack of consistency in the definition and assessment of learning disability. The financial issues involved in the identification of learning disability may also be to blame. As noted above, elementary and secondary schools receive additional funding for students labeled as having a learning disability as opposed to having low cognitive ability (Dwyer, 1987). It could be assumed that postsecondary institutions concerned with enrollment and retention numbers would rather provide support services to a student diagnosed with a learning disability, than risk losing tuition income when a student with low cognitive ability leaves the institution because he or she was unable to cope with the challenging academic environment.

In 1993, Brinckerhoff et al. suggested that postsecondary institutions adopt the definition of learning disability developed by the National Joint Committee on Learning Disabilities (NJCLD).

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, and 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. (National Joint Committee on Learning Disabilities, 2001).

The current federal definition of a specific learning disability, as stated in the Individuals with Disabilities Education Improvement Act of 2004 (IDEA), refers to:

A disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which may manifest itself in an imperfect ability to listen, speak, read, write, spell, or to do mathematical calculations. The term includes such conditions as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia. The term does not include children who have learning disabilities that are primarily the result of visual, hearing, or motor handicaps, of mental retardation, of emotional disturbance, or of environmental, cultural, or economic disadvantage.

Discrepancy Models

Regulations for establishing classification criteria for learning disability previously included the requirement of a severe discrepancy between academic achievement and intellectual ability (Reschly, Hosp, & Schmied, 2003). Reference to such a discrepancy has been included in definitions of learning disability dating back to 1965, when Bateman defined learning disability as involving a discrepancy between estimated intellectual potential and actual level of performance (Carrier, 1986). While the requirement of a discrepancy between ability and achievement is common among definitions of learning disability, it is hotly contested and there is no consistent method for determining such a discrepancy. The Diagnostic and Statistical Manual of Mental Disorders – 4th Edition – Text Revision (American Psychiatric Association, 2000) defines a learning disorder as academic achievement “substantially below” the individual’s expected age, grade, and intelligence (p.49). “Substantially below” is later described as *usually* two standard deviations between achievement and IQ. In practice, many professionals use a discrepancy of at least 1.0 to 2.0 standard deviations, though this criterion was chosen arbitrarily, with no research supporting its reliability or validity in identifying learning disabilities (Reschly et al, 2003).

In addition to learning disability, there are many other reasons why a student’s achievement may be significantly lagging behind ability, with poor motivation or limited educational opportunities being two of the more obvious possibilities. Individuals with limited educational opportunities often perform poorly on measures of both ability and achievement, and do not exhibit the necessary discrepancy despite the presence of

learning deficits. Individuals who never learned how to read or write have been found to produce a pattern of neuropsychological deficits similar to individuals with reading disabilities, though clearly the etiology is potentially very different (Mapou, 2009). Studies have also shown significant variability among the mean IQ scores of different ethnic groups. A lower IQ makes it more difficult to demonstrate the necessary discrepancy against achievement; therefore some ethnic groups are disproportionately underdiagnosed based on the discrepancy model (Stanovich, 1999).

In theory, tests of cognitive ability (or IQ) are measuring a construct that is qualitatively different from the construct of academic achievement. In the context of learning disabilities, cognitive ability is intended to represent one's potential level of school performance, while achievement represents one's actual level of performance. According to discrepancy models, a significant difference between potential and actual performance constitutes impairment in the ability to learn and process information.

There has been longstanding debate about how best to measure intelligence or cognitive ability, as it is generally believed to be a multifaceted entity comprised of numerous different types of skills, some of which are abstract and extremely difficult to quantify, such as the concepts of creativity and cognitive flexibility. Discrepancy models of learning disability necessitate that these various facets of cognitive ability be condensed into a unified number to be compared to one's score on a measure of a specific academic skill. The expected strengths and weaknesses across these facets of intelligence are lost when grouped into a single IQ score; therefore, the IQ score may not be at all representative of an individual's potential ability in a specific area of functioning, such as mathematics or reading. Thus, the IQ/achievement discrepancy would be an unreliable

indicator of impaired ability to learn and process information. Furthermore, the tests commonly used to measure intelligence often involve assessment of factual knowledge or skills that are taught in school. For example, tests of cognitive ability frequently involve assessment of vocabulary and ability to solve math problems. These represent skills that are presumably taught in the classroom. If a student has a true learning disability, he/she is less likely to learn this information in school and therefore will be unable to correctly answer these items on the test of cognitive ability. This represents a significant confound, as the line between potential academic performance and actual academic performance is blurred, negating the validity of the proposed ability/achievement discrepancy. According to Spreen and Strauss (1998), the correlations between IQ and academic grades is approximately .50, suggesting that IQ is far from perfect at predicting school performance. Additionally, due to wide variability in the rate of normal early academic progress, it is difficult for students to achieve a discrepancy of sufficient magnitude before the third or fourth grade, thus delaying the opportunity for special education services until the child has fallen significantly behind his or her peers academically (Silver & Hagin, 2002).

Absent from the federal definition of learning disability is the requirement of average to above average intellectual ability. While not included in some definitions of learning disability, this criterion is widely used in identification of learning disability, both in research and in practice (Brinckerhoff et al., 1993; Dalke, 1988; Hughes & Smith, 1990). The discrepancy formula fails to establish a floor for ability level, under which the student would be diagnosed with low cognitive ability or mental retardation (sometimes referred to as “intellectual disability”) rather than a learning disability. Many definitions

of learning disability require proof of localized skill deficits in a specific domain, relative to average or above average general IQ. These definitions distinguish between specific learning disability and generalized low cognitive ability, but this is also a point of contentious debate in the field of learning disabilities. Stanovich (1999, 2005) whose research has specifically focused on reading disabilities, argues that average IQ is not necessary for a diagnosis of learning disability. He states that the same deficit in phonological awareness underlies poor reading ability in both low IQ and high IQ individuals who struggle with reading, and both groups benefit from the same form of remediation. Under the discrepancy model, only the poor readers with high IQ are diagnosed as having a learning disability and therefore gain access to remediation opportunities. Stanovich proposes that learning disability is unrelated to IQ, and should be diagnosed based on achievement scores alone. According to this reasoning, low ability need not be differentiated from learning disability.

Mapou (2009) explains that a diagnosis of disability is sometimes based exclusively on documentation of below-average skills. This does not take into account the possibility that an individual may be functioning well above average in most areas, but have a *relative* weakness in a localized skill area. Functioning in that circumscribed area may be assessed as falling within the average range, which fails to meet the “below-average skills” criteria for a disability. However, that average performance represents a significant deficit relative to the individual’s superior functioning in all other skill domains. This point becomes particularly complex in the case of postsecondary students seeking a diagnosis of disability.

The rights of postsecondary students fall under the ADA and not the IDEA; therefore establishing a relative academic weakness is not sufficient. According to the ADA, individuals must demonstrate functional impairment. In case law, functional impairment has been interpreted as meaning greater than normal difficulty functioning in an area of everyday life. There is still considerable room for interpretation of what constitutes greater than normal. Additionally, if there is objective evidence of impairment in daily functioning, the documentation of performance deficits is not necessary for a diagnosis of disability. In contrast, an individual with documented deficits may not qualify for a diagnosis of disability if he or she has achieved academic success in the classroom and on standardized assessments, without the use of accommodations (i.e., he or she has learned and implemented effective compensatory strategies), because there is no evidence of functional limitation.

The recent influx of students seeking accommodations on college or postgraduate entrance examinations has led to more strict interpretation of the definition of disability and, therefore, fewer students are being granted accommodations. Often, students who have received accommodations throughout their academic career are suddenly unable to qualify for accommodations on postgraduate entrance examinations, because their learning disability was diagnosed based on outdated approaches, like the discrepancy model, which does not take into account functional impairment.

At the elementary through high school level, implementation of educational policy is left largely to the individual states. The federal government has encouraged states to adopt its policies regarding special education by offering federal money. A comparison of the various state definitions and criteria for learning disability was

conducted by Reschly, Hosp, & Schmied (2003) and demonstrated that the majority of states had adopted the federal definition and the discrepancy criteria, although there were large variations in the criteria utilized. Only nine states were found to be using a definition that significantly differed from the federal definition, yet state prevalence of learning disability in the school age population ranged from 2.96% to 9.46% across states. Only one state required average or above average intelligence, and only nine states required intelligence above the cutoff for mental retardation. States without any intelligence criteria allow students with low cognitive ability to be identified as learning disabled and thus receive special services. Some students applying for accommodations at the college level may fall into this category (Brinckerhoff, 1993).

According to Reschly et al., only 13 states were found to require documentation of a processing disorder, despite its inclusion in the majority of state LD definitions. Low achievement was found to be universal among state criteria, although states without criteria for intellectual ability did not differentiate between low achievement due to low ability, versus low achievement due to a specific learning disability. At the time of the study, in 2003, states were universal in the use of the exclusion criteria listed in the federal definition (visual/hearing impairment, mental retardation, emotional disturbance, etc.). Almost all states used the discrepancy criteria, although only 58% of states provided guidelines for determining that discrepancy, and the methods used varied widely across states. In addition, two-thirds of states allowed local education agencies to give a diagnosis of learning disability even if the criteria were not met (Reschly et al., 2003). In a survey of state education agency personnel, the majority agreed that learning

disability was being diagnosed too often, particularly in minorities, in an effort to ensure that students without a true learning disability could receive services.

The Individuals with Disabilities Education Improvement Act became effective in July 2005. It states that elementary and secondary schools do not have to require a significant discrepancy between intellectual ability and achievement in order to establish a specific learning disability. Instead, schools may diagnose a specific learning disability by using any “process” to determine if a student responds to scientific research-based interventions in the educational setting. A diagnosis may be made on the basis of a student’s failure to meet age or grade-level standards, as determined by the state. It is still relatively early in the implementation of these legislative changes, and it remains uncertain whether the number of students being diagnosed with learning disabilities will increase exponentially, based on this much more liberal set of criteria.

As previously noted, students transitioning into postsecondary institutions are no longer protected by IDEA. Instead, they are protected by the Americans with Disabilities Act (ADA) and Section 504 of the Rehabilitation Act. This is significant, as the ADA criteria for a diagnosis of disability is much less broad than the criteria set forth by IDEA. It is designed to ensure *equal access* to education for all individuals, while IDEA ensures *academic success of all students*, by requiring specialized instruction for students with disabilities. The ADA applies to all individuals (not just students), unlike IDEA, which specifically targets students in Kindergarten through 12th grade. Under the ADA, accommodations are not required or guaranteed for postsecondary students and they must serve as their own advocate rather than have school staff advocate for them (Gormley, 2007; Mapou, 2009). Evidence of cognitive impairment or academic difficulties is not

sufficient for a diagnosis of disability under the ADA. There must be documentation of significant limitation in a major life activity, which can include learning. It is generally recommended that a diagnosis of learning disability in young adults should not be based on the discrepancy model, but rather based on comprehensive clinical assessment of a broad range of academic and neuropsychological skills (Mapou, 2009).

Learning Disabilities in College Populations

The majority of research concerning learning disabilities has been conducted with children. Research on the performance profiles of college students is relatively new, yet important for assessing the impact of learning disabilities in higher education. It was once believed that learning disabilities did not persist into adulthood, but several studies have shown that certain deficits remain significant beyond adolescence (Corodoni, O'Donnell, Ramaniah, Kurtz, & Rosenshein, 1981; Dalke, 1988; Salvia, Gajar, Gajria, Salvia, 1988).

Corodoni et al. (1981) cite several studies of children's performance on the Wechsler Intelligence Scale for Children and its revision (WISC, WISC-R) that found children with learning disabilities show marked deficits on the Arithmetic, Coding, Information, and Digit Span subtests. This profile, known as the ACID profile, was consistent enough to be used as an indicator of learning disability among children. Another common profile of WISC performance in learning disabled children cited by Corodoni et al., is the Sequential factor group proposed by Bannatyne. This factor group is composed of the Digit Span, Arithmetic, and Coding (Digit Symbol Coding on the WAIS) subtests and produces significantly impaired performance from learning disabled children. Corodoni et al. attempted to replicate these findings in college students. The

sample consisted of 57 college students with a mean WAIS Full Scale IQ of 108, who had been previously diagnosed with a learning disability before enrolling in college. The control group was matched for age and IQ, and was screened to exclude any students with learning disabilities or brain injury. Results revealed that the WAIS ACID profile correctly classified 82% of the learning disability subjects and 94% of controls, with Digit Span being the most sensitive and Arithmetic being least sensitive to learning disability. Bannatyne's Sequential factor group was also successful at differentiating between learning disability subjects and controls. This study by Cordoni et al. suggests that the deficit patterns observed in children with learning disabilities persist into adulthood.

A review of the literature pertaining to performance of college students with learning disabilities was conducted by Hughes and Smith (1990). The authors conclude that students with learning disabilities who are admitted to college, generally possess average or above average intellectual ability, as evidenced by average WAIS Full Scale IQ scores.

Dalke (1988), compared the performance of college students with and without learning disabilities on the Woodcock-Johnson Psycho-Educational Battery. Participants in this study were first-semester freshmen involved in a federally funded support program for college students with learning disabilities, making this sample comparable to the sample used in Cordoni et al. (1981). Control subjects were first-semester freshmen volunteers who were screened for previous participation in special education services. Students with learning disability performed significantly lower than controls on all cluster groupings across ability and achievement, except for two clusters concerning

scholastic and nonscholastic interests. These results are consistent with findings from Cordoni et al., suggesting that deficits due to learning disabilities persist into adulthood. Dalke also concludes that college freshmen with learning disabilities do not perform as well as their counterparts and are not academically competitive at the college level, unless they are provided with supports to level the academic playing field, a conclusion also supported by Rath and Royer (2002).

As outlined above, there is wide variability in the way postsecondary schools operationalize the ADA definition of disability. Brinckerhoff et al. (1993) proposes that learning disability assessments of college students require normal or above average performance in at least one domain, in addition to a significant weakness in one or more of the following areas: math, reasoning, writing, reading, speaking, listening, or a particular subject area. The authors propose that a deficit must be demonstrated in executive processes, attention, memory, organization, learning efficiency, knowledge base, or cognitive processes. Several areas of weakness is suggestive of low ability or limited educational opportunities, while a profile of variable strengths and weaknesses across many areas is characteristic of a learning disability.

Tests commonly used in the assessment of learning disability in college students include the Wechsler Adult Intelligence Scale – 3rd Edition (WAIS-III), the Woodcock-Johnson III Tests of Cognitive Ability and Achievement, and the Wechsler Individual Achievement Test (WIAT) (AHEAD, 2003; McGuire, Madaus, Litt, & Ramirez, 1996). The Wide Range Achievement Test – 3rd Edition (WRAT-3) is a popular measure of achievement, and often used in research on learning disability, but it is not comprehensive enough to be used with this population and therefore should be utilized

only as a screening measure (AHEAD, 2003). Instruments used to measure specific information processing domains, such as visual and auditory perception, memory, and motor abilities are helpful in determining a more precise profile of strengths and weaknesses.

Mathematics Disability

Definition of Mathematics Disability

Learning disabilities in the area of reading have dominated the research literature even though the prevalence of mathematics learning disabilities has been reported, in some instances, to be approximately equal to that of disabilities in reading; comprising approximately 5 to 8% of the school age population (Geary, 2004; Ginsburg, 1997). In contrast, the American Psychiatric Association (2000) reports the prevalence of reading and mathematics learning disability to be approximately 4% and 1%, respectively. It is difficult to estimate the true prevalence of any specific learning disability, because of significant overlap between disability subtypes and the failure of many studies to differentiate by disability subtype. Recently, more attention has been focused on disabilities in mathematics and the volume of research is steadily growing. Without delving into the theoretical question of “what is mathematics,” it is difficult to establish a meaningful definition of learning disabilities in this area. The literature even fails to agree on a single term used to describe this constellation of academic difficulties (learning disability, learning disorder, specific math disability, arithmetic disorder, mathematics disorder and dyscalculia). In a vague and difficult to operationalize definition, the American Psychiatric Association (2000) refers to Mathematics Disorder as mathematical

calculation or reasoning ability that is *substantially below expected levels* based on age, education, and intelligence.

Mazzocco (2005) cautions that the lack of consensus about what criteria are used to define/diagnose mathematics disability creates a significant confound in the research in this area. Different studies define math disability in different ways, and therefore populations may vary significantly in their specific deficits. Without sound research on patterns of skill deficits in math disability, the field cannot establish a universally accepted definition and diagnostic criteria.

Multiple subtypes of mathematics disability have been proposed many of which involve concomitant deficits in reading, spelling, or both (Brandys & Rourke, 1991; DeLuca, Rourke, & Del Dotto, 1991; Fleischner & Garnett, 1987; Geary, 1993; Geary & Hoard, 2001; Ginsburg, 1997; Morris & Walter, 1991; Rasanen & Ahonen, 1995; Rourke, 1993; Rourke & Del Dotto, 1994; Share, Moffitt, & Silva, 1988; Silver, Pennett, Black, Fair, & Balise, 1999; Strang & Rourke, 1985; White, Moffitt, & Silva, 1992). It has been argued that the types of deficits in specific math disability are qualitatively different from the deficits seen in disabilities involving both math and reading.

Geary (1993) proposes three subtypes of mathematics learning disability (MLD). The first subtype is characterized by procedural deficits. These individuals tend to use developmentally immature procedures, make frequent procedural errors, have a poor understanding of the basic underlying concepts, and exhibit sequencing difficulties. The overall performance of these individuals can be summarized as developmentally delayed, as their performance is similar to that of younger children.

The second subtype is characterized by semantic memory deficits. These individuals have difficulty retrieving math facts from long-term memory and there are often errors in the facts that they are able to retrieve, suggesting that retrieval deficits resistant to instructional intervention might be an indicator of mathematics learning disability. In contrast to a developmental delay, this second subtype is believed to represent a qualitative difference in cognitive processes underlying math ability. It is believed to be associated with dominant (most often left) hemisphere dysfunction and perhaps involvement of subcortical regions. The final subtype is characterized by poor spatial representation of numbers and other mathematic information. These individuals often misinterpret spatially represented mathematical information. It is believed to be associated with non-dominant (most often right) hemisphere dysfunction, more specifically visuospatial deficits.

Impairments in visuoperceptual and visuospatial abilities are often cited in the research literature as being commonly observed in children with specific math disabilities (Fleischner & Garnett, 1987; Pennington, 1991). McCue and Goldstein (1991) propose that visuoperceptual, visuospatial, and visuomotor abilities are key for development of mathematical skills and should be carefully evaluated in learning disability assessments for children. Visuoperceptual ability has been found to account for more variance than intellectual ability in the area of math achievement (Pennington, 1991). However, there is evidence that these deficits are not as universal or important among college students with mathematics learning disabilities. It has been hypothesized that early difficulties in mathematics may be due to a delay in visuospatial skills, preventing learning of basic math skills and concepts. Once visuospatial skills improve, the individual is still at a

disadvantage because he or she never adequately learned the fundamentals of mathematics, thus preventing learning of more advanced and complex concepts even though there are no longer deficits in visuospatial skills (Morris & Walter, 1991).

In a study of 300 college students referred for evaluation due to difficulties in their mathematics coursework, visuospatial skills were not significantly correlated with math skills (Cirino, Morris & Morris, 2002). Executive functioning and semantic retrieval abilities were found to be most predictive, although they only accounted for a combined 17% of variability in scores of calculation skills. It was proposed that any predictive contribution of visuospatial abilities was accounted for by overlap with executive functioning or semantic retrieval abilities.

Specific mathematics disability has also been shown to correlate with deficits in tactile-perceptual and psychomotor skills, with intact rote verbal skills (White, Moffitt, & Silva, 1992). Memory abilities are important in mathematics, and are necessary for recalling the meaning of numbers and symbols, retrieval of steps in a given operation, and recall of previous experience with mathematics to know if a given answer is reasonable (Morris & Walter, 1991). Poor encoding ability is believed to underlie disabilities in mathematics, although retrieval abilities are also below average (DeLuca, Rourke, Del Dotto, 1991). This means that the biggest memory problem in math LD concerns adequate acquisition of necessary information. Encoding ability can be affected by attention, which some researchers believe is a key component in learning disabilities (Cordoni et al., 1981). Retrieval of information that has been successfully encoded is below average, but not significantly impaired for individuals with math LD. Geary and Hoard (2001) suggest that impairments in working memory allow information to

deteriorate before it can be encoded, and abnormal development of the prefrontal cortex interferes with retrieval abilities.

Baddeley's model of working memory incorporates many of the skills discussed above. He proposes that a central executive processing center, which controls attention and sensory input, communicates via a constant feedback loop with a phonological loop for temporarily rehearsing acoustic or language-based information for immediate retrieval. Measures such as the Digit Span subtest of the WAIS-III, are an example of information that would be held in working memory via the phonological loop. The central executive system also communicates with the visuospatial sketchpad, which allows for manipulation, storage and retrieval of visual and spatial information. The Rey-Osterrieth Complex Figure is an example of a task that measures this aspect of memory.

To further complicate matters, frequent computational errors lead to incorrect associations between problems and answers being stored in long-term memory (Geary, 1993). The combination of deficits in visual and memory abilities leads to difficulties on tasks of visual memory, measured by requiring individuals to reproduce drawings from memory. The addition of psychomotor difficulties makes visual memory tasks requiring drawing even more sensitive to math learning disabilities (Rourke & Del Dotto, 1994).

Rourke (1993) provides a list of seven specific types of arithmetic errors often observed in individuals with math LD: 1) spatial organizational errors resulting in misaligned columns of numbers and problems with the direction of operations (subtracting the larger number from the smaller number); 2) errors of visual detail including neglect of details such as decimal points in answers, and misreading numbers or symbols; 3) procedural errors involving omission of steps or addition of extraneous

steps in a mathematical procedure, or using the wrong procedure for a given operation; 4) failure to shift set, occurring when the individual perseverates and fails to use a different procedure when the operation changes; 5) graphomotor errors resulting from poor handwriting and an inability to interpret one's own writing; 6) errors of memory occurring when the individual fails to remember a given mathematical fact, even if temporary, evidenced by remembering the necessary fact at a later time or on a later problem; 7) judgment and reasoning errors including failure to notice unreasonable answers, poor planning for solving novel problems, and attempting problems that are beyond the individual's range of skill.

This list reveals that many of the errors seen in math LD are due to a poor understanding of the basic concepts underlying mathematics and the reasoning behind mathematical procedures. Analysis of the types of mathematical errors produced on an LD assessment is critical in identifying the underlying pattern of deficits and for recommending appropriate accommodation or remediation strategies.

The term dyscalculia refers to a developmental difficulty resulting in general impairment in all areas of mathematical skill (Fleischner & Garnett, 1987). The type of impairments seen in dyscalculia are very similar to the impairments observed in mathematical learning disabilities, which has led some authors to consider them one disorder (Geary, 1993). However, there are also many authors who maintain a distinction between the two, citing not only etiology, but also the fact that deficits in dyscalculia tend to be more widespread, whereas deficits in mathematical learning disability are more circumscribed (Shalev, Manor, Karem, Ayali, Badichi, & Friedlander, 2001). This distinction might be important if diagnosis of learning disability strictly adheres to the

federal or NJCLD definitions, but given the wide variability in criteria and the difficulty of distinguishing between developmental disorders and learning disabilities in adulthood, assessments will not be likely to differentiate between the two. Most definitions of learning disability include the exclusion of poor academic skills due to environmental factors or emotional problems. Poor development of mathematical skills has been tied to poor teaching, low intellectual ability, environmental deprivation, and anxiety (Shalev, Manor, Kerem, Ayali, Badichi, Fiedlnder, & Gross-Tsur, 2001).

Diagnosing Mathematics Disability

There are no measures specifically designed to diagnose math learning disability in the postsecondary population. Most research and assessments rely on standardized achievement tests in combination with measures of intellectual ability. Lower than expected math achievement, relative to ability, is not sufficient for a diagnosis of mathematics learning disability. Rourke has produced one of the most extensive collections of research in the area of mathematical learning disabilities, and routinely uses the discrepancy between WRAT Arithmetic and Reading/Spelling scores to identify this disorder. WRAT Arithmetic scores at least 15 points or two grade levels below Reading and Spelling scores is effective at identifying children with specific math disability, but is not reliable at identifying college students with this disability (Strang & Rourke, 1985).

Hanich, Jordan, Kaplan, & Dick (2001) used composite scores below the 35th percentile from the Calculation and Applied Problems subtests of the Woodcock-Johnson Test of Achievement to identify math LD.

Silver, Pennett, Black, Fair, & Balise (1999) used the WRAT-R Arithmetic subtest and the Calculation or Applied Problems subtests of the Woodcock Johnson-Revised to assess for math LD. In a sample of 26 children between the ages of 9 and 13 who were diagnosed with a specific arithmetic learning disability, only 50% continued to display arithmetic deficits after 19 months. The authors conclude that math LD subtypes are not necessarily stable over time. This reinforces the need for college students with previous diagnoses of math LD to be re-tested at the postsecondary level.

In the Hughes and Smith (1990) study of college students with learning disabilities, math performance was measured by the Math Achievement subtest of the Woodcock Johnson Test of Achievement, with standard scores ranging from 89 to 104 for learning disability students. College students with learning disabilities earned an average grade equivalency of 7.3 on the Arithmetic subtest of the WRAT. Hughes and Smith noted that the tests often used to assess mathematical difficulties in college students are adequate only as screening measures, because they do not assess higher order math skills similar to those required in college coursework (i.e., standardized assessment instruments rarely assess advanced math skills, such as calculus and/or advanced statistics).

Mathematics Disabilities and College Students

Studies have found that some mathematical learning disabilities continue into adulthood and can present significant problems at the college level (Cirino, Morris, & Morris, 2002). Nevertheless, difficulties in mathematics are considered more common than other types of academic deficits, and are more socially accepted (Fleischner &

Garnett, 1987). According to NCES (Wirt et al., 2004), 28% of incoming college freshmen in the fall of 2000, were enrolled in remedial courses, with 22% of freshmen taking remedial courses in mathematics. Ginsburg (1997) goes so far as to describe the American culture as “math-phobic” (p.23). Mathematics does appear to be an area of relative weakness for college students, as evidenced by the high percentage of non-disabled students requesting and receiving remedial help in this subject (HEATH, 2001). It is also one of the most common course requirements to be waived for students requesting accommodations for a learning disability (Rath & Royer, 2002). McGlaughlin, Knoop and Holliday (2005) reiterate that there is a qualitative difference between college students who have an actual mathematics learning disability, versus non-disabled students who simply struggle in mathematics.

McGlaughlin et al. (2005), analyzed data from a pool of college students presenting for mathematics learning disability evaluations. When data from students eventually diagnosed with math LD was compared to data from students who were not given the diagnosis, they found that college students with math disabilities demonstrated significant weaknesses in the areas of reading comprehension, nonverbal reasoning, working memory and math fluency. Attention difficulties were not able to differentiate between students with and without mathematics disabilities. The authors cited these findings as proof that learning disability was characterized by a more complex set of deficits than a mere discrepancy between IQ and achievement scores. A major limitation of this study is the lack of a normal or control population. It is assumed that the students in this study who did not receive a diagnosis of mathematics disability were nonetheless experiencing difficulties in math, for whatever reason; or there was a comorbid condition

responsible for their struggle, thus their performance on the various test measures was not indicative of a “normal” or “typical” college student, as some unidentified factor was causing difficulty with mathematics.

The vague language of “appropriate accommodations” used in Section 504 of the Rehabilitation Act of 1973 allows for a wide variety of services and modifications granted to postsecondary students with learning disabilities. Institutions decide what type of accommodations will be available. Rath & Royer (2002) conducted a comprehensive review of the literature regarding accommodations provided to college students with learning abilities. The most common accommodation is tutoring (used by 89% of institutions), followed by extra time for taking tests (88%). The majority of institutions also used strategy or study skills training, teaching student self-advocacy, audiotaped textbooks, note takers, and readers. Although less than one quarter of faculty and administrators felt that it was appropriate, 42% of institutions were willing to waive course requirements or allow course substitutions, most commonly in the areas of foreign language and mathematics (Rath & Royer, 2002; Yost, Shaw, Cullen, & Bigaj, 1994).

Those who argue against course waivers and substitutions cite the compromised integrity of the educational curriculum, and a less comprehensive education for students who earn a degree equivalent in comparison to students that completed all degree requirements. If the educational experience can be deemed sufficient without completion of a required course, the institution must ask itself why the requirement exists. The appeal of course waivers and substitutions is obvious for students, particularly those who have received poor grades in a given subject area, or those who are struggling to fulfill a

course requirement prior to graduation. [A search of the literature did not produce any statistics on the prevalence of students seeking course waivers or substitutions.]

Taking into consideration the prevalence of requests for accommodations of learning disabilities that are found to be unsubstantiated, and the higher frequency of requests for accommodations in the area of mathematics, it can be inferred that a large portion of college students seeking evaluations for a learning disability in mathematics do not truly have an LD. Despite the commonality of weakness in mathematics, there is evidence of a specific learning disability in this domain that necessitates remediation and, in some cases, accommodation. Identifying students with subtypes of mathematical disabilities that involve other areas of deficits (reading, spelling, etc.) might be considered less difficult, because there is a wider range of deficits to detect. Identifying specific math disability is more challenging, because the range of deficits is more restricted and very similar to difficulties seen in low math ability. Differentiating a true mathematics disability from common difficulties or low ability in mathematics is a formidable challenge for postsecondary institutions (Ginsburg, 1997). According to Stanovich (1999, 2005), there is no need to differentiate students with low math ability from students with specific math learning disability. However, this argument seems to be less valid in the postsecondary setting. While college students may receive accommodations, they will not necessarily receive remediation. At the college level, there is no requirement that schools must attempt to “fix” the learning impairment. The new concept of response to intervention has little applicability at the postsecondary level, and is not useful as a means of diagnosing learning disability. It seems that there is some validity to separating low ability from learning disabled at the college level, as the very

nature of the college admissions process is often to recruit the most highly-abled students from the applicant pool.

When LD assessments of college students requesting accommodations indicate that a true learning disability is not present, there seem to be two potential explanations: either the student genuinely believed that he/she had a disability based on a previous diagnosis or based on academic struggle, or the student intentionally exaggerated or feigned difficulties in order to gain a diagnosis of LD in hopes of being given academic accommodations? The appeal of course waivers or substitutions in an area of academic struggle is undeniable and according to the given statistics, students are not afraid to seek those accommodations. With course waivers and an improved grade point average as just two of many potential benefits of being diagnosed with a learning disorder, the possibility of malingering must be considered in all LD evaluations at the postsecondary level. Regardless of whether one chooses to include students with low math ability in the category of mathematics disability, there should be consensus in the field that it is important to differentiate feigned or exaggerated impairment from true learning disability.

Malingering

Definition of Malingering

Malingering is defined as the intentional misrepresentation or exaggeration of symptoms for the purpose of obtaining external incentives (American Psychiatric Association, 2000). The concepts of intentional and external incentive are key in differentiating malingering from Conversion Disorder or Factitious Disorder. Conversion

Disorder can involve the same exaggeration or simulation of symptoms, though the behavior is unintentional. Factitious Disorder involves feigning symptoms for internal rather than external incentive (American Psychiatric Association, 2000). Malingering, or dissimulation, is actually quite prevalent and is regarded as a major area of concern for psychologists, particularly those involved in assessment (Giuliana, Barth, Hawk, & Ryan, 1997). Depending on the context and purpose of the evaluation, estimates of malingering have been as high as 50% (Rogers, 1997).

The majority of the literature on malingering comes from the field of forensic evaluations, particularly from the study of individuals involved in personal injury or disability litigation. Such individuals typically undergo neuropsychological testing, and it is often this testing that lends veracity to (or fails to support) their claims of impairment. For example, Larrabee (2007) reports that base rates of malingering in forensic populations are estimated to vary from 8% (general medical patients) to 40% (personal injury litigants alleging mild traumatic brain injury). One study of Social Security Disability applicants reported that 72.4% met criteria for a diagnosis of definite or probable malingering.

Slick, Sherman and Iverson (1999) proposed that malingering involved the “volitional exaggeration or fabrication of cognitive dysfunction for the purpose of obtaining substantial material gain, or avoiding or escaping formal duty or responsibility.” (p.552) They cite three categories of malingered neurocognitive dysfunction: 1) definite malingering, characterized by the presence of external incentive to malingering and definite negative response bias (such as below chance performance); 2) probable malingering, characterized by the presence of external incentive plus failure on

two or more effort tests (excluding below chance performance), or failure on one effort test and one instance of non-credible self-reported symptom or test data discrepancy; 3) possible malingering, characterized by the presence of external incentive plus discrepant evidence from self-report. The Slick criteria are widely cited in the malingering literature, but it has not been universally adopted in the field of psychology. While it serves an important role in trying to standardize the diagnosis of malingering, it is questionable how many professionals strictly abide by these criteria when making the diagnosis.

The majority of malingering research has focused on the adult population. Relatively few studies have assessed malingering in child and/or adolescent populations. It is often proposed that children do not engage in malingering, because a) they are not sophisticated enough to organize this type of deliberate, prolonged, alteration of their behavior; or b) they have no motivation to malingering. Faust et al., demonstrated that children and adolescents who are instructed to simulate cognitive impairment are capable of feigning convincing neuropsychological deficits to the extent that they are able to elude identification by experts in the field of neuropsychology (Faust, Hart & Guilmette 1988). In a subsequent article, Faust (1995) warns that psychologists should not underestimate the preparation or sophistication of individuals attempting to malingering deficits. Particularly in this age of widespread dissemination of information over the Internet, examinees have access to information regarding disorders, examination methods, and in some cases, the actual test content and information on interpretation of scores. Additionally, examinees can be “trained” by attorneys or other doctors, on how to believably simulate a disability or disorder.

Lu and Boone (2002) provide a case example of a nine year-old child that was involved in litigation following a traumatic brain injury. It was eventually determined that the child had deliberately feigned cognitive symptoms during a neuropsychological examination, in such a convincing manner as to elicit sympathy from the examiner. From this example, it is apparent that children and adolescents are willing and capable of simulating convincing cognitive deficits during formal neuropsychological examinations, further underscoring the need for assessment of malingering during all types of neuropsychological examinations, and across all segments of the population. Nonetheless, there has been very little research looking at the possibility of malingering in learning disability evaluations (Boone, et al., 2002; Mapou, 2009). This is somewhat surprising considering that the accommodations available to students with learning disabilities can represent the key to maintaining a respectable grade point average in college, and can be instrumental in fulfilling course requirements for one's major or graduation. These could certainly be interpreted as external incentives and could serve as motivation for misrepresenting one's academic skills.

It has been suggested that malingering of learning disabilities is unlikely to occur, because of the social stigma attached to being identified as learning disabled (Rogers, 1997). However, the sheer number of students applying for accommodations, many of whom are found to not meet criteria for a diagnosis of LD, is evidence that social stigma is not a major deterrent for thousands of college students. The absence of any negative consequences from being found ineligible for accommodations may encourage students to assume a "might as well try" attitude.

Just as potential financial settlements provide strong incentive for malingering among personal injury litigants and disability applicants, academic accommodations may represent an equally strong incentive for students seeking a diagnosis of learning disability. Lu and Boone (2002) propose that the potential for malingering is high in learning disability evaluations, as students diagnosed with LD are provided “advantages unavailable to other students, such as untimed or individualized testing sessions, additional academic assistance, and extended deadlines.”

Harrison, Edwards and Parker (2008), report that dyslexia and ADHD have become the most accommodated disorders in North American postsecondary institutions, and there has been a dramatic increase in college students seeking first-time evaluations for ADHD or specific reading disabilities. The authors point out that students with a diagnosed disability not only receive valuable accommodations such as extended time on tests and assignments, but are sometimes granted access to funds for the purchase of assistive technology (i.e., computers), and in some instances, are eligible for tax benefits based on their disabled status. In a related study, they found that college students without a diagnosis of ADHD could successfully feign the symptoms just by reading the diagnostic criteria contained in the Diagnostic and Statistical Manual of Mental Disorders-Fourth Edition. They refer to a study by Sullivan et al, (2007), which found that 47.6% of students seeking evaluation for ADHD and 15.4% of students presenting for evaluation of dyslexia failed the Green Word Memory Test, which is a widely used and well-validated test of malingering. Research has shown that college students are not likely to fail malingering measures based solely on the presence of a learning disability (Alfano & Boone, 2007).

Finally, studies show that close inspection of previous documentation and careful assessment procedures results in a high percentage of rejections among students with a previous diagnosis of learning disability that actually fail to meet minimal criteria for such a diagnosis (Brinckerhoff, Shaw, and McGuire, 1993; McGuire, Madaus, & Litt, 1996; Sparks et. al, 2003). Students may be under the impression (perhaps justifiably so) that it is not difficult to obtain a diagnosis of learning disability, and it simply requires performing poorly in certain classes and exhibiting severely impaired performance on instruments used to assess for a specific area of disability. Given the self-described struggle of U.S. college students in math, their perceived need for remedial help in mathematics, and the fact that more course waivers and substitutions are granted for mathematics requirements than almost any other subject area, it is reasonable to assume that college students might attempt to malingering a mathematics disorder on learning disability evaluations.

Techniques for Detection of Malingering

Indicators of malingering have been studied for almost every instrument utilized in neuropsychological testing, and several free-standing instruments have been developed for the sole purpose of identifying malingering. The utility of a measure's ability to detect malingering is often assessed in terms of its sensitivity and specificity. Sensitivity refers to an instrument's ability to accurately identify a given condition; in this case, malingering. Specificity refers to an instrument's ability to accurately identify the absence of a given condition. Subtracting the specificity from 100% will give the percentage of false positives, which is an easily understood estimate of an instrument's

utility. The overall diagnostic power or efficiency of an instrument can be measured by the combined hit rate, which represents the total percentage of correctly identified cases, both with and without the condition of interest. Measures of malingering often have very high specificity rates typically falling at or above 90%, in order to avoid the potential risk associated with false positives and incorrectly labeling an individual as malingering (Larrabee & Berry, 2007). Due to the need for high specificity, the sensitivity level of malingering measures is usually relatively low in comparison to other diagnostic measures.

Perfect sensitivity is not realistic for malingering measures, but perfect or near perfect specificity is often achieved (Greve & Bianchini, 2007). Use of multiple, unrelated measures of effort is recommended, in order to compensate for low individual rates of sensitivity. Larrabee and Berry (2007) explain that using a combination of effort measures significantly increases diagnostic accuracy without increasing false positives. This is only effective if the measures are not highly correlated with one another. Positive predictive power (PPP) takes into account the base rate of the condition in the sample population and represents the probability of having the condition of interest given a positive test result. Larrabee and Berry argue that failure on a test with a PPP of 1.0 is almost as strongly suggestive of malingering as below chance performance on a forced-choice measure.

There are several instruments designed specifically for detection of malingering. Lezak (1995, 2004) provides a summary of some of these instruments, including the Rey Dot Counting Test, Rey 15-Item Memory Test, Portland Digit Recognition Test, Word Memory Test, and the Test of Memory Malingering. Multiple studies have shown these

instruments to be effective at detecting feigned impairment or dissimulation (Nitch & Glassmire, 2007). These free standing malingering measures are generally simple and most individuals, regardless of their level of actual impairment, are able to perform fairly well. When such tasks are presented to the individual, they are often described as being quite difficult in order to encourage someone who is feigning impairment to over-exaggerate symptoms in an attempt to convince others of their disability. Typically, performance from these individuals is so poor that they perform significantly worse than individuals who legitimately possess the impairments that are being simulated. This extremely poor performance becomes a red flag for suspected malingering (Haines & Norris, 2001). Of course there are some individuals with true impairments who perform extremely poorly, so multiple measures must be considered in determining the presence of malingering (Babikian & Boone, 2007; Larrabee, 2007; Lezak, 1995, 2004; Rogers, 1997, 2008). The presence of learning disability does not appear to significantly compromise effort test performance (Alfano & Boone, 2007).

The majority of malingering measures focus on memory. One popular technique for detecting malingering that is not limited to memory is forced-choice recognition or symptom validity testing (Lezak, 1995; Pankratz & Binder, 1997). This technique can be adapted for any presenting complaint. Several simple multiple-choice items are presented to the individual, with each item composed of a correct response choice and a distracter response. If the individual is truly impaired and unable to perform the given task, he or she will be forced to guess the correct response. There is a 50% chance of guessing correctly for each item. Overall performance that is significantly below 50% (or chance level), is indicative of malingering. Versatility and simplicity has made this one of the

most popular techniques for detection of malingering. Very few individuals score significantly below chance on these forced-choice measures. Sensitivity is typically low, but the measures tend to have good specificity. Boone and Lu (2007) point out that only the most unsophisticated malingerers perform significantly below chance on these tests.

Some of the more popular free-standing measures of malingering include the Test of Memory Malingering (TOMM), Word Memory Test (WMT), Victoria Symptom Validity Test, and the Computerized Assessment of Response Bias (CARB). Green (2009), reports that the WMT is able to correctly identify 97.7% of simulators and 100% of controls. The Test of Memory Malingering has good specificity, making false positives unlikely, but the test has been criticized for being too easy and failing to detect many cases of malingering. A cut-off score of 45 on Trial 2 is associated with a specificity of 91%.

The Rey Dot Counting Test is a free-standing measure of generalized effort comparing the time required for individuals to count a series of ungrouped dots with the time required to count the same number of dots divided into familiar group formations (groupings typically observed on a dice). By easily identifying the number of dots in each group, the individual can multiply this number by the number of groups and quickly calculate the total number of dots. Counting the grouped dots should take significantly less time than counting the ungrouped dots. Additionally, a linear relationship is expected between the number of dots on the card and the number of seconds required to count the dots. Any deviation from this expected relationship is considered suggestive of possible malingering.

Warner-Chacon (1994) found that adult students with learning disabilities were able to pass this measure without difficulty, with only one participant obtaining a mean grouped score greater than his or her mean ungrouped score. No individuals with learning disability exceeded an ungrouped time of 62 seconds or a grouped time of 38 seconds. The mean ungrouped time was 10.2 seconds. Warner-Chacon also found that speed of counting grouped dots was significantly correlated with math skills, visuospatial ability, basic attention and nonverbal intellectual skills. Counting of ungrouped dots was correlated (though not significantly) with visuospatial ability and processing speed. The study looked at the performance of individuals with learning disability on other measures of effort/malingering, and found a very low failure rate. It was concluded that the skill deficits associated with learning disabilities rarely have a significant effect on effort test performance.

Boone and Lu (2007) report similar findings of low failure rates among individuals with LD on measures of effort. In a sample consisting of individuals with learning disability and individuals with a traumatic brain injury, both groups were able to pass the Rey Dot Counting Test without difficulty. Only 7% of the sample required six or more seconds to complete each grouped dot trial. None of the participants with a diagnosis of LD required more than six seconds to complete any of the grouped trials.

A number of different scoring procedures have evolved over the years, some of which involve only the time required to complete each trial, while others involve a ratio of grouped to ungrouped time, or an effort cut-off score that incorporates the number of errors. Boone et. al., (2002) found that the performance of college students with learning disability was reliably different from the performance of forensic and civil litigation

malingers. The authors suggest a cut-off of equal to or greater than 130 seconds for the total grouped trials score, which resulted in a false positive rate of less than one percent among college students with learning disability. An effort cut-off score of 13 was associated with a sensitivity of 88.2%, and a specificity of 90.3%. The authors determined that psychosis and learning English as a second language were both related to an increased probability of false positive findings on the Rey Dot Counting Test. The mean ungrouped counting time among malingerers ranged from 7 to 126 seconds. The mean counting time for individuals with learning disability ranged from 1.2 to 63 seconds.

Another way to identify malingering is to look at performance patterns on standard neuropsychological instruments, which are commonly used as part of a learning disability evaluation. A number of studies have derived embedded malingering indicators for popular assessment instruments such as the WAIS-III, WMS-III, California Verbal Learning Test-II, Rey Auditory Verbal Learning Test, Category Test, and Finger Tapping, to name a few. Iverson & Franzen (1994, 1996) found that performance on the Digit Span subtest of the WAIS-R could be used as an effective measure of malingering. The test measures immediate memory and simple auditory attention, which often remain intact following acquired impairment. Even individuals with severe memory impairment can perform adequately on this measure (Suhr & Barrash, 2007). An age-corrected scaled score of less than 4 correctly classified 75 to 88% of malingerers, with specificity ranging from 65 to 100%.

The utility of the Digit Span subtest in detecting malingering generalizes from the WAIS-R, to the WAIS-III. Numerous studies over the past decade have looked at the

Digit Span subtest as an indicator of malingering. A scaled score cut-off of 4 or less has been consistently associated with a specificity level of greater than 90%. High specificity comes at the expense of sensitivity, which is only 19 to 30% for this cut-off level.

Reliable Digit Span (RDS) is another popular malingering indicator derived from the Digit Span subtest. It consists of the longest string of correctly repeated digits across two trials, in both the forward and backward direction. An RDS of 7 or less is associated with a sensitivity of 68%, while a cut-off of less than 8 digits has been associated with sensitivity falling anywhere between 19 and 71%, with at least 93% specificity (Suhr & Barrash, 2007).

The Logical Memory subtests of the WMS-R and WMS-III have also proven useful in the identification of malingered performance. Iverson and Franzen (1996) found that a Logical Memory I cut-off score of less than 6 resulted in 18% sensitivity and 100% specificity. Raising the cut-off score to 14 resulted in 60% sensitivity and 95% specificity. The Rarely Missed Index was developed by Killgore and DellaPietra (2000), and consists of six true/false items from the Logical Memory Recognition subtest of the WMS-III that are infrequently missed, even by individuals unfamiliar with the stimulus stories. A weighted regression formula was developed and a cut-off score of 136 or less resulted in a sensitivity of 97% and specificity of 100%.

Bernard, Houston, and Natoli (1993) found that a discriminant function involving the recall score from the Rey-Osterrieth Complex Figure Test (ROCFT) and the Rey Auditory Verbal Learning Test (RAVLT) trial 1 and recognition scores could correctly classify 86% of malingerers versus non-malingerers. The ROCFT is a measure of visual memory and visuospatial organization, the latter of which is commonly assessed during

evaluations for mathematics learning disabilities (Mapou, 2009). According to Suhr and Barrash (2007), a score of less than 28 on the copy trial was able to identify 50% of individuals malingering head injury, with a specificity of 91.4%. An immediate recall trial score of less than 10 was able to correctly identify 36.2% of malingerers, with a respectable false positive rate of less than 9%.

There are very few instruments designed to identify malingering of learning disability, much less malingering of a specific math disability. Osmon, Plambeck, Klein and Mano (2006) designed the Word Reading Test to identify malingering of reading disabilities. They found that malingering of specific learning disabilities (math, reading, etc.) is best identified with the use of effort tests that incorporate layperson knowledge or beliefs regarding the types of deficits commonly believed to be associated with the disorder. For example, their Word Reading Test incorporates a forced-choice format with foils involving layperson beliefs about dyslexia (reading disability). Foils included letter reversals (“dad” versus “dab”), homophones (“see” versus “sea”), and substitutions of similar letters (“paint” versus “point”). While measures incorporating these layperson beliefs were most effective at identifying feigned impairment (65% sensitivity, 96% specificity), generalized effort measures were also effective at identifying malingering.

Conducting Research on Malingering

It is important to point out that the majority of the previously mentioned studies on malingering involved individuals simulating head injury. Therefore, the above patterns of performance are seen when trying to appear as if one has sustained lasting cognitive impairment as a result of a head injury. There are no data available to help predict the

types of cognitive impairments that would be simulated if trying to appear as if one had a mathematics learning disability. This would depend somewhat on how knowledgeable the student was about learning disabilities, and what layperson beliefs exist about the performance of individuals with a math disability. It would be reasonable to assume that college students wishing to appear as if they were learning disabled might produce the same types of simulated impairments as individuals simulating head injury, because both are ultimately simulating cognitive impairments. On the other hand, college students seeking a diagnosis of specific math disability might confine their simulated impairments to tasks that involve an obvious mathematic component. In this case, it would be important to look for the general performance patterns typical of learning disabled students, along with performance in areas that are more subtly related to a mathematics disorder, such as memory or visuoperceptual ability. However, because there are no pre-existing data or literature on this topic, research is necessary to discover the symptom simulation patterns of individuals attempting to feign learning disability and compare these to performance patterns of individuals that legitimately meet criteria for a learning disability.

One of the primary difficulties with conducting research on malingering is the near impossibility of gathering a sample of individuals motivated to malingering the specific disorder prior to conducting the study. In reality, the malingering sample is typically composed of individuals without any impairments, who are asked in the study to perform as if they are trying to simulate a given disorder. This presents two main problems: 1) You are asking individuals to simulate malingering, which could produce a qualitatively different performance than seen with true malingerers; 2) It is very difficult to provide an

equivalent level of incentive or motivation to malingering when using analog malingerers. Studies often provide a monetary incentive for participants who are asked to malingering, and participants are sometimes told that eligibility for the monetary reward is dependent upon the individual's ability to produce a believable pattern of impairment (Frederick & Foster, 1991). Another technique involves challenging the participants to beat the test if they are skilled enough (Rogers, 1997, 2008).

Another dilemma is how to present the malingering task and what information to provide the participants. It is important that all participants understand the purpose of the experiment and their role as simulators. The more explicit the instructions, the more uniform the performance of the simulating sample. In some cases, the group of analog malingerers is provided with a specific scenario describing an individual seeking some type of compensation who attempts to prove the existence of his or her impairments when asked to complete psychological testing (Killgore & DellaPietra, 2000). Research shows that there is a qualitative difference in performance between participants asked to simulate malingering and participants asked to simulate a specific disorder. When instructed to simulate malingering, impairments are generally over exaggerated and produce unrealistic patterns of performance (Iverson & Franzen, 1996). By providing participants with a specific scenario as context for malingering, participants may have a better understanding of the task, but it may also limit the generalizability of the findings (Rogers, 1997). Many real-world malingerers possess some knowledge of the type of symptoms typically seen in individuals with a legitimate disorder (Franzen & Martin, 1996). Attorneys can provide this information to clients, or such information can be attained through books or the Internet. In rare occasions the malingering individual has

knowledge about specific test taking strategies to avoid detection of exaggerated or simulated performance.

There are conflicting results as to whether providing analog malingerers with information about specific impairments or specific test strategies helps improve the quality of their simulation. Frederick and Foster (1991) found that providing participants with such information did not significantly improve their ability to avoid detection of malingering, while Franzen and Martin (1996) found that analog malingerers with information were able to produce more believable patterns of performance than participants without information, though both groups of malingerers were still relatively easy to detect with the use of malingering indicators on standard neuropsychological instruments.

Rogers (1997) proposes that information regarding specific test taking strategies is more useful (although more unlikely in the case of real world malingerers) than information about the specific disorder being simulated. Examples of testing strategies provided to participants to increase the believability of their simulated impairments include 1) performing at or above chance level (50%), getting easy answers correct and missing only harder items (DiCarlo, Gfellar, & Oliveri, 2000; Frederick & Foster, 1991).

It is important to perform some type of check after the experiment to make sure analog malingerers correctly understood their role and the task, and to find out what (if any) malingering strategies were used. Debriefing questionnaires typically include questions regarding: 1) understanding and memory of the directions, 2) any preparation materials or prior knowledge of impairments used in their performance, 3) level of motivation to produce a believable pattern of deficits, 4) what strategies were employed,

and 5) how successful they think they were are performing in a believable manner that will avoid detection (Rogers, 1997).

Summary of Literature

In conclusion, every year thousands of college students apply for academic accommodations due to alleged learning disabilities. Mathematics is one of the most common areas of struggle for college students, and therefore one of the most common reasons for students to seek accommodations. Often times these accommodations include course waivers or substitutions, allowing the student to earn a degree by circumventing an area of particular academic difficulty. Thousands of these students can provide accurate documentation demonstrating a true impairment in a specific area of learning, often characterized by a significant discrepancy between academic ability and achievement in that area of learning. On the other hand, it has been determined that many of the students applying for accommodations do not meet diagnostic criteria for a learning disability, even if they held a previous diagnosis of LD.

In order to prevent the useless allocation of personnel and financial resources, it is important for departments performing learning disability evaluations in the postsecondary population to carefully screen out individuals who are unlikely to meet criteria. This can be accomplished through the use of simple screening measures that look at the typical performance patterns of college students with learning disabilities. It is particularly important to be able to identify and screen out students who attempt to exaggerate or simulate learning difficulties in order to receive accommodations. There is a surprising lack of research in this area, especially given the ever increasing number of students

undergoing learning disability evaluations and the documented prevalence of malingering in other populations where individuals are alleging disability in order to obtain some type of compensation or reward. College students presenting for learning disability evaluations are certainly faced with an incentive to malingering deficits, yet this possibility has been largely ignored by the research community.

Hypotheses

The purpose of this study is to identify a set of indicators that can reliably differentiate between malingered and true cognitive impairment on a battery of tests used to assess for the presence of a mathematics learning disability among college students. It is hypothesized that 1) it will be possible to reliably differentiate between sophisticated and non-sophisticated student malingering of a mathematics learning disability; 2) it will be possible to differentiate students who are attempting to simulate a learning disability from the population of students with a true mathematics learning disability; 3) it will be possible to differentiate students who are attempting to simulate a mathematics learning disability from students without a learning disability who are performing at their best (i.e. controls); and 4) it will be possible to reliably differentiate malingered from non-malingered (controls plus LD) performance. It is reiterated that this study does not seek to identify or diagnose actual mathematics learning disabilities. Rather, the focus of this study is on identifying malingered performance; therefore, the last hypothesis, regarding malingered versus non-malingered performance, has tremendous practical significance. Even if it is not possible to differentiate the performance of malingerers from that of

individuals with a true learning disability, it is still quite useful to be able to reliably differentiate malingerers from the more generalized category of non-malingerers.

CHAPTER III

METHOD AND DESIGN

Participant Characteristics, Sampling Procedures, and Participant Instructions

A between-subjects design was utilized for this study. Participants were assigned to one of three experimental groups: a) uncoached malingerers, b) coached malingerers, or c) controls. A fourth group was composed of archival data from students with a previous diagnosis of learning disability (LD).

The sample was composed of 31% males and 69% females (see Table 1). The ratio of males to females did not vary significantly across groups ($\chi^2(3) = .73, p = .87$). The majority of participants were in their freshmen (64%) or sophomore (25%) year of college. There were significantly more juniors and seniors in the LD group compared to the three experimental groups ($\chi^2(9) = 23.15, p = .006$).

Regarding ethnicity, 83% of the sample was Caucasian and 11% was African American. Less than 1% of participants listed their ethnicity as Hispanic or “other.” English was the primary language for all but one of the participants. Participants ranged in age from 17 to 25 years, with a mean age of 19.20 years ($SD = 1.43$). Age varied significantly between groups ($F(3, 76) = 8.327, p = 0.00$), with the LD group being older than the three experimental groups (see Table 1). Age did not have a significant effect on performance on the dependent variables.

Table 1

Participant Demographics by Group

		Frequency (% of group)			
		Uncoached	Coached	Control	LD
<i>n</i>		19	18	23	20
Gender					
	Male	5 (26.3)	7 (38.9)	7 (30.4)	6 (30.0)
	Female	14 (73.7)	11 (61.1)	16 (69.6)	14 (70.0)
Grade ^a					
	Freshman	14 (73.7)	13 (72.2)	16 (69.6)	6 (30.0)
	Sophomore	3 (15.8)	5 (27.8)	7 (30.4)	4 (20.0)
	Junior	2 (10.5)	0	0	4 (20.0)
	Senior	0	0	0	3 (15.0)
Ethnicity					
	Caucasian	17 (89.5)	14 (77.8)	21 (91.3)	14 (70.0)
	African American	2 (10.5)	3 (16.7)	1 (4.3)	3 (15.0)
	Hispanic	0	0	1 (4.3)	0
	Other	0	1 (5.6)	0	4 (20.0)
Age					
	Mean	19.21	18.56	18.70	20.35
	SD	1.32	.71	.77	1.90
	range	18 – 22	18 – 20	18 – 20	17 – 25
IQ ^b					
	Mean	100.42	101.78	104.04	100.70
	SD	7.57	6.01	7.06	15.20
	range	87-116	91-112	93-116	76-138

^a The grade level missing for 3 participants in the LD group.

^b IQ was derived from NAART score for experimental groups. IQ for the LD group is the WAIS-III FSIQ.

All participant recruiting and data collection was performed by graduate students enrolled in the Clinical Psychology Doctoral Program at a moderately-sized, four-year, state university in rural western Pennsylvania. A total of 71 participants agreed to participate in the study. Data from 11 participants were excluded from the study. Two cases were excluded from the uncoached group: one due to a reported history of head injury with an approximate two-minute loss of consciousness, and one that reported on the debriefing questionnaire that he/she forgot to follow the malingering instructions during testing. Five cases were excluded from the coached malingering group: two participants reported on the debriefing questionnaire that they did not follow the malingering instructions. Two more cases were excluded due to administration errors. One case was excluded due to a pattern of scores that was significantly deviant from the other participants in the coached group. A total of four cases were excluded from the control group: one participant reported a previous head injury with loss of consciousness, while three participants reported that they did not follow instructions to perform to the best of their ability during testing. The final tally consisted of 19 participants in the uncoached group, 18 participants in the coached group, and 23 participants in the control group.

The LD comparison group consisted of assessment data collected from students who were previously diagnosed with a mathematics learning disability after completing a full battery of psychological and neuropsychological assessment instruments administered by advanced graduate students in the Clinical Psychology Doctoral Program between 1999 and 2003. Consent forms signed by all students undergoing learning disability evaluations in the Center for Applied Psychology include a provision reserving

the right to use collected data in future research studies (see Appendix G). Students who reported a history of serious medical conditions or psychological disorders were excluded from the study. In addition, data from previous evaluations of students who were suspected of possible malingering were not used. One case was excluded based on the age of the student (41 years), which was a significant outlier among the rest of the sample (mean age = 20.35, SD = 1.90). A total of 20 cases were selected for the archival comparison group, bringing the total study sample size (N) to 80.

Research assistants underwent training in administration of all study measures and were reimbursed for every completed testing protocol. Each protocol was pre-assembled by the principal investigator. Protocols for the three experimental conditions differed only in the instruction sheet provided to the participant. An equal number of protocols were prepared for each of the three experimental conditions and distributed randomly to each research assistant. Each protocol was assigned a three-digit code that identified the participant number. Participants were randomly assigned to one of the three experimental conditions and research assistants were blind to the assigned condition, except in the rare event that a participant raised specific questions about the instruction sheet. After each administration, the Drawing Entry Form, Debriefing Questionnaire, and instruction sheet were separated from the participant's protocol in order to remove any identifying information from the test data and to maintain anonymity of the participant's assigned condition. Completed protocols were returned to the principal investigator, who completed all scoring before comparing the three-digit code to a master list to determine the experimental condition.

Participants in the coached, uncoached, and control groups were randomly selected from the Subject Pool of students enrolled in undergraduate General Psychology (101) courses for the first-time. They were initially contacted by phone or e-mail and provided with a brief description of the study, after which they were asked if they wished to participate. Interested students were scheduled to meet with the research assistant. The Informed Consent Form (see Appendix A) was reviewed with each potential participant, detailing the purpose of the study, potential risks and benefits of participation, and extent of confidentiality.

Benefits of participating in the study included earning credit toward the mandatory Subject Pool requirement, and the opportunity to be entered into a lottery for a chance to win \$50 if the participant was able to perform within one standard deviation of the expected mean across all measures. The drawing was intended to serve as extrinsic incentive to motivate the participants to adhere to the given instructions to the best of their ability. In actuality, all participants were entered into the drawing, regardless of their level of performance. This benign use of deception was disclosed to all participants in the debriefing session following testing. Participants wishing to be included in the drawing completed a drawing entry form (see Appendix F) following completion of the testing. This identifying information was kept separate from the raw data, in order to maintain anonymity and confidentiality. The random drawing took place approximately 1 month after all data had been collected. The winner of the drawing was sent, via certified mail, a Visa gift card with a balance of \$50.

Participants were given an instruction sheet explaining how they were expected to perform on the assessment measures (see Appendix E). Instruction sheets for the

uncoached and coached groups instructed the participants to perform as if they were pretending to have a mathematics learning disability, in hopes of being granted a mathematics course waiver, enabling them to graduate without having to fulfill the math requirement for their major. Participants were warned that their testing performance had to be believable, in order to avoid detection. The coached group was provided with information about the types of errors commonly associated with mathematics learning disability and suggested strategies for effectively malingering a math learning disability (see Appendix E). For example, they were told answer correctly on at least 50% of all multiple choice items and avoid incorrect responses on very simple items. They were also provided with specific information about common arithmetic errors, such as slowed/impaired motor performance, failure to recall math facts, using the wrong procedure, or failing to change operations from item to item. Participants in the control group were not provided with any information regarding malingering or math learning disabilities. They were asked to perform to the best of their ability on all measures.

All participants completed the testing battery in a single administration session, which required approximately 60 to 90 minutes. The majority of the dependent variables used in this study were taken from measures commonly administered as part of learning disability evaluations. They assess calculation ability, as well as neuropsychological domains shown to be correlated with mathematics learning disability, such as attention, memory and visuospatial skills. Some dependent variables were derived from embedded malingering indices in the various assessment measures (i.e., the Rarely Missed Index and Digit Span cut-off score), shown in past research to be effective at identifying exaggerated or simulated performance. Other dependent variables were based on overall

performance on an assessment measure, such as subtest standard scores or total completion time. A goal of this study was to choose measures that were already being used in learning disability evaluations, or that could be easily derived from measures already in use. The purpose of this study did not include identification of a learning disability; therefore the chosen dependent variables did not need to provide a comprehensive assessment of all relevant areas of academic and cognitive functioning. Because this study focuses on malingering of mathematics learning disabilities, a free-standing measure of malingering (Rey Dot Counting Test) was included in the dependent variables. This measure was chosen because of its use of counting, which was expected to be a target for individuals attempting to malingering difficulties with mathematics.

Assessment Measures

The Woodcock Johnson Psychoeducational Battery – 3rd Edition (WJ/A-III; Mather & Walter, 2001) is a comprehensive battery used to assess the cognitive and academic achievement skills of individuals between the ages of 2 and 90 years-old. The Calculation subtest requires the participant to solve a series of simple written addition, subtraction, multiplication, and division problems. The raw score was converted to a standard score, which was used in the statistical analyses. The Math Fluency subtest is a timed measure assessing one's ability to efficiently solve simple arithmetic problems. Once again, the standard score was used in statistical analyses. Each of these subtests requires approximately five minutes to administer. Scoring was facilitated by the WJ-A III Scoring Assistant software.

Memory is a domain frequently assessed in learning disability evaluations and there is evidence of a correlation between disabilities in mathematics and impaired memory. This correlation is not necessarily common knowledge among laypeople, which makes it useful in differentiating between malingered and true mathematics disability. The Wechsler Memory Scale-3rd Edition (WMS-III; Wechsler, 1997) is a collection of subtests measuring various abilities in the domain of memory. The publisher of the WMS-III, (Harcourt assessment, Inc.), granted permission for the relevant portions of the Response Booklet to be photocopied and used for the purposes of this study (see Appendix H).

The Logical Memory subtests require the individual to remember facts and general themes from two paragraph-length stories that are read by the examiner. The test involves both immediate memory and delayed memory (30 minutes) trials, in addition to a recognition trial consisting of a series of ‘yes’ or ‘no’ questions regarding facts from the stories. Each Logical Memory subtest requires approximately five to ten minutes to administer. Standard scores were used to measure performance on the Logical Memory I and Logical Memory II subtests.

The Rarely Missed Index (RMI) was developed by Killgore and DellaPietra (2000) to differentiate between malingered cognitive dysfunction and true neurological impairment. It consists of six items from the Logical Memory Delayed Recognition trial. An incorrect response on any of these items is very unusual. They are answered correctly, at above-chance levels, even by individuals who have never been exposed to the Logical Memory stories. Each item comprising the RMI is assigned a weighted coefficient and the total weighted score for all six items is calculated. Possible RMI values range from -

22 to 226, with lower scores being more indicative of malingering. A cut-off score of 136 has been reported to reliably differentiate between individuals instructed to malingering memory impairment and patients with true neurocognitive impairment, with a sensitivity of 97% and specificity of 100% (Killgore & DellaPietra, 2000). For the current study, each participant's total weighted RMI score was calculated and compared to the cut-off score of 136 in order to assign a pass/fail score.

The Digit Span subtest of the WMS-III measures attention and working memory by requiring the individual to repeat an increasingly lengthy series of numbers in the forward and backward directions. The subtest requires approximately 5 to 10 minutes to administer. It was predicted that the inclusion of numbers in this task would make it a likely target for exaggerated impairment by participants attempting to malingering a mathematics disability. Two scores were utilized from the Digit Span subtest. The standard score was calculated as a continuous measure of performance. An embedded categorical indicator of malingering was also used, with a scaled score greater than 4 qualifying as passing. This cut-off was derived by Iverson and Franzen (1994, 1996), and correctly classified 82.5% of experimental malingerers, 100% of controls, and 95% of patients with closed head injury. In a second study, this cut-off correctly classified 77.5% of malingerers and 100% of memory impaired and control participants.

The North American Adult Reading Test (NAART; Blair & Spreen, 1989/1998) requires the individual to read a series of 61 irregularly spelled/pronounced words (e.g. aisle, heir). The correct pronunciation of these words is not phonetically evident from their spellings. The NAART requires approximately 10 minutes to administer and is in the public domain. There is a high correlation between reading ability and intellectual

functioning, and the NAART has been proven to provide a reliable estimate of IQ.

Equations are used to derive an estimated Full Scale IQ, Verbal IQ, and Performance IQ from the total error score. For the purposes of this study, an estimated Full Scale IQ was used to rule out inequality of intellectual functioning across the four participant groups as a potential confounding variable. It was not used for the detection of malingering.

The Rey-Osterrieth Complex Figure Test (Rey-O; Rey, 1941/1995) requires the individual to copy, with pencil and paper, a fairly complex visual design. The individual is then asked to reproduce the design from memory after a delay of 30 minutes. The task measures visuoconstructional ability, visual memory, planning, organization and visuomotor skills. Research has shown a correlation between visuospatial abilities and mathematics disabilities. Again, this correlation is not widely known to the public, which suggests this task may be valuable in differentiating between malingered and true mathematics impairment. This task requires approximately five minutes for each trial and is in the public domain. Scoring, using the Taylor criteria (1989) is based on accuracy and proper placement of 18 design elements. In the current study, standard scores were calculated, but found to be non-normally distributed. Therefore, raw scores for the copy and delay trials were used in the analyses.

The Rey Dot Counting Test (Rey, 1941/1995) was developed for the specific purpose of detecting malingering. Individuals must count, as quickly as possible, various arrays of dots presented on a series of cards. In the grouped trial, the dots are arranged in easily identifiable clusters (similar to dice), as described in Lezak (1995). The clustering/grouping makes it easier to count the total number of dots on the card. For the ungrouped trial, the dots are presented in a linear array. The test requires approximately

10 minutes to administer and is in the public domain. Scores are based on the total number of seconds required to complete the grouped and ungrouped trials. In the current study, standard scores were calculated, but resulted in a significant floor effect; therefore, raw scores were used in the analyses. Boone et. al., (2002), report that a total grouped time of greater than 130 seconds and a total ungrouped time of greater than 180 seconds, resulted in 100% specificity among college students with learning disability.

A pass/fail score was also calculated for the Rey Dot Counting Test by determining if the total time on the grouped trials exceeded the total time on the ungrouped trials. Significantly slow or impaired performance on the grouped trials, or better performance on the ungrouped trials, is considered suggestive of malingering. Boone et. al., (2002), report that better performance on the ungrouped over grouped trials resulted in 100% specificity among college students with learning disability. It was believed that this task might be a target of malingerers in this study, because it involves the mathematical skill of counting.

Debriefing Questionnaire

A Debriefing Questionnaire (see Appendix C) was used to assess participant compliance with their assigned condition. Participants were asked to disclose which experimental group they had been assigned to and which malingering strategies they used during testing. Data were excluded from any participant demonstrating confusion as to their assigned condition. Participants were also asked to rate how much the chance to win a \$50 gift certificate motivated them to perform as instructed, with choices ranging

from “not motivated at all” to “very motivated.” Additionally, participants rated their self-perceived success at performing as instructed.

Debriefing Form

Finally, participants were given a debriefing form that was reviewed with the researcher, explaining the full design of the study and disclosing the use of relatively benign deception regarding the performance criteria necessary to qualify for the \$50 incentive. The form also included appropriate contact information, should the participant have future questions or concerns about the study.

CHAPTER IV

RESULTS

Manipulation Checks

Participants in the uncoached and coached malingering groups were asked what strategies they utilized in their attempt to feign a mathematics learning disability (see Table 2). The most popular malingering strategy utilized by both groups was deliberate endorsement of incorrect answers, used by 75.7% of the malingering participants. A large number of those participants also endorsed deliberately skipping items (62.2%) and deliberately missing both very easy and very difficult items (56.8%). See Table 2 for a summary of other malingering strategies used in the study.

All participants were asked to rate their perceived success at performing as instructed. Most participants rated their success as “average” (53.3%) or “somewhat successful” (41.7%). Few participants rated themselves as “very successful (3.3%), and only one participant rated him/herself as not at all successful (1.7%). Perceived level of success did not vary significantly between groups ($F(2, 57) = .717, p = .49$).

Participants were also asked to rate how much the \$50 gift certificate motivated their performance. A large percentage of participants responded that they were not at all motivated by the incentive (41.7%). Most other participants rated the incentive as “somewhat” or “slightly” motivating (33.3% and 23.3%, respectively). Only one participant rated the incentive as “very” motivating. Level of motivation did not vary significantly between groups ($F(2, 57) = 1.15, p = .33$).

Table 2

Strategies Used by Malingering Participants

Strategy	Frequency	%
Acted confused	19	51.4
Pretended to forget	15	40.5
Deliberately provided incorrect answers	28	75.7
Deliberately took longer time to answer	23	62.2
Pretended to not understand directions	6	16.2
Missed harder items	15	40.5
Missed both easy and hard items	21	56.8
Pretended to have difficulty drawing	15	40.5
Deliberately skipped items	23	62.2
Other	2	5.0

Analysis of Categorical/Binary Measures

Three binary measures were used in this study (See Table 3): Digit Span pass score ($SS > 4$); RMI pass score (weighted score > 136), and the Rey Dot Counting Test pass score (total grouped time $<$ total ungrouped time). The latter score is not available for the LD group, as the data for that group are archival and the Rey Dot Counting Test was not administered as part of previous learning disability evaluations. According to Pearson chi-square analyses, performance on these measures did not vary significantly between groups: Digit Span pass ($\chi^2 (3) = 2.33, p = .51$), RMI ($\chi^2 (3) = 3.49, p = .32$), and Dot Pass ($\chi^2 (2) = 4.15, p = .13$). Therefore, these measures were not effective at differentiating between groups and were excluded from further analyses.

Table 3

Binary Variable Frequencies by Group

Variable		Uncoached	Coached	Control	LD
Digit Span	Pass	18	17	23	19
	Fail	1	1	0	0
RMI	Pass	15	16	22	15
	Fail	4	2	1	4
Dot Counting	Pass	16	15	23	N/A
	Fail	3	3	0	N/A

Analysis of Continuous Measures

Of the four groups, the control group performed the best on all measures except the Rey-O Copy and Delay trials, on which the LD group performed marginally better (see Figures 1 through 4). All groups produced a wide range in scores for each measure, with the coached malingering group having the greatest standard deviation on most measures (see Table 4). As noted above, the three experimental groups were administered the NAART in order to obtain an estimate of their level of intellectual functioning. These scores were compared with the WAIS-III Full Scale IQ scores of the LD group, to determine if all four groups demonstrated a similar level of intellectual ability. IQ scores ranged from 76 to 138, with a mean IQ of 101.84 (SD = 9.62) [see Table 1 for mean scores by group]. IQ did not vary significantly between groups ($F(3, 76) = .625, p = .601$).

Table 4

Continuous Measures Descriptives by Group

Variable	<i>Mean (SD)</i> <i>Range</i>			
	Uncoached (n=19)	Coached (n=18)	Control (n=23)	LD (n=20)
<u><i>WJ/A-III</i></u>				
Calculation	80.47 (14.19)	86.67 (14.84)	92.70 (9.76)	79.30 (12.91)
SS	56 – 115	59 – 121	76 – 115	52 – 106
Math Fluency	72.79 (23.41)	79.56 (17.17)	90.74 (13.43)	80.94 (14.77)
SS	38 - 111	50 - 118	65 - 114	53 - 114
<u><i>WMS-III</i></u>				
Logical Memory I	93.42 (14.05)	91.94 (14.47)	100.57 (14.05)	98.42 (12.92)
SS	75 - 110	75 - 120	75 - 130	65 - 115
Logical Memory II	92.63 (13.06)	93.33 (16.45)	104.35 (14.48)	95.79 (13.67)
SS	65 - 110	70 - 120	75 - 135	70 - 115
Digit Span	91.58 (12.81)	92.50 (13.85)	103.04 (11.55)	96.58 (13.02)
SS	65 - 110	60 - 115	85 - 125	80 - 130
<u><i>Rey-O</i></u>				
Copy	27.03 (4.88)	27.42 (6.13)	30.00 (3.30)	30.63 (6.43)
raw	16 - 35	13 - 34	24 - 36	16 - 36
Delay	14.50 (5.73)	17.06 (7.31)	19.41 (6.11)	20.68 (7.57)
raw	5 - 23	3 - 28	8 - 31	6 - 30
<u><i>Rey Dot</i></u>				
Grouped	50.05 (37.10)	36.56 (23.85)	23.39 (7.10)	n/a
(total time in seconds)	14 - 155	9 - 107	10 - 35	
Ungrouped (total	75.05 (30.46)	53.33 (14.19)	53.57 (17.62)	n/a
time in seconds)	40 - 137	28 - 90	30 - 104	

Note. Due to missing data, the number of observations for the LD group will vary across dependent variables.

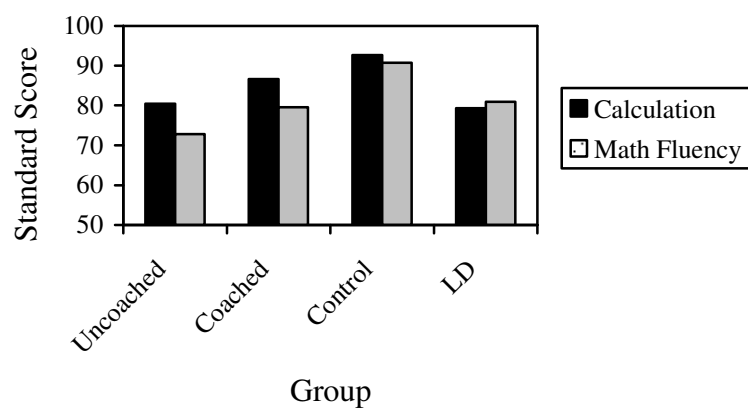


Figure 1. WJ-III mean standard scores by group.

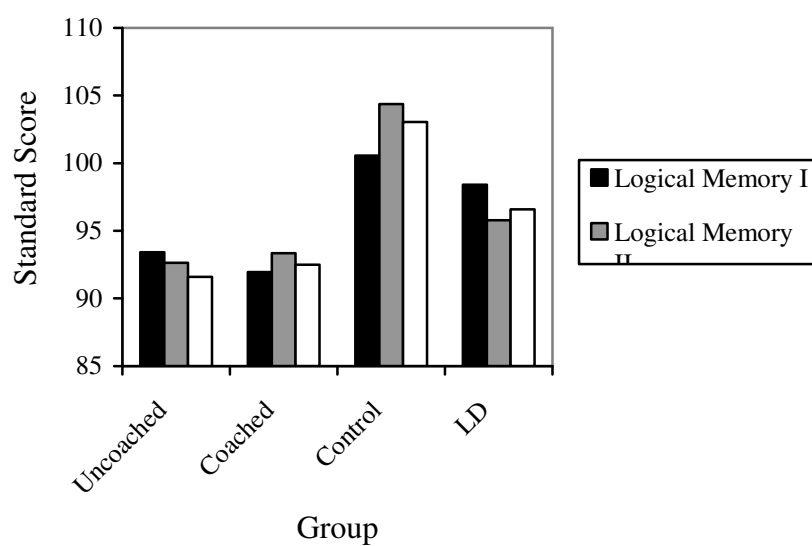


Figure 2. WMS-III mean standard scores by group.

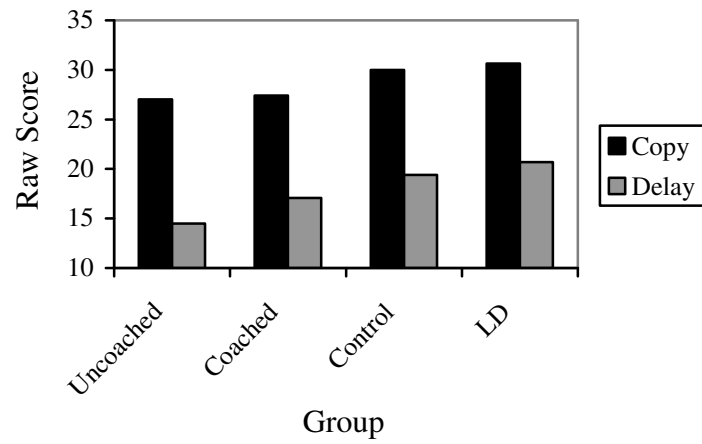


Figure 3. Rey-Osterrieth mean raw scores by group.

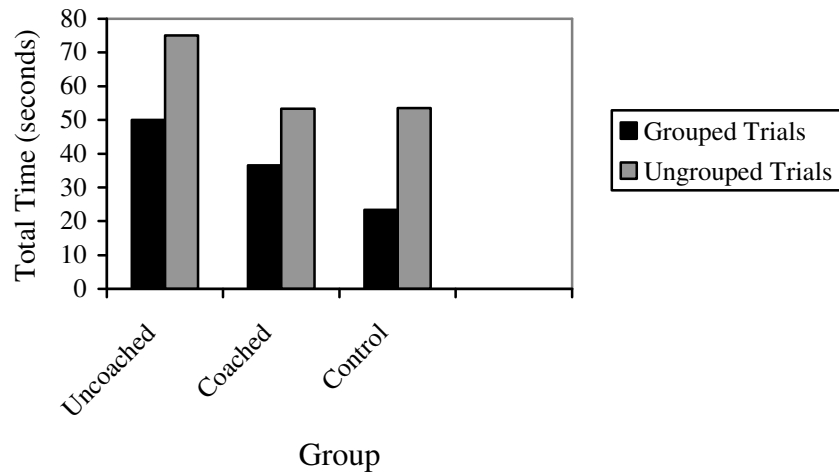


Figure 4. Rey Dot Counting Test mean time by group.

The multivariate analysis of variance (MANOVA) is similar to the ANOVA, except that it is used when there are multiple dependent or predictor variables. The MANOVA has several advantages over the ANOVA. First, MANOVA takes into account all of the dependent variables at once, to determine if there is a significant difference in performance between groups across all of the dependent variables combined. Type I error is minimized by simultaneously taking into consideration all of the dependent variables, as opposed to running multiple ANOVA's which results in accumulated familywise error. MANOVA also takes into consideration the correlations between predictors, giving it greater power to detect an effect, because it assesses various combinations of predictors. The power of the MANOVA analysis is determined by both the size of the correlations between variables and the effect size.

If a significant difference between groups is detected by MANOVA, it is followed by univariate ANOVAs and/or logistic regression to determine the nature of the difference between groups. Binary logistic regression is used if there are two groups; multinomial logistic regression is used if there are more than two groups being predicted. Logistic regression takes into account the correlations or overlap between predictors, while multiple univariate ANOVAs do not.

Assumptions of Multivariate Parametric Statistics

There are three basic assumptions underlying multivariate parametric analyses: multivariate normality, homogeneity of variance and independence of observations.

In order to meet the assumption of multivariate normality, all independent variables must be normally distributed, all linear combinations of dependent variables

must be normally distributed, and all subsets of variables must be normally distributed (Weinfurt, 1995). The Kolmogorov-Smirnov test compares the scores in a sample to a normal distribution of scores with an identical mean and standard deviation. If the test statistic is significant, the sample is significantly different from the normal distribution. Non-normal distributions were identified for the following variables: Logical Memory I, Logical Memory II, Rey-O Copy and Delay trials, and the Grouped and Ungrouped trials of the Rey Dot Counting Test. These non-normal distributions primarily involve the coached and LD groups. Multiple data transformations were attempted, but were unsuccessful at producing a normal distribution. Non-normal distribution violates the basic assumptions of parametric tests such as ANOVA and MANOVA, though it has been argued that both of these analyses are fairly robust to such a violation, given adequate sample sizes (Field, 2005; Weinfurt, 1995).

Homogeneity of variance is another basic assumption of parametric tests. This refers to equality of variances across conditions and across variables. In the case of multivariate statistics, the shared variance (covariance) between all possible pairs of variables must be equal across all groups (Weinfurt, 1995). This is assessed by examining the variance of each dependent variable across each group, in addition to examining the covariance matrices for each group.

The null hypothesis for the Levene Test proposes that the variances of dependent variables are equal across conditions (or groups). A significant test value indicates that the null hypothesis is incorrect and the variances are significantly different. According to Weinfurt (1995), violation of the assumption of homogeneity of variance/covariance causes only a minor decrease in statistical power if the number of participants is

approximately equal across groups. If group size is substantially different, there will be a significant increase or decrease of Type I error.

Box's test is used to assess for homogeneity of covariance matrices. The null hypothesis for Box's test proposes that the covariance matrices are equal across groups. If Box's test is not significant, covariance matrices are assumed to be equal across all combinations of variables and across all groups. The final assumption underlying parametric tests involves independence of observations. All participants were tested individually, thus minimizing any possibility of participants influencing one another's performance.

Several of the dependent variables in this study did not follow a normal distribution. Variances were equal across groups for most dependent variables, except for Math Fluency and occasionally the copy trial of the Rey-O. Standard data transformations were not successful at equating variances. Only the cubed transformation produced an acceptable Levene statistic for Math Fluency, but this produced multiple detrimental effects with regard to the skew of the score distribution and the decline from ratio measurement to ordinal measurement. While parametric tests are typically assumed to be robust to minor violations of the underlying assumptions (Field, 2005; Weinfurt, 1995), attempts were made to compensate for these violations whenever possible. This included the use of more conservative test statistics and those best suited for instances of unequal variances and unequal group sizes.

Pearson's correlations (two-tailed) were calculated to determine the degree of correlation among the variables (see Table 5). Several of the dependent measures are significantly correlated. As expected, the measures with the strongest correlations came

from the same parent test (i.e., Logical Memory I and II, Rey-O Copy and Delay, and Rey Dot Grouped and Ungrouped).

Table 5

Pearson Correlations for Dependent Variables

	Calc.	Fluency	LM I	LM II	Digit Span	Rey-O Copy	Rey-O Delay	Dot Grp.	Dot Ungrp.
Calc.	1								
Fluency	.583**	1							
LM I	.353**	.368**	1						
LM II	.411**	.388**	.825**	1					
Digit Span	.485**	.559**	.256*	.243*	1				
Rey-O Copy	.209	-.007	.271*	.291**	.221	1			
Rey-O Delay	.194	.064	.251*	.298**	.219	.713**	1		
Dot Grp.	-.411**	-.519**	-.384**	-.474**	-.457**	-.289*	-.191	1	
Dot Ungrp.	-.344**	-.527**	-.197	-.280*	-.366**	-.221	-.178	.611**	1

Note. Calc.= Calculation subtest standard score from WJ-III; Fluency=Math Fluency subtest standard score from WJ-III; LM I=Logical Memory I subtest standard score from WMS-III; LM II=Logical Memory II subtest standard score from WMS-III; Digit Span=subtest standard score from WMS-III; Rey-O Copy=Copy trial raw score from Rey-Osterrieth Complex Figure; Rey-O Delay=30 minute Delay trial raw score from Rey-Osterrieth Complex Figure; Dot Grp.=Total grouped time (in seconds) from Rey Dot Counting Test; Dot Ungrp.=Total ungrouped time (in seconds) from Rey Dot Counting Test.

*p<.05 (2-tailed)

**p<.01 (2-tailed)

As mentioned above, correlated variables in a MANOVA may overlap in the variance they explain. While follow up univariate ANOVA's and logistic regression will partition out the amount of unique variance explained by each variable, thus providing

the most parsimonious set of predictors, it is prudent to include as few dependent variables/predictors as possible in each analysis and run as few analyses as necessary to minimize risk of Type I error. In an effort to reduce redundancy among variables, the Logical Memory I, Rey-O Delay, and Rey Dot Ungrouped variables were excluded from subsequent analyses.

Hypothesis 1: Coached vs. Uncoached Malingering

The first hypothesis proposes that it will be possible to reliably differentiate between sophisticated (coached) and non-sophisticated (uncoached) students attempting to malingering a mathematics learning disability.

A MANOVA was conducted using the following dependent variables: standard scores from the Calculation, Math Fluency, Logical Memory II, and Digit Span subtests; and the raw score from the Copy trial of the Rey-Osterrieth. The independent variable consisted of the four groups: uncoached, coached, control and LD. Dependent variables from the Rey Dot Counting Test could not be included because that measure was not administered to the archival LD group. [See Table 4 for group means and standard deviations.]

The MANOVA revealed a significant difference between groups on overall performance (Wilks' $F(15, 185) = 2.247, p = .006$), with a small effect size (partial eta squared = .143). This significant finding was followed by a series of univariate ANOVAs with a Bonferroni correction to protect against type I error. A Bonferroni correction involves dividing the alpha level by the number of tests being performed. In this case, the resulting alpha level is $p = .010$.

Table 6

ANOVA Results for Four Groups

DV	Type IV Sum of Squares	df	Mean Sum of Squares	F	Sig.	Partial Eta Squared
Calculation	2148.180	3	716.060	4.241	.008*	.152
Math Fluency	3474.416	3	1158.139	3.796	.014	.138
Logical Memory II	1839.695	3	613.232	2.937	.039	.110
Digit Span	1929.245	3	643.082	4.104	.010*	.148
Rey-O Copy	179.485	3	59.828	2.178	.098	.084
Error		71				

* Significant with Bonferroni correction $p = .010$.

Results from the ANOVAs indicated a significant difference among groups on the Calculation ($p=.008$) and Digit Span ($p=.010$) measures (see Table 6). This was followed by a series of Helmert planned contrasts (see Table 7). There was not a significant difference in performance between the uncoached and coached malingering groups; therefore Hypothesis 1 is not supported. The coaching of participants did not make their malingering performance any more “believable” than the performance of naïve malingerers. These two groups were combined for subsequent analyses.

Table 7

Helmert Planned Contrasts Significance Levels

	Calculation	Math Fluency	Logical Memory II	Digit Span	Rey-O Copy
Control vs. LD & malinger	.002*	.006*	.008*	.011*	.219
LD vs. malinger	.372	.258	.329	.034*	.035*
Uncoached vs. coached	.152	.243	.883	.824	.822

* Significant at $p < .05$

Hypothesis 2: Malingering vs. Learning Disability

The second hypothesis states that it will be possible to reliably differentiate between students that are malingering a mathematics disability and those students with a true learning disability.

The second of the Helmert contrasts displayed in Table 7 compared the LD group to the combined performance of the coached and uncoached malingering groups. The LD group performed significantly better than the malingering groups on Digit Span and the Copy trial of the Rey-O.

In order to determine how much of the variance between groups is explained by each measure, a forced entry logistic regression was performed with the malinger and LD groups, and the five dependent variables used in the MANOVA described above (see Table 8). Logistic regression takes into account correlations between predictor variables and provides estimates of each variable's unique ability to differentiate between groups. It formulates the most parsimonious and reliable equation for classifying cases into the

malinger or control group. Logistic regression is not bound by the same assumptions of parametric tests; therefore it is not compromised by non-normal distributions or unequal variances. Due to missing data in the LD group, 5 of the 20 cases from that group were excluded from this analysis.

Table 8

Maligner vs. LD: Forced Entry Logistic Regression Parameter Estimates

	B	SE	Wald	df	Sig.	Exp(B)
Calculation	-.080	.034	5.435	1	.020*	.923
Math Fluency	.035	.028	1.573	1	.210	1.036
Logical Memory II	.013	.029	.193	1	.661	1.013
Digit Span	.070	.041	2.886	1	.089	1.073
Rey-O Copy	.125	.076	2.690	1	.101	1.133
Constant	-8.745	4.260	4.213	1	.040	.000

*Significant at $p < .05$

In contrast to findings from the planned contrasts, the copy trial of the Rey-O was not effective at differentiating between the malingering and LD groups. The Calculation subtest was the only predictor variable to have a significant contribution to the model ($p = .020$). As a participant's score on the Calculation subtest increased, his/her chance of being from the LD group decreased (i.e., the malingering group performed better than the LD group on this subtest). The final regression model, with a default cut value of .500, correctly classified 76.9% of participants as belonging to either the malingering or LD group (see Table 9). According to Cox & Snell and Nagelkerke R^2 values, the regression

model explained between 23.9% and 34.1% of the variability between the malingering and LD groups. This is significantly better than the base model, according to the omnibus test of model coefficients ($\chi^2 (5) = 14.186, p = .014$); and the Hosmer and Lemeshow Goodness of Fit Test ($\chi^2 (8) = 9.686, p = .288$).

Table 9

Malingering vs. LD: Logistic Regression Classification Table

		Predicted		% Correct
		Malingering	LD	
Condition	Malingering	34	3	91.9
	LD	9	6	40.0
Overall				76.9

Sensitivity is defined as the probability of finding the condition of interest when it is present, while specificity is the probability of not finding the condition of interest when it is absent. Positive predictive power (PPP) represents the chances of actually having the condition of interest (malingering), given a positive test result (Larrabee & Berry, 2007). Because PPP takes into account the base rate of the condition of interest in the sample, it is a more reliable estimate of an indicator's accuracy than overall hit rate; however, it is only applicable to populations sharing the same base rate as the sample used in the regression analysis. In this particular analysis, the base rate of malingering is 71.2%, which is likely higher than the true rate of malingering among mathematics LD evaluations. Thus, if all participants were classified as malingering, regardless of their performance on the predictor measures, the hit rate would be 71.2%.

Using the default cut value of .500, the regression model had a sensitivity of 91.9%, specificity of 40.0%, and PPP of 79.07%. Despite impressive statistical sensitivity to malingering, the model produced a false positive rate of 60%, with over half of the LD participants being misclassified as malingering.

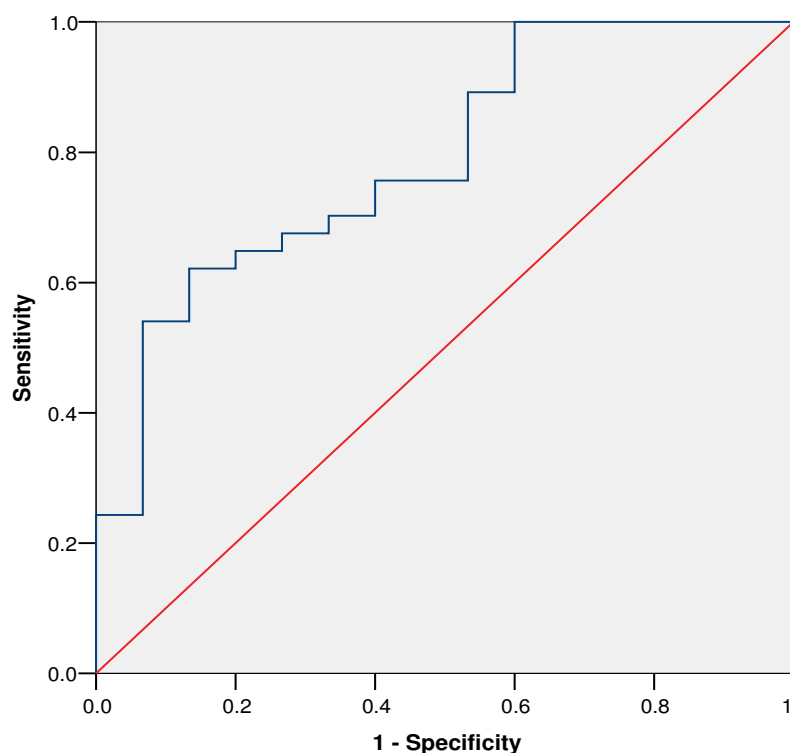


Figure 5. ROC curve for malingering vs. LD.

An ROC curve was plotted using the predicted probability values from the regression equation (see Figure 5). This produced an area under the curve (AUC) of .789, which is significant at $p = .001$. Alternate regression cut values were chosen by reviewing a table of sensitivity and 1-specificity values for various coordinates of the curve. New

cut values were chosen with a goal of keeping the specificity rate close to 90%. A cut value of .17 produced a hit rate of 65.4%, with a sensitivity of 54.1%, specificity of 93.3% and PPP of 95.2%.

Cut-off values are more convenient and useful than a regression equation for classifying cases in everyday clinical practice. Given the Calculation subtest's reliability in differentiating between these groups, an attempt was made to establish a cut-off score above which an individual could be flagged as potentially malingering a mathematics disability. The cut-off was chosen by examining the frequency distribution of standard scores and calculating the minimum score that would produce a specificity of approximately 90.0%. A Calculation standard score greater than 92 resulted in specificity of 85%, but sensitivity of only 24.32% and a hit rate of 45.61%. A cut-off score of 80 correctly identified 54.05% of malingerers, but misclassified 50% of LD participants for an overall hit rate of 52.63%.

The Digit Span score approached significance in the regression model, therefore an attempt was made to establish a cut-off score for this subtest, as well. A standard score of less than 80 resulted in 100% specificity, but only 10.8% sensitivity, with an overall hit rate of 41.07%. In contrast, a cut-off of less than 90 resulted in specificity of 79.0%, sensitivity of 32.43%, and an overall hit rate of 51.79%. With hit rates near 50%, none of these four cut-off values are significantly better than chance at detecting malingering; however, a Digit Span standard score below 80 (equivalent to a scaled score < 6) would be considered strongly indicative of malingering.

Hypothesis 3: Malingering vs. Control

The third hypothesis states that it will be possible to reliably differentiate between students attempting to malingering a mathematics disability and students without a disability who are performing at their best (controls).

A MANOVA was run with the malingering and control groups. Dependent variables included the five variables used in the previous analyses, as well as the grouped trial raw score from the Rey Dot Counting Test (see Table 10).

Table 10

ANOVA Results for Malingering vs. Control

DV	Type IV Sum of Squares	df	Error Sum of Squares	F	Sig.	Partial Eta Squared
Calculation	1202.871	1	9816.113	7.107	.010	.109
Math Fluency	3047.408	1	19267.192	9.174	.004*	.137
Logical Memory II	1835.143	1	12288.190	8.662	.005*	.130
Digit Span	1721.321	1	9159.929	10.899	.002*	.158
Rey-O Copy	109.913	1	1308.270	4.873	.031	.078
Rey Dot Grouped	5727.462	1	37234.722	8.922	.004*	.133
Error		58				

* Significant with Bonferroni correction $p=.008$

Results of the MANOVA indicated an overall difference in performance between the two groups (Wilks' $F(6, 53) = 2.915$, $p = .016$), with a small effect size (partial eta-squared = .248). Results of follow-up ANOVAs with a Bonferroni correction ($p = .008$)

indicated that the control group performed significantly better than the malingering group on Math Fluency, Logical Memory II, Digit Span and the grouped trial of the Rey Dot Counting Test (see Table 10 for ANOVA results).

Using the same set of variables entered in to the MANOVA, a forced entry logistic regression analysis was performed using the malingering and control groups. The Hosmer and Lemeshow Goodness of Fit Test indicated the model was significantly better at predicting group membership than the base model ($\chi^2(8) = 5.212, p = .735$). The Cox/Snell and Nagelkerke pseudo R^2 indicated that between 28.9% and 39.3% of the variability between groups was explained by this set of predictor variables. Using a default cut value of .500, the model was able to correctly classify 70.0 % of participants as belonging in the malingering or control group, with a sensitivity of 75.7%, specificity of 60.9%, and PPP of 75.7%, given a malingering base rate of 61.7% in this sample. If the base rate was adjusted to a hypothetical 30%, the PPP would be 45.4%. Examination of Wald statistics from the forced entry model revealed that none of the variables, by themselves, contributed significantly to the predictive ability of the model, suggesting that groups were differentiated based on an underlying relationship between predictor variables (see Table 11).

Table 11

Malingers vs. Control: Forced Entry Logistic Regression Parameter Estimates

	B	SE	Wald	df	Sig.	Exp(B)
Calculation	-.006	.033	.032	1	.859	.994
Math Fluency	.031	.028	1.241	1	.265	1.031
Logical Memory II	.013	.027	.237	1	.627	1.013
Digit Span	.038	.036	1.152	1	.283	1.039
Rey-O Copy	.134	.103	1.710	1	.191	1.144
Rey Dot Grouped	-.037	.031	1.387	1	.239	.964
Constant	-10.413	5.216	3.986	1	.046	.000

An ROC curve was plotted using the predicted probabilities from the logistic regression model (see Figure 6). The AUC was .803, which is significant at $p < .000$. After examination of the sensitivity and 1-specificity values for various coordinates of the curve, an alternate cut value of .28 was chosen for the logistic regression. This produced a classification hit rate of 70.0%, with a sensitivity of 56.8%, specificity of 91.3%, and a PPP of 91.3%. If the base rate of malingering was hypothetically set at 30%, this regression model would have a PPP of 73.7%.

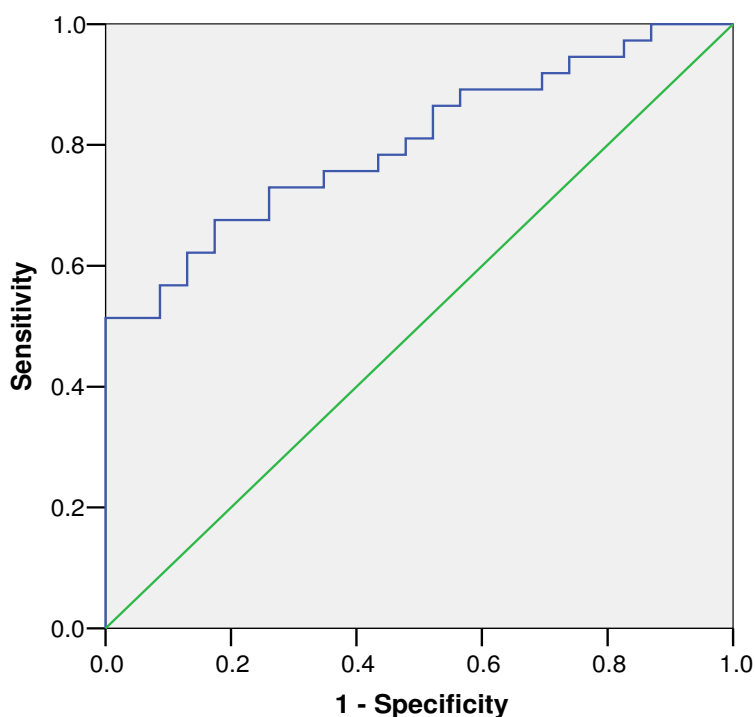


Figure 6. ROC curve for malingering vs. control.

A subset of these variables was chosen to develop a more parsimonious set of optimal cut-off values to use in differentiating between the performance of malingerers and controls. Several characteristics were considered when choosing this subset of variables. Results of the ANOVAs indicated that all of the measures, with the exception of the copy trial of the Rey-O, were significant at the .05 alpha level and four of the measures were significant at the .01 level. The Calculation subtest was chosen as one of cut-offs, because it was felt that a measure of actual mathematic skill would be most useful in a battery designed for use in diagnosing mathematics disability. The Calculation variable was believed to be more reliable than the Math Fluency variable, because the

latter variable violated the assumption of homogeneity of variance. The Logical Memory II and Digit Span subtests were chosen due to their strong significance levels. Finally, the grouped trial of the Rey Dot Counting Test was included as the sole free-standing measure of malingering.

Frequency distributions for each variable were studied in order to determine the optimal cut-off score producing the highest possible sensitivity, while maintaining a false positive rate of 10% or less (specificity 90% or higher) [see Table 12 for the respective cut-off values]. High specificity and relatively low sensitivity is typical of malingering measures, resulting in a large number of malingerers that go undetected, but very low probability of mistakenly labeling an individual as malingering when they are not (false positive).

Table 12

Ability of Single Cut-Offs to Differentiate Between Malinger and Control Groups

		Calculation	Logical Memory II	Digit Span	Rey Dot Grouped
Cut-off		< 80	< 85	< 90	> 35
# failures	Malinger	15	11	12	18
	Control	2	2	2	0
	Total	28.33%	21.67%	23.33%	30.00%
Sensitivity		.41	.30	.32	.49
Specificity		.91	.91	.91	1.0
Hit Rate		60.00%	53.33%	55.00%	68.33%

The Rey Dot grouped trial was most effective at differentiating between malingerers and controls; with an overall hit rate of 68%, sensitivity of 49% and 0 false positives. Larrabee (2007) has reported that the use of multiple diagnostic indicators, or cut-offs, generally increases sensitivity without compromising specificity. To test this theory with the current data, failure rates were calculated for any single cut-off, any pairwise combination of cut-offs, and any three-way combination of cut-offs (see Table 13). More specifically, the single indicator column in Table 13 represents the total number of participants, in both the malingering and control groups, who failed at least one of the four cut-offs listed in Table 12. The pairwise column represents participants who failed at least two of the cut-offs, and the 3-way column represents participants who failed at least three of the cut-offs. Combined sensitivity, specificity, hit rate, positive predictive power (PPP) and negative predictive power (NPP) were calculated for the use of a single cut-off, pair of cut-offs, and trio of cut-offs.

Failure on any one cut-off produced an overall hit rate of 73.33%, with a moderate sensitivity rate, but high false positive rate (22%). Failure on any two cut-offs produced a hit rate of 62.67%, with a good false positive rate (4%), but very low sensitivity. Requiring failure on a combination of three cut-offs was even less sensitive to malingering, though failure on this many measures would be very strongly suggestive of malingering (specificity = 100%).

To summarize, in this sample, participants instructed to mangle could be reliably differentiated from controls based on their performance on the grouped trial of the Rey Dot Counting Test. A total counting time of greater than 35 seconds is a very strong indicator of malingering, with no controls failing this cut-off. Using a regression equation

composed of all six measures, overall classification accuracy is not significantly improved over using just the Rey Dot Counting Test cut-off. Likewise, requiring failure on any pairwise or three-way combination of cut-offs did not significantly improve classification accuracy over the Rey Dot Counting cut-off.

Table 13

Comparison of Single, Pairwise, and 3-Way Cut-Off Models in Differentiating Between Malingering and Control Groups

		Single Cut-off	Pairwise Combination	3-Way Combination
# failing	Malingering	26	15	9
	Control	5	1	0
Sensitivity		.70	.41	.24
Specificity		.78	.96	1.0
Hit Rate		73.33%	62.67%	53.33%
PPP*		83.87%	93.75%	100%
NPP*		62.07%	50.00%	45.10%

*Condition of interest = malingering, base rate in this sample = 61.67%.

Hypothesis 4: Malingering vs. Non-Malingering

The fourth hypothesis states that it will be possible to reliably differentiate malingered from non-malingered performance. This hypothesis, while similar to hypothesis 3 (malingering versus control), holds greater practical significance. When conducting learning disability evaluations, it will be useful to be able to identify

malingered performance from the pool of students giving optimal effort who happen to not have a learning disability after all (i.e. controls), and from those students giving optimal effort who do, in fact, have a learning disability (LD group). For these analyses, the control and LD groups were combined to form a “non-malingering” group to compare to the malingering group. Due to missing scores, data from five of the LD participants was excluded.

A MANOVA was performed using the same five variables included in the four-group analysis. Results indicated there was a significant difference in performance between the two groups (Wilks' $F(5, 69) = 4.417, p = .002$). Follow-up ANOVAs with Bonferroni correction ($p = .010$) revealed that the non-malingering group performed significantly better than the malingering group on the Math Fluency and Digit Span measures (see Table 14).

Table 14

ANOVA Results for Malingering vs. Non-Malingering

DV	Type IV Sum of Squares	df	Error Sum of Squares	F	Sig.	Partial Eta Squared
Calculation	330.333	1	13805.454	1.747	.190	.023
Math Fluency	2399.551	1	22733.836	7.705	.007*	.095
Logical Memory II	1388.431	1	15278.236	6.632	.012	.083
Digit Span	1854.720	1	11199.947	12.089	.001*	.142
Rey-O Copy	174.041	1	1955.639	6.497	.013	.082
Error		73				

* Significant with Bonferroni correction of $p = .010$.

A forced entry logistic regression analysis was performed using the dependent variables from the MANOVA as the predictors, and group (malinger versus non-malinger) as the dependent variable. The resulting model was significantly better than the base model at differentiating between malingered and non-malingered performance, according to the omnibus test ($\chi^2(5) = 21.732, p = .001$) and the Hosmer and Lemeshow Goodness of Fit Test ($\chi^2(7) = 6.174, p = .520$). Cox/Snell and Nagelkerke pseudo R^2 statistics indicated that between 25.2% and 33.5% of the variation between groups was explained by the model.

Table 15

Malinger vs. Non-Malinger: Forced Entry Logistic Regression Parameter Estimates

	B	SE	Wald	df	Sig.	Exp(B)
Calculation	-.042	.026	2.632	1	.105	.959
Math Fluency	.037	.022	2.848	1	.091	1.038
Logical Memory II	.026	.021	1.452	1	.228	1.026
Digit Span	.059	.029	4.015	1	.045*	1.060
Rey-O Copy	.121	.063	3.700	1	.054	1.129
Constant	-11.181	3.443	10.547	1	.001	.000

* Significant at $p < .05$

Using the default cut value of .50, the regression model was able to correctly classify 65.3% of participants as either malingering or non-malingering, with a sensitivity of 64.9%, specificity of 65.8%, and PPP of 64.86, given the base rate of malingering in this sample was 50.7%. Examination of Wald values revealed that Digit Span was the only variable able to reliably differentiate between malingered and non-malingered performance, with non-malingerers scoring significantly better than malingerers (see Table 15 above).

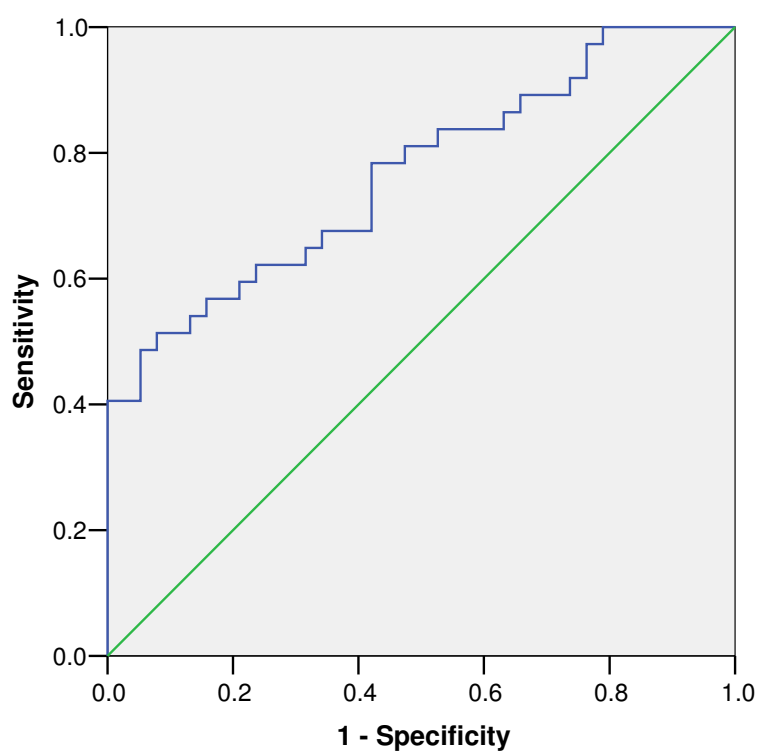


Figure 7. ROC curve for malingering vs. non-malingering.

An ROC curve was plotted using the predicted probabilities from the regression model (see Figure 7 above). The AUC was .766, which is significant at $p < .000$. By examining the sensitivity and 1-specificity values for various coordinates of the ROC curve, an alternate regression cut value of .380 was chosen. The logistic regression model produced a hit rate of 72.0%, with a sensitivity of 51.4%, specificity of 92.1%, and a PPP of 86.3%, given a malingering base rate of 50.7% in this sample. If the base rate was hypothetically changed to 30%, to be presumably more representative of the rate of malingering in a real world setting, the model would have a PPP of 73.60%.

Optimal cut-offs were calculated for the same set of variables used to differentiate between malingered and control performance. The copy trial of the Rey-O was included instead of the Rey Dot Counting Test, because data for the latter measure was not available for the archival LD group. Sensitivity, specificity and hit rate were calculated for each cut-off (see Table 16). Digit Span and the copy trial of the Rey-O had the greatest hit rates of all individual cut-offs. Digit Span identified only 4 of the 37 malingerers, but there were no false positives. The copy trial of the Rey-O correctly identified 5 of 37 malingerers, with two false positives from the LD group. Sensitivity and specificity were nearly equal for all four cut-offs involved in this analysis.

Sensitivity and specificity rates were also calculated for failure on any single, pairwise, or three-way combination of cut-offs (see Table 17). Requiring failure on any single cut-off produced a hit rate of 60%, with relatively low sensitivity and a high rate of false positive errors (16%). Two of the control participants and five of the LD participants failed at least one cut-off. Requiring failure on any two cut-offs resulted in zero false positives, but very low sensitivity. Failure on any two cut-offs was highly

suggestive of malingering (specificity = 100%), but the majority of true malingerers avoided detection. Additionally, requiring failure on at least two cut-offs was no more effective at detecting malingering than using just the Digit Span cut-off. Requiring failure on any three indicators resulted in extremely low sensitivity and was less accurate than the single cut-off and pairwise models at differentiating between malingered and non-malingered performance.

Table 16

Ability of Single Cut-Offs to Differentiate Between Malingering and Non-Malingering Groups

		Calculation	Logical Memory II	Digit Span	Rey-O Copy
Cut-off		< 69	< 80	< 80	< 22
# failures	Malinger	4	4	4	5
	Control	0	2	0	0
	LD	3	2	0	2
	Total	8.75%	10.0%	5.0%	8.75%
Sensitivity		.11	.11	.11	.14
Specificity		.93	.91	1.0	.95
Hit Rate		55.00%	53.75%	58.75%	57.50%

Note. Condition of interest = malinger

Table 17

Comparison of Single, Pairwise, and 3-Way Cut-Off Models in Differentiating Between Malingering and Non-Malingering Groups

		Single Cut-off	Pairwise Combination	3-Way Combination
# failing	Maligner	12	4	1
	Control	2	0	0
	LD	5	0	0
Sensitivity		.32	.11	.03
Specificity		.84	1.0	1.0
Hit Rate		60.00%	58.75%	55.00%
PPP*		63.20%	100%	100%
NPP*		59.00%	56.58%	54.43%

* Condition of interest = malingering, with a base rate in this sample of 50.7%. Pairwise and 3-way statistics were calculated while taking into account combination overlap to avoid redundancy.

CHAPTER V

DISCUSSION

Summary of Findings

In general, participants who were instructed to malingering performed more poorly than participants who were not malingering. Specifically, malingerers were reliably differentiated from the control participants based on their significantly worse performance on select measures of cognitive functioning. It was much more difficult to differentiate malingerers from the LD group.

Most of the measures in this study (Digit Span scaled score < 4 , Rarely Missed Index < 136 , Math Fluency, Delay trial of the Rey-Osterrieth Complex Figure) were not effective at detecting malingering of mathematics disability. Despite the inclusion of measures with demonstrated utility in predicting malingering in other clinical populations, none of the measures in this study had particularly robust cut-off values that resulted in good sensitivity *and* specificity. A meta-analysis by Vickery, Berry, Inman, and Orey (2001), compared sensitivity and specificity rates of several popular measures of malingering, and reported an average sensitivity of 56% and an average specificity of 96%, with a mean classification hit rate of 77%. Previous research in the field of malingering has primarily focused on the exaggeration or feigning of memory deficits. Results of the current study suggest that measures sensitive to malingering of memory impairment are not always sensitive to malingering of learning disability.

Of the dependent measures in this study, Digit Span was most consistently effective at detecting malingering; though its sensitivity rate was persistently low and fell between 11% and 32%. A standard score of less than 80, which is equivalent to a scaled

score less than 6, results in a specificity of 100% for all groups. No control or LD participants scored below this cut-off. A clinician can be confident in concluding that an individual scoring below 80 is almost certainly malingering, but this cut-off would fail to detect 90 out of every 100 malingerers. Performance on the Grouped trial of the Rey Dot Counting Test was effective at differentiating between malingered math LD and controls, with a classification rate in this sample of 68.33% and a specificity of 100%. It remains to be seen whether this measure can reliably differentiate malingering from true math learning disability.

Logistic regression models using a combination of predictive measures accurately classified between 65.4% and 72.0% of participants when specificity was held at .90 or greater. In practice, cut-off values are much more useful than logistic regression equations for predicting group membership. Failure on any one cut-off value produced a sensitivity of 70.0% when differentiating malingerers from controls, but sensitivity dropped to 32.0% when differentiating malingerers from non-malingerers. As recommended by Larrabee (2007) and Slick et. al, (1999), requiring failure on any two cut-offs resulted in perfect or near perfect specificity when differentiating malingerers from controls and malingerers from non-malingerers. However, using pairs of cut-offs did not result in improved sensitivity, possibly because the dependent/predictor measures in this study were too highly correlated. Despite impressive specificity values, using a combination of two cut-offs was no more effective than using the cut-off from the grouped trial of the Rey Dot Counting Test to differentiate between malingerers and controls; and no better than using the Digit Span cut-off to differentiate between malingerers and non-malingerers.

Hypothesis 1

The research literature contains conflicting results regarding whether performance becomes more believable when participants are provided with information on the specific disorder to be malingered and strategies for successfully avoiding detection. Frederick and Foster (1991) reported no benefit from providing such information, while Franzen and Martin (1996) found that coaching resulted in more believable patterns of performance when compared to uncoached malingerers.

In the current study, it was hypothesized that the performance of sophisticated malingerers could be reliably differentiated from non-sophisticated malingerers. This study did not find a significant difference between the performance of coached and uncoached participants, suggesting that educating individuals on mathematics disability did not make their simulation any more believable. Despite receiving information about how to successfully feign a disability, the coached malinger group used many of the same dissimulation strategies as the naïve uncoached group. Both groups reported that their most frequently utilized malinger strategy involved deliberate endorsement of incorrect responses. Other popular strategies utilized by the uncoached group involved deliberately skipping items, feigning confusion, and missing both very easy and very difficult items. For the coached malinger group, popular strategies involved taking longer than usual to answer items, deliberately skipping items, and missing both very easy and very difficult items.

It should be noted that this study did not measure participants' pre-existing knowledge about mathematics learning disability. It was assumed that none of the

participants in the uncoached group possessed any formal knowledge of the type of deficits expected to correlate with a math disability; though this assumption cannot be verified, which is a limitation of this study. Likewise, it is impossible to reliably measure whether the coached participants actually utilized the information provided to them. It is also impossible to measure the amount of effort/motivation each of the malingering participants exerted toward producing a valid learning disability profile. At debriefing, participants indicated that the \$50 gift certificate provided little to no incentive to perform as instructed. It remains unclear whether participants were truly unmotivated to perform as instructed, or whether they simply did not perceive the monetary incentive as a primary factor motivating their performance.

There was wide variability in performance among each of the two malingering groups, particularly within the coached group, which had the greatest number of participants excluded as outliers, yet still produced non-normal distributions on several dependent variables. It would be presumptuous to assume that outliers among the two malingering groups were not performing as instructed. There is likely wide variability in what individuals believe is “typical” performance for students with a learning disability. Markedly aberrant performance on a measure is not necessarily indicative of failure to adhere to instructions, it may simply reflect a layperson’s inaccurate assumption that individuals with learning disabilities uniformly perform in the extremely low range on measures of cognitive functioning. Lack of a cohesive pattern of performance amongst each group of participants (i.e., non-normal distributions) has a negative impact on statistical power and is assumed to have interfered with this study’s ability to accurately

detect malingering. The removal of additional outlier cases may have resulted in improved classification rates, but this step is not justified from a theoretical perspective.

Hypothesis 2

It was hypothesized that it would be possible to reliably differentiate between malingered performance and a true mathematics learning disability. After combining the coached and uncoached groups, there were nearly twice as many participants in the malingering group as compared to the LD group. Missing data points for five of the LD participants further exacerbated the difference in group size. The base rate of malingering in this sample was 71.2%, meaning that if all participants were classified as malingering, without considering their performance on any of the dependent/predictor measures, the hit rate would be 71.2%.

Most of the dependent measures used in this study were not able to reliably differentiate between these groups of participants. A logistic regression model containing all five of the dependent measures was able to correctly classify 76.9% of participants, but resulted in a false positive rate of 60%. In a clinical setting, this would be an unacceptably high risk of misdiagnosing malingering in an individual with true impairment. Adjusting the cut value to maintain a false positive rate of 10% or less resulted in a hit rate of 65.4%, sensitivity of 54.1%, and positive predictive power (PPP) of 95.2%, which is commensurate with the values reported by Vickery, et. al., (2001) for other measures of malingering. Therefore, while the chances are relatively low of misclassifying someone with a learning disability as malingering, almost half of individuals who are malingering will be missed.

If the base rate of malingering in the sample was changed from 71% to 30%, to presumably more accurately reflect the rate of malingering in a learning disability evaluation setting, the PPP would drop to 77.5%. Using the logistic regression model does significantly increase predictive accuracy over using just the base rate, but this model explains only approximately one-third of the variability between groups, suggesting that while the malingering participants in this study may have performed quantitatively different from the LD participants, the regression model is not particularly effective at explaining or measuring that difference.

Translating the regression findings into practical cut-off scores resulted in even less impressive classification accuracy. Cut-off scores were derived for the Calculation and Digit Span subtests (the two dependent measures with the greatest, albeit not necessarily significant, contribution to the regression model). At best, individual cut-off scores for these measures produced classification rates of approximately 50%, and participants rarely failed cut-offs on both Digit Span and Calculation subtests. It is notable that the malingering group performed significantly worse than the LD group on Digit Span, but significantly better than LD participants on the Calculation subtest.

It is significant that most of the measures in this study were unable to differentiate between malingered performance and true mathematics disability. In the context of a comprehensive evaluation for learning disabilities, malingering would likely be undetectable on most measures. This finding adds to the body of literature that demonstrates cognitive and neuropsychological deficits can be effectively malingered without the benefit of expert knowledge, regardless of age or level of education (Faust, 1995; Faust et al., 1988; Franzen & Martin, 1996; Harrison et. al., 2008; Lu & Boone,

2002). This also underscores the importance of assessing motivation/effort in all psychological assessments, including learning disability evaluations.

The Rey Dot Counting Test was not administered to the archival LD group, therefore it is uncertain whether use of this free-standing measure of malingering would improve the ability to differentiate between malingered and true mathematics disability. Previous research (Boone et. al., 2002) found that college students diagnosed with learning disability were able to pass the Rey Dot Counting Test without difficulty, with false positive rates of less than 1%. The findings suggest that this measure might be clinically useful in screening for malingering during learning disability evaluations, though further research is necessary to determine how college students with specific mathematics disability perform on this measure.

Hypothesis 3

It was hypothesized that the performance of malingerers could be reliably differentiated from the performance of control participants. The current study found that a logistic regression model incorporating the six continuous dependent variables was able to correctly classify 70.0% of malingerers and controls, with a false positive rate of less than 10%. The Logical Memory II subtest was the only variable to make a significant contribution to the model.

Larrabee (2003) and Rogers (2008), recommend the use of cut-off scores over regression equations for identifying malingered performance on a battery of tests. The current study derived cut-off scores for the Calculation, Logical Memory II, Digit Span and Grouped Dot Counting measures. The choice of which variables to use was based

partly on statistical analysis and partly on practicality. The Calculation subtest was included because of its specific measurement of math abilities and the presumed likelihood that it would be a target for attempts to simulate a mathematics disability. In contrast, the Logical Memory II and Digit Span subtests were included because of their reliable ability to differentiate between groups, yet their lack of face validity to individuals guessing how to appear mathematically impaired. The Rey Dot Counting Test was included because of its utility as a free-standing measure of malingering, as well as the likelihood that it would be a target for malingerers. Haines and Norris (2001) recommend the use of both embedded indices and free-standing measures when assessing for malingering.

Optimal cut-off scores were calculated for each of these measures by setting specificity at 90% or greater. A cut-off of greater than 35 seconds on the Grouped Dot Counting trial was most effective at differentiating between malingerers and controls. A standard score cut-off of less than 80 on the Calculation subtest was similar in its effectiveness at discriminating between these groups. Unfortunately, sensitivity for each of these cut-offs was relatively low, falling below 50% and allowing over half of malingering participants to go undetected.

Requiring failure on any one of the four cut-off indicators resulted in improved sensitivity of 70.0%, but a low specificity rate of 78.0%. There is not strong confidence that an individual failing one of these cut-off is truly malingering. Five of the control participants (22%) failed at least one cut-off, and 11 of the malingerers (30%) did not fail any cut-offs. Requiring failure on a combination of two or three cut-offs greatly reduces the risk of incorrectly labeling someone as malingering, but comes at the price of

significantly diminished sensitivity, allowing between 59% and 76% of malingerers to go undetected. Despite poor sensitivity, failure on a cut-off with a specificity of 100% is diagnostically meaningful.

As with most measures of malingering, it would be impossible to infer the absence of malingering based on passing scores on one, two, or even three of these cut-offs. Despite this limitation, the sensitivity level of the pairwise (41%) and three-way (24%) combination failures is commensurate with sensitivity levels reported in the research literature for some established malingering measures. For example, Berry and Schipper (2008) report sensitivities falling below 20% for malingering indices from the Trail Making Test. Furthermore, their comparison of four malingering studies utilizing the Rarely Missed Index from the Logical Memory subtest reveals a median sensitivity of 25%. In studies attempting to identify malingered memory impairment, a scaled score of less than 4 on the Digit Span subtest has been utilized, despite sensitivities between 19% and 30% (Suhr & Barrash, 2007). In contrast, many studies of malingering measures have reported much greater sensitivity, such as the Word Memory Test, which reportedly achieved 97.7% sensitivity and 100% specificity in identifying malingered memory impairment, and the Dot Counting effort score cut-off of 13, which reportedly boasts a sensitivity of 88.2% and specificity of 90.3% (Boone et. al., 2003).

Hypothesis 4

It was hypothesized that malingered performance could be reliably differentiated from non-malingered performance. This has more practical utility than separating malingered from control performance. In clinical settings, few evaluations are conducted

on individuals resembling the control group, which was absent of any cognitive/learning complaints and would therefore be unlikely to present for a learning assessment. The non-malingering group from this study includes the clinical LD group. This study did not seek to identify specific learning disability, nor did it seek to differentiate students with learning disability from controls. For the purposes of this study, these two groups are similar in that they presumably did not engage in malingering. Data from the control and LD groups were combined to form a “non-malingering” group. Using the same set of dependent variables utilized in Hypothesis 3, with the exclusion of the Rey Dot Counting Test, there was a reliable difference between the performance of malingerers and non-malingerers, with an overall hit rate of 72.0% when holding specificity at 90% or higher.

Optimal cut-offs were derived for the Calculation, Logical Memory II, Digit Span, and Rey-O Copy variables. Digit Span was most effective at differentiating between malingered and non-malingered performance, with a hit rate of 59% (sensitivity 11%, specificity 100%). Failure on any one of these cut-offs resulted in low sensitivity and a rather modest rate of false positives (25% of LD participants and 8.7% of control participants failed at least one cut-off). Requiring failure on any two cut-offs resulted in a specificity of 100%, but a diminished sensitivity rate. Of the 37 malingering participants, 33 (89%) did not fail two or more of these cut-offs and only one of the malingerers failed three or more cut-offs. None of the control or LD participants failed more than one cut-off. It can be concluded with great confidence that any individual who fails two or more of these cut-offs is likely to be malingering. However, this collection of cut-offs remains far less sensitive to malingering than previous studies, such as Victor et al., (2009) and Larrabee (2003), which report pairwise malingering sensitivities of greater than 80%.

Limitations

The current study involved many limitations that may have compromised the ability to differentiate malingering from true impairment. It is possible that the current study lacked the power necessary to identify a significant effect between these rather heterogeneous and diffusely defined groups. As mentioned above, wide variability in performance within both the LD and malingering groups compromised the ability to detect a significant effect. There was a very wide range in the scores of LD participants on each measure. The LD group was more heterogeneous in terms of age and academic year, which may have contributed to the variability in their performance. It may also be partly attributable to the fact that these data were collected and scored by several different examiners over the course of several years, introducing numerous opportunities for inter-rater error. In contrast, data for the three experimental groups were collected over the course of a few weeks and scored only by the principal investigator, allowing less opportunity for error variance.

The number of participants in each group was relatively small for the number of dependent variables used in the study, which diminishes the study's power to detect an effect if it is present. According to Wright (1995), logistic regression ideally requires 50 participants for each predictor variable included in the model. Although an attempt was made to control for differences in group size, missing data points, and non-normally distributed variables, these factors further compromise statistical power.

As pointed out by Rogers (2008), it is very difficult to create an experimental malingering condition that realistically induces the same level of intrinsic and extrinsic

motivation seen in true malingerers. It is presumed that the anticipated academic accommodations that accompany a diagnosis of learning disability are far more motivating to a college student than an opportunity to win \$50, as used in this study.

Additionally, it is nearly impossible to ensure that there are no cases of malingering in an established diagnostic group, particularly if data from that group were gathered from an archival source. It is possible that some of the participants in the LD group were malingering and went undetected at the time of their assessments. Use of archival data presented an additional obstacle in this study, because those participants were not administered the Rey Dot Counting Test; therefore, data from that test could not be included in any analysis attempting to differentiate the LD group from the three experimental groups. As previously noted, past research has reported that individuals with learning disability are able to pass the Rey Dot Counting Test without difficulty (Boone et. al., 2002). This suggests that the inclusion of the test would have likely improved the ability to differentiate between the malingering and LD groups.

Implications for Further Research and Theoretical Considerations

Until recently, there was no research regarding malingering of learning disabilities. In the past decade, a few studies have considered the possibility of feigned or exaggerated performance on learning disability evaluations and the incentives that might encourage students to malingering such conditions (Lu, Boone, Jimenez & Razani, 2004; Osmon, Plambeck, Klein and Mano, 2006). The scientific literature remains sparse in this area. As of yet, there are no estimates of the suspected prevalence of malingered learning disability, nor is there sufficient discussion about suggested methods for detecting such

dissimulation. There is also a dearth of information regarding mathematics learning disabilities in the college population, despite this being one of the most commonly cited subjects of academic struggle among both disabled and non-disabled college students, and being associated with the highest prevalence of academic course waivers (Rath & Royer, 2002; Yost, Shaw, Cullen & Bigaj, 1994). Further research on the pattern of impaired performance among college students with a mathematics disability will allow for the development of measures to more accurately detect feigned disability.

Most research on mathematics disability has focused on the school age population. The concept of math disability remains a vaguely defined collection of deficits spanning multiple domains of cognitive functioning and including numerous possible difficulties involving number skills. There is no single prototype of mathematics disability upon which to base definitive diagnostic criteria. The lack of a clear diagnostic definition undermines research on mathematics disability among all age groups. Past studies appear to have been measuring disability in very different ways, and may have been measuring different constructs (i.e., low math ability versus math learning disability). This compromises the reliability of reported prevalence rates and draws us further away from establishing a standard pattern of test performance against which to compare suspected cases of malingering.

The lack of consensus among learning disability definitions is not unique to mathematics. Despite decades of pertinent legislation, there is not a universally accepted diagnosis of learning disability and many questions remain unanswered: Should Attention Deficit Hyperactivity Disorder be considered a learning disability? Is it mandatory that all students with learning disability have average to above average IQ? If a student has an IQ

in the superior range and is achieving in the high average range, can he or she be considered to have a learning disability? If the discrepancy model is not used to identify learning disability, how will gifted students qualify for a diagnosis of learning disability? How is low math ability differentiated from math learning disability, and should these be considered two different diagnostic conditions? If response to intervention (RTI) is used as the diagnostic standard, how are postsecondary students, who generally do not have the benefit of individualized teaching interventions, diagnosed with learning disability?

Conclusions

In summary, coaching students on how to feign a mathematics learning disability did not result in a more believable pattern of performance, as compared to naïve participants instructed to simulate a math learning disability. Both malingering groups were able to produce performance profiles that would be difficult to reliably differentiate from the performance of individuals with an actual diagnosis of math LD. None of the measures used in this study were particularly sensitive to the presence of malingering, but failure on any combination of cut-offs can be considered a very strong indication of malingering. A Digit Span standard score below 80, and a Rey Dot Counting grouped time greater than 35 seconds are also strong indicators of malingering. Nonetheless, the majority of malingerers will go undetected with all of these measures.

The inability to differentiate most malingerers from individuals with a true diagnosis of mathematics learning disability highlights the need for further research on malingering of learning disabilities. Multiple researchers and authors have acknowledged the potential issue of malingering in this population (Alfano & Boone, 2007; Boone et.

al., 2002; Mapou, 2009; Sparks, et. al., 2003), but there have been very few studies of this phenomenon and no studies of the specific malingering of mathematics disabilities.

Dating back to the *Guckenberger v. Boston University* case in the mid-1990s, it has been proposed that academic accommodations provide ample incentive for students to consider feigning or exaggerating a learning disability. Prevalence rates of malingered learning disabilities cannot be established until we have developed a reliable method of measuring this phenomenon. There is also a great need for further research on the nature of mathematics disabilities. It is futile to develop a method of screening out simulated mathematics disability if there is no clear consensus on the type of deficits that establish the true presence of this disorder. Response to intervention, popularly used to diagnose learning disability in elementary through high school, is not applicable in the college setting. Currently, there exists a large loophole in the postsecondary learning disability evaluation process that allows disabled students to potentially gain a significant academic advantage over their non-disabled peers.

REFERENCES

- Alfano, K., & Boone, K. B. (2007). The use of effort tests in the context of actual versus feigned Attention-Deficit Hyperactivity Disorder and Learning Disability. In K. Boone (Ed.), *Assessment of feigned cognitive impairment: A neuropsychological perspective* (pp. 366-383). New York, NY: Guilford.
- American Psychiatric Association (2000). *Diagnostic and statistical manual of mental disorders* (4th ed. Text revision). Washington, DC: Author
- Americans With Disabilities Act of 1990, 42 U.S.C. § 12101 et seq. (2010).
- Association on Higher Education and Disability (AHEAD) (2003). *Policy statement for documentation of a learning disability in adolescents and adults*. Retrieved from www.ahead.org.
- Aud., S., Hussar, W., Planty, M., Snyder, T., Bianoc, K., Fox, M., ... Drake, L. (2010). *The Condition of Education 2010* (NCES 2010-028). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC. Retrieved from NCES website: <http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2010028>.
- Babikian, T., & Boone, K. B. (2007). Intelligence tests as measures of effort. In K. Boone (Ed.) *Assessment of feigned cognitive impairment: A neuropsychological perspective* (pp.103-127). New York, NY: Guilford.
- Baddeley, A. (2003). Working memory: Looking back and looking forward. *Nature* 4. Retrieved from: www.nature.com/reviews/neuro.

- Bernard, L. C., Houston, W., & Natoli, L. (1993). Malingering on neuropsychological memory tests: Potential objective indicators. *Journal of Clinical Psychology*, 49(1), 45-53.
- Boone, K. B., & Lu, P. H. (2007). Non-Forced choice effort measures. In G. Larrabee (Ed.), *Assessment of malingered neuropsychological deficits* (pp. 27-43). New York, NY: Oxford.
- Boone, K. B., Lu, P., Beck, C. King, C., Lee, A., Philpott, L., Shamieh, E., & Warner-Chacon, K. (2002). Sensitivity and specificity of the Rey Dot Counting Test in patients with suspect effort and various clinical samples. *Archives of Clinical Neuropsychology* 17, 625-642.
- Brandys, C. F., & Rourke, B. P. (1991). Differential memory abilities in reading-and-arithmetic disabled children. In B. Rourke (Ed.), *Neuropsychological validation of learning disability subtypes* (pp. 73-96). New York, NY: Guilford.
- Brinckerhoff, L. C., Shaw, S. F., & McGuire, J. M. (1993). *Promoting postsecondary education for students with learning disabilities*. Austin, TX: Pro-Ed.
- Cirino, P. T., Morris, M. K., & Morris, R. D. (2002). Neuropsychological concomitants of calculation skills in college students referred for learning difficulties. *Developmental Neuropsychology*, 21(2), 201-218.
- Cordoni, B. K., O'Donnell, J. P., Ramaniah, N.V., Kurtz, J., & Rosenshein, K. (1981). Wechsler Adult Intelligence Score patterns for learning disabled young adults. *Journal of Learning Disabilities*, 14(7), 404-407.
- Cortiella, C. (2009). *The State of Learning Disabilities*. New York, NY: National Center for Learning Disabilities (NCLD), retrieved from www.LDonline.org

- Dalke, C. (1988). Woodcock-Johnson PsychoEducational Test Battery profiles: A comparative study of college freshmen with and without learning disabilities. *Journal of Learning Disabilities, 21*(9), 567-570.
- DeLuca, J. W., Rourke, B. P., & Del Dotto, J. E. (1991). Subtypes of arithmetic-disabled children: Cognitive and personality dimensions. In B. Rourke (Ed.) *Neuropsychological validation of learning disability subtypes*. New York, NY: Guilford. pp.180-232.
- DiCarlo, M. A., Gfellar, J. D. & Oliveri, M. V. (2000). Effects of coaching on detecting feigned cognitive impairment with the Category Test. *Archives of Clinical Neuropsychology, 15*(5), 399-413.
- Dwyer, K. P. (1987). School psychology assessment. In A. Kavale, S. Forness, & M. Bender (Eds.), *Handbook of learning disabilities: Dimensions and diagnosis* (Vol. I, pp. 325-348). Boston, MA: College Hill Press.
- Education for All Handicapped Children Act of 1975, Pub. L. No. 94-142, § 89, Stat. 773 (1975).
- Educational Testing Service [ETS]. (2007). *Policy statement for documentation of learning disability in adolescents and adults, second edition*. Retrieved from ETS website:
http://www.ets.org/disabilities/documentation/documenting_learning_disabilities/.
- Elliott, S. N., & Roach, A. T. (2002). *The Impact of providing testing accommodations to students with disabilities*. Retrieved from University of Wisconsin-Madison, Department of Educational Psychology website: www.wcer.wisc.edu/testacc.
- Faust, D. (1995). The detection of malingering. *Neurologic Clinics, 13*(2), 255-265.

- Faust, D., Hart, K., Guilmette, T. J. & Arkes, H. R., (1988). Neuropsychologists' capacity to detect adolescent malingerers. *Professional Psychology: Research and Practice*, 19(5), 508-515.
- Fleischner, J. E., & Garnett, K. (1987). Arithmetic difficulties. In A. Kavale, S. Forness, & M. Bender (Eds.), *Handbook of learning disabilities: Dimensions and diagnosis* (Vol. I, pp. 189-209). Boston, MA: College Hill Press.
- Franzen, M., & Martin, N. (1996). Do people with knowledge fake better? *Applied Neuropsychology*, 3, 82- 85.
- Frederick, R. I., & Foster, H. G. (1991). Multiple measures of malingering on a forced-choice test of cognitive ability. *Psychological Assessment*, 3(4), 596-602.
- Geary, D. C. (1993). Mathematical disabilities: Cognitive, neuropsychological, and genetic components. *Psychological Bulletin*, 114(2), 345-362.
- Geary, D. C., & Hoard, M. K. (2001). Numerical and arithmetic deficits in learning disabled children: Relation to dyscalculia and dyslexia. *Aphasiology*, 15(7), 635-647.
- Ginsburg, H. P. (1997). Mathematics learning disabilities: A view from developmental psychology. *Journal of Learning Disabilities*, 30(1), 20-33.
- Greve, K.W., & Bianchini, K. J. (2007). Detection of cognitive malingering with tests of executive function. In G. Larrabee (Ed.), *Assessment of malingered neuropsychological deficits* (pp. 171-225). New York, NY: Oxford.
- Guckenberger v. Boston University, 974 F. Supp. 106 (D. Mass. 1997).

- Haines, M. E., & Norris, M. P. (2001). Comparing student and patient simulated malingerers' performance on standard neuropsychological measures to detect feigned cognitive deficits. *The Clinical Neuropsychologist, 15*(2,) 171-182.
- Hanich, L. B., Jordan, N. C., Kaplan, D. & Dick, J. (2001). Performance across different areas of mathematical cognition in children with learning difficulties. *Journal of Educational Psychology, 93*(3), 615-626.
- Harrison, A. G., Edwards, M. J., & Parker, K. C., (2008). Identifying students feigning dyslexia: Preliminary findings and strategies for detection. *Dyslexia, 14*, 228-246.
- HEATH Resource Center. (2001). *College freshmen with disabilities: A biennial statistical profile*. Retrieved from LD Online website:
www.ldonline.org/ldindepth/postsecondary/
- Horn, L., Berkold, J. & Bobbitt, L. (1999). *Students with disabilities in postsecondary education: A profile of preparation, participation, and outcomes* (NCES 1999-187). U.S. Department of Education, National Center for Education Statistics. Washington, DC: U.S. Government Printing Office. Retrieved from NCES website: <http://nces.ed.gov>.
- Hughes, C. A., & Smith, J. O. (1990). Cognitive and academic performance of college students with learning disabilities: A synthesis of the literature. *Learning Disability Quarterly, 13*, 66-79.
- Individuals With Disabilities Education Act, 20 U.S.C. § 1400 et. seq. (2010).
- Iverson, G. L., & Franzen, M. A. (1994). The Recognition Memory Test, Digit Span, and Knox Cube Test as markers of malingered memory impairment. *Assessment, 1*, 323-334.

- Iverson, G. L., & Franzen, M. D. (1996). Using multiple objective memory procedures to detect simulated malingering. *Journal of Clinical and Experimental Neuropsychology*, 18(1), 38-51.
- Johnstone, C. J., Altman, J., Thurlow, M. L. & Thompson, S. J. (2006). *A summary of research on the effects of test accommodations: 2002 through 2004* (Technical Report 45). Retrieved from University of Minnesota, National Center on Educational Outcomes website:
www.education.umn.edu/NCEO/OnlinePubs/Tech45/.
- Killgore, W. D.S., & DellaPietra, L. (2000). Using the WMS-III to detect malingering: Empirical validation of the Rarely Missed Index (RMI). *Journal of Clinical and Experimental Neuropsychology*, 22(6), 761-771.
- Larrabee, G. J. (2007). *Assessment of malingered neuropsychological deficits*. New York, NY: Oxford.
- Larrabee, G. J., & Berry, T. R. (2007). Diagnostic classification statistics and diagnostic validity of malingering assessment. In G. Larrabee (Ed.), *Assessment of malingered neuropsychological deficits* (pp. 14-26). New York, NY: Oxford.
- Lewis, L., & Farris, E. (1999). *An institutional perspective on students with disabilities in postsecondary education* (NCES 1999-046). U.S. Department of Education, National Center for Education Statistics. Washington, DC: U.S. Government Printing Office. Retrieved from NCES website: <http://nces.ed.gov>.
- Lezak, M. D. (1995, 2004). *Neuropsychological assessment*. New York, NY: Oxford University Press.

- Lu, P. H., & Boone, K. B. (2002). Suspect cognitive symptoms in a 9-year-old child: Malingering by proxy? *The Clinical Neuropsychologist*, 16(1), 90-96.
- Lu, P. H., Boone, K. B., Jimenez, N., & Razani, J. (2004). Failure to inhibit the reading response on the Stroop Test: A pathognomonic indicator of suspect effort. *Journal of Clinical and Experimental Neuropsychology*, 26, 180-189.
- Mapou, R. L. (2009). *Adult learning disabilities and ADHD*. New York, NY: Oxford University Press.
- Mather, N., & Woodcock, R.W. (2001). *Examiner's manual: Woodcock-Johnson III Tests of Achievement*. Itasca, IL: Riverside.
- Mather, N., & Woodcock, R.W. (2001). *Examiner's manual: Woodcock-Johnson III Tests of Cognitive Abilities*. Itasca, IL: Riverside.
- Mazzocco, M. M., (2005). Challenges in identifying target skills for math disability screening and intervention. *Journal of Learning Disabilities*, 38(4), 318-323.
- McCue, M., & Goldstein, G. (1991). Neuropsychological aspects of learning disability in adults. In B. Rourke (Ed.) *Neuropsychological validation of learning disability subtypes* (pp. 311-329). New York, NY: Guilford.
- McGlaughlin, S. M., Knoop, A. J. & Holliday, G. A. (2005). Differentiating students with mathematics difficulty in college: Mathematics disabilities vs. no diagnosis. *Learning Disability Quarterly*, 28 (summer), 223-232.
- McGuire, J. M., Madaus, J. W., Litt, V., & Ramirez, M. O. (1996). An investigation of documentation submitted by university students to verify their learning disabilities. *Journal of Learning Disabilities*, 29(3), 297-304.

- Morris, R. D., & Walter, W. (1991). Subtypes of arithmetic-disabled adults: Validating childhood findings. In B. Rourke (Ed.) *Neuropsychological validation of learning disability subtypes* (pp.330-348). New York, NY: Guilford.
- National Joint Committee on Learning Disabilities. (2001). *Collective perspectives on issues affecting learning disabilities: Position papers, statements, and reports* (2nd ed.). Austin, TX: Pro-ed.
- Nitch, S. R., & Glassmire, D. M. (2007). Non-Forced choice measures to detect noncredible cognitive performance. In K. Boone (Ed.), *Assessment of feigned cognitive impairment: A neuropsychological perspective* (pp.78-102). New York, NY: Guilford.
- No Child Left Behind Act of 2001, 20 U.S.C. § 6301 et seq. (2010).
- Osman, D. C., Plambeck, E. A., Klein, L., & Mano, Q. (2006). The Word Reading Test of effort in adult learning disability: A simulation study. *The Clinical Neuropsychologist*, 28, 84-95.
- Pankratz, L., & Binder, L. M. (1997). Malingering on intellectual and neuropsychological measures. In R. Rogers (Ed.) *Clinical Assessment of Malingering and Deception*, 2nd Edition (pp. 223-238). New York, NY: Guilford.
- Pennington, B. F. (1991). *Diagnosing learning disorders: A neuropsychological framework*. New York, NY: Guilford.
- Rasanen, P., & Ahonen, T. (1995). Arithmetic disabilities with and without reading difficulties: A comparison of arithmetic errors. *Developmental Neuropsychology*, 11(3), 275-295.

- Rath, K. A., & Royer, J. M. (2002). The nature and effectiveness of learning disability services for college students. *Educational Psychology Review*, 14(4), 353-381.
- Rehabilitation Act of 1973, 29 U.S.C. § 794 (2010).
- Reschly, D. J., Hosp, J. L., & Schmied, C. M. (2003). *And miles to go: State SLD requirements and authoritative recommendations*. Retrieved from the U.S. Department of Education, Office of Special Education Programs website: <http://idea.ed.gov>.
- Rogers, R. (1997). *Clinical assessment of malingering and deception*, 2nd Edition. New York, NY: Guilford.
- Rourke, B. P. (1993). Arithmetic disabilities, specific and otherwise: A neuropsychological perspective. *Journal of Learning Disabilities*, 26(4), 214-226.
- Rourke, B. P., & Del Dotto, J. E. (1994). *Learning disabilities: A neuropsychological perspective*. Thousand Oaks, CA: Sage.
- Salvia, J., Gajar, A., Gajria, M., & Salvia, S. (1988). Comparison of WAIS-R profiles: Nondisabled college freshmen and college students with learning disabilities. *Journal of Learning Disabilities*, 21(10), 632-636.
- Scott, S. S. (1994). Determining reasonable academic adjustments for college students with learning disabilities. *Journal of Learning Disabilities*, 27(7), 403-412.
- Shalev, R. S., Manor, O., Kerem, B., Ayali, M., Badichi, N., Friedlander, Y., & Gross-Tsur, V. (2001). Developmental dyscalculia is a familial learning disability. *Journal of Learning Disabilities*, 34(1), 59-65.
- Shapiro, J. & Rich, R. (1999). *Facing learning disabilities in the adult years*. New York, NY: Oxford University Press.

- Share, D. L., Moffitt, T. E., & Silva, P. A. (1988). Factors associated with arithmetic-and-reading disability and specific arithmetic disability. *Journal of Learning Disabilities, 21*(5), 313-320.
- Silver, A. & Halgin, R. A. (2002). *Disorders of learning in childhood* (2nd Ed.). New York, NY: Wiley & Sons.
- Silver, C. H., Pennett, H. D., Black, J. L., Fair, G. W., & Balise, R. R. (1999). Stability of arithmetic disability subtypes. *Journal of Learning Disabilities, 32*(2), 108-119.
- Slick, D., Sherman, E. & Iverson, G. (1999). Diagnostic criteria for malingered neurocognitive dysfunction: Proposed standards for clinical practice and research. *The Clinical Neuropsychologist, 13*(4,) 545-561.
- Sparks, R. L., Philips, L., & Javorsky, J. (2003). Students classified as LD who petitioned for or fulfilled the college foreign language requirement-are they different? A replication study. *Journal of Learning Disabilities, 36*(4), 348-362.
- Stanovich, K. E. (1999). The sociopsychometrics of learning disabilities. *Journal of Learning Disabilities, 32*(4), 350-361.
- Stanovich, K. (2005). The future of a mistake: Will discrepancy measurement continue to make the learning disabilities field a pseudoscience? *Learning Disability Quarterly, 28* (Spring), 103-106.
- Strang, J. D., & Rourke, B. P. (1985). Arithmetic disability subtypes: The neuropsychological significance of specific arithmetical impairment in childhood. In B. Rourke (Ed.), *Neuropsychology of learning disabilities: essentials of subtype analysis* (pp. 167-183). New York, NY: Guilford.

- Suhr, J. A. & Barrash, J. (2007). Performance on standard attention, memory, and psychomotor speed tasks as indicators of malingering. In G. Larrabee (Ed.) *Assessment of malingered neuropsychological deficits* (pp.131-170). New York, NY: Oxford.
- The College Board (2010). *2010 college bound seniors total group profile report*. Retrieved from <http://professionals.collegeboard.com/profdownload/2010-total-group-profile-report-cbs.pdf>.
- U.S. Department of Education-Office of Special Education Programs (October 2006). *Identification of Specific Learning Disabilities*. Retrieved from <http://idea.ed.gov/explore/view/p/%2Croot%2Cdynamic%2CTopicalBrief%2C23%2C>
- U.S. Department of Education – Office of Special Education Programs (2008) *IDEA state reported data, Part B child count*. Retrieved from http://www.ideadata.org/arc_toc10.asp#partbCC.
- U.S. Government Accountability Office (GAO). (2009). *Higher education and disability: Education needs a coordinated approach to improve its assistance to schools in supporting students* (GAO-10-33). Retrieved from <http://www.gao.gov/news.items/d1033.pdf>.
- Vickery, C. D., Berry, D. T., Inman, T. H., Harris, M. J., & Orey, S. A. (2001). Detection of inadequate effort on neuropsychological testing: A meta-analytic review of selected procedures. *Archives of Clinical Neuropsychology*, 16, 45-73.

- Weinfurt, K. (1995). Multivariate analysis of variance. In L. Grimm & P. Yarnold (Eds.), *Reading and understanding multivariate statistics* (pp.245-276). American Psychological Association: Washington, DC.
- White, J. C., Moffitt, T. E., & Silva, P. A. (1992). Neuropsychological and socio-emotional correlates of specific-arithmetic disability. *Archives of Clinical Neuropsychology*, 7, 1-16.
- Winters, A. A., & Greene, J. P. (2009). *How special education vouchers keep kids from being mislabeled as disabled*. Manhattan Institute Civic Report. Retrieved from: www.manhattan-institute.org/html/cr_58.htm,
- Wirt, J., Choy, S., Rooney, P., Provasnik, S., Sen, A., and Tobin, R. (2004). *The condition of Education 2004* (NCES 2004-077). U.S. Department of Education, National Center for Education Statistics. Washington, DC: U.S. Government Printing Office. Retrieved from NCES website: <http://nces.ed.gov/pubsearch/pubinfo.asp?pubid=2004007>.
- Wolinsky, S. & Whelan, A. (1999). Federal law and the accommodation of students with LD: The lawyer's look at the BU decision. *Journal of Learning Disabilities*, 32(4), 286-291.
- Wright, R. E. (1995). Logistic regression. In L. Grimm & P. Yarnold (Eds.), *Reading and understanding multivariate statistics* (pp.217-244). American Psychological Association: Washington, DC.
- Yost, D. S., Shaw, S. F., Cullen, J. P., & Bigaj, S. S. (1994). Practices and attitudes of postsecondary learning disability service providers in North America. *Journal of Learning Disabilities*, 27(10), 631-639.

Appendix A

Informed Consent Form

Study Title: Identification of Malingering by College Students on Evaluations for Mathematics Learning Disability

You have been invited to participate in this research study because you are a member of the General Psychology Research Subject Pool at Indiana University of Pennsylvania (IUP). Your participation in this study is completely voluntary, and you may decline to participate or withdraw from this study at any time. The following information is provided to help you make an informed decision regarding your participation in this study.

The purpose of this study is to better identify patterns of performance in college students who are evaluated for mathematics learning disabilities. As a participant in this study, you will be asked to complete a number of different tasks, such as solving math calculation and story problems, identifying visual patterns, copying designs, remembering stories, reading lists of words, and performing some motor tasks. You may be asked to use specific test-taking strategies, or to perform as if you were experiencing specific academic problems. Your total participation time for this study will not exceed 2 hours. In addition to earning 2 credits toward fulfillment of the Subject Pool requirement, successful performance and adherence to instructions will earn you entry into a drawing to win a \$50 gift certificate.

All information will be kept completely confidential. Your name and other identifying information will not be attached to your test data. Only the research assistants, primary researcher, and dissertation chair will have access to the raw data. If you choose to participate in the \$50 drawing, you will be asked to provide your name, phone number, and e-mail address so that you can be contacted if you win. This identifying information will be destroyed after the drawing. All experimental data will be retained for a minimum of three years in compliance with federal regulations.

There are no foreseeable risks to participating in this study. If you do not wish to participate, please inform the research assistant before signing this form. If you do choose to participate and become uncomfortable at any point during testing, you may also withdraw from the study by informing the research assistant. You will not be penalized for withdrawal, and you may choose to have your name returned to the Subject Pool or ask your professor for an alternative assignment. Any data collected prior to withdrawal will be destroyed. If you do choose to withdraw from the study, you will not be eligible to win the \$50 gift certificate.

If you have any questions regarding this study or would like more information, please feel free to contact:

Primary Researcher

Andrea Sanders, MA
1020 Oakland Avenue
Uhler Hall
Indiana, PA 15705
(724) 422-6083

Dissertation Chair

David J. LaPorte, Ph.D.
1020 Oakland Avenue
Uhler Hall
Indiana, PA 15705
(724) 357-4524

This project has been approved by the Indiana University of Pennsylvania Institutional Review Board for the Protection of Human Subjects (phone: (724) 357-7730).

I have read and understand the above information and I consent to volunteer to be a participant in this study. I understand that my responses are completely confidential and that I have the right to withdraw at any time. I have received an unsigned copy of this Informed Consent Form to keep in my possession.

Signature _____
Print Name _____

Date _____
Phone _____

I certify that I have explained to the above individual the nature and purpose, the potential benefits, and possible risks associated with participating in this research study, have answered any questions that have been raised, and have witnessed the above signature.

Investigator _____

Appendix B

Demographic Questionnaire

The following information is being requested in order to gain an overall understanding of the sample population used in this study. This information will only be reported in group form and will not be used in any way to identify your particular testing results.

1) Gender: ____M ____F

2) Age:_____

3) Grade level: __Freshman __Sophomore __Junior __Senior____Other

4) Ethnicity: ____African American ____Caucasian ____Hispanic

____Asian/Pacific Islander ____Native American ____Other

1) Is English your native language? ____Y ____N

Appendix C

Debriefing Questionnaire

Please answer the following questions based on the testing you just completed.

1) Place an X next to the performance group to which you were assigned.

- ☐ Malingering – uncoached (asked to simulate math LD but not given any information as to what strategies to use)
- ☐ Malingering – coached (asked to simulate math LD and given specific strategies to utilize)
- ☐ Control (asked to perform your best on all tests)

2) Place an X next to the group of facts that best summarizes the information you used to guide your performance.

- ☐ 1 semester of classes left before graduation, failing grade in math course, fears will not be able to fulfill the math requirement, seeks out information about possible accommodations, staff and student agree to need for LD evaluation
- ☐ 1 semester of classes left before graduation, failing grade in math course, fears will not be able to fulfill the math requirement, seeks out information about possible accommodations, staff and student agree to need for LD evaluation. In addition, you were told that memory problems and problems with visual perception often occur with a math LD. To perform in a believable manner you were told to miss only harder items, and get at least 50% of multiple choice items correct.
- ☐ No information other than to perform your best on every task

3) Place an X next to ALL strategies used when completing the tasks.

- ☐ I tried to act confused
- ☐ I pretended to forget things easily
- ☐ I deliberately got answers incorrect
- ☐ I deliberately took longer than usual to answer questions
- ☐ I pretended to have trouble understanding the directions for the task
- ☐ I tried to miss only harder items
- ☐ I tried to miss both easy and hard items
- ☐ I pretended to have difficulty seeing and drawing things accurately
- ☐ I deliberately skipped items
- ☐ Other (explain) _____

4) Rate how well the chance to win a \$50 gift certificate motivated you to perform as instructed (malingering, malingering with strategies, or best performance).

- | | |
|--|---|
| ☐ very motivated | ☐ somewhat motivated |
| ☐ only slightly motivated | ☐ not motivated at all |

5) Rate how successful you believe you were at performing as instructed.

- | | |
|--|--|
| ☐ very successful | ☐ somewhat successful |
| ☐ average | ☐ not very successful |

Appendix D

Debriefing Form

Identification of Malingering by College Students on Evaluations for Mathematics Learning Disabilities

The purpose of this study is to better understand the patterns of performance by college students who are evaluated for mathematics learning disabilities. While it is evident that many college students are diagnosed with learning disabilities in the area of mathematics, there is also reason to believe that some students present for learning disability evaluations in the hopes of receiving special accommodations such as course waivers or substitutions. These students may not possess a true learning disability, but may try to exaggerate their difficulties in order to qualify for accommodations. More specifically, this study will compare the performance patterns of students who are instructed to malingering a math learning disability, students with previously diagnosed mathematical learning disabilities, and students with no disability performing at their best. It is hypothesized that students instructed to malingering will produce a predictable pattern of performance on standard neuropsychological and intellectual assessment instruments, and that malingered performance can be reliably differentiated from non-malingered performances.

You were randomly selected to participate in one of three experimental conditions.

1) Malingering – coached : These students were given a scenario of a college student who is presenting for an LD evaluation because he/she is not going to be able to fulfill the math requirement for graduation. In addition, these students were provided specific information to help them avoid detection and make their performance appear more like that of an individual with a true learning disability.

2) Malingering – uncoached: These students were given the same scenario described for the malingering – coached condition, but they did not receive any specific information or strategies to guide their performance.

3) Control: These students were not presented with a scenario, but were instead instructed to perform to the best of their ability on all tests

Data was also used from past student evaluations that were found to be indicative of a mathematics learning disability. This data was used as a comparison group, representative of performance of individuals with true mathematics learning disabilities.

At the beginning of this study, you were informed that if you completed all tests and scored within a specified range, you would be eligible to participate in a drawing for a \$50 gift certificate. In fact, all participants who complete the testing, regardless of their scores, will be entered into the drawing. This deception was necessary in order to assure all participants tried their best to perform as instructed. In order to assure confidentiality and maintain the integrity of this study, it is asked that you not discuss your participation in this study with other students participating in the Subject Pool.

If you would like to learn more about learning disabilities please visit the following website:

www.nldonline.org

If you believe you may have a learning disability, or if you would like more information about college students and learning disabilities, please contact the Advising and Testing Center on the IUP campus.

If you have questions or would like more information about this study, please contact the following individuals:

Primary Researcher

Andrea Sanders, MA
1020 Oakland Avenue
Uhler Hall
Indiana, PA 15705
(973) 270-8300

Dissertation Chair

David J. LaPorte, Ph.D.
1020 Oakland Avenue
Uhler Hall
Indiana, PA 15705
(724) 357-4524

Appendix E

Participant Instructions: *Coached Malingering*

You have been randomly assigned to be a participant in the *Coached Malingering* condition of this study. Malingering is defined as the **intentional misrepresentation or exaggeration of symptoms in the pursuit of external incentive** (American Psychiatric Association, 2000). This means that you are asked to complete today's testing procedures as if you were in the predicament described below. This is the story of a college student who is desperate to graduate and is hoping to meet criteria for a learning disability in order to earn a course waiver in mathematics. Receiving this course waiver will allow the student to graduate after next semester, rather than being forced to stick around and struggle through another math course. This student is desperate and decided that he/she is willing to intentionally exaggerate or make up difficulties in the area of mathematics, so that evaluators will recommend he/she receive the desired accommodations.

Please pay close attention to the details described in the following paragraph, with particular attention on the specific strategies for avoiding detection. **Your strict adherence to these instructions is vital to the integrity of this study.** If you are successful at malingering and able to produce performance patterns within one standard deviation of the mean performance for individuals with a true mathematics learning disability, you will be entered into a drawing to win a \$50 gift certificate. If you feel uncomfortable with the task of simulating mathematics impairment, please notify the research assistant immediately.

Jordan is a senior in college and has only 1 semester of classes left before graduation, but he received a failing grade in his/her math course and fears that he will not be able to fulfill the mathematics requirement for the major. Jordan asks the school's Advising and Testing Center for assistance, and learns about the various accommodations available to students with learning disabilities. Such accommodations include special tutoring, note-takers, audiotaped textbooks, study skills training, and in some cases course waivers or substitutions. Jordan and the staff member agree that he should be evaluated for a possible learning disability. Jordan hopes that he can convince the evaluator that he is experiencing significant problems with math and deserves a course waiver, allowing him to graduate without having to struggle through another semester of math.

In order to prove how much you need these accommodations, you intend to exaggerate or simulate your math difficulties. Remember that your simulation must be believable in order to avoid detection. This means that **you should not miss simple items and should get at least 50% of multiple choice questions correct.** The following is a list of errors or problems often seen in individuals with a disability in mathematics. Take a few minutes to review this list, and try to incorporate this information into your testing performance. Remember, the goal is to convince the evaluator that you have a math disability.

Participant Instructions: Coached Malingering cont.

Common arithmetic errors (Rourke, 1993)

- 1) Visual/spatial/organizational errors – this has to do with your visual processing of the math problem. Specific errors might include misaligning columns of numbers, misplacing or leaving out decimal points, misreading symbols or numbers, or completing operations in the wrong direction (subtracting larger from smaller number).
- 2) Procedural errors – this might include leaving out or incorrectly adding steps to a mathematical procedure, or using the wrong procedure for a given item.
- 3) Failure to change operations – this means using the same procedure on all items, regardless of the operation (+, -, etc.) indicated in the item.
- 4) Motor difficulties – this could be either very poor handwriting that results in misreading one's own work, or slowed motor performance on items (writing, drawing, etc.)
- 5) Memory errors – individuals may fail to remember basic math facts, or they may forget the steps or order of steps necessary to complete a given operation.
- 6) Judgment and Reasoning errors – in this case, the individual fails to notice when his or her answer is unreasonable, can not plan out how to go about solving a novel problem, or does not realize when problems are beyond his or her capability.

Please try to incorporate these tips into your performance today. Do not forget that your performance must be believable in order to qualify for the \$50 gift certificate. These strategies are provided as a means of increasing the believability of your performance, so be sure to incorporate them somehow.

Participant Instructions: *Uncoached Malingering*

You have been randomly assigned to be a participant in the malingering condition of this study. Malingering is defined as **the intentional misrepresentation or exaggeration of symptoms in the pursuit of external incentive** (American Psychiatric Association, 2000). This means that you are asked to complete today's testing procedures as if you were in the predicament described below. This is the story of a college student who is desperate to graduate and is hoping to meet criteria for a learning disability in order to earn a course waiver in mathematics. Receiving this course waiver will allow the student to graduate after next semester, rather than being forced to stick around and struggle through another math course. This student is desperate and decided that he is willing to intentionally exaggerate or make up difficulties in the area of mathematics, so that evaluators will recommend he receive the desired accommodations.

Please pay close attention to the details described in the following paragraph. **Your strict adherence to these instructions is vital to your successful performance and the integrity of this study.** If you are successful at malingering and able to produce performance patterns within one standard deviation of the mean performance for individuals with a true mathematics learning disability, you will be entered into a drawing to win a \$50 gift certificate. If you feel uncomfortable with the task of simulating mathematics impairment, please notify the evaluator immediately.

Jordan is a senior in college and has only 1 semester of classes left before graduation, but he received a failing grade in his math course and fears that he will not be able to fulfill the mathematics requirement for the major. Jordan asks the school's Advising and Testing Center for assistance, and learns about the various accommodations available to students with learning disabilities. Such accommodations include special tutoring, note-takers, audio-taped textbooks, study skills training, and in some cases course waivers or substitutions. Jordan and the staff member agree that he should be evaluated for a possible learning disability. Jordan hopes that he can convince the evaluator that he is experiencing significant problems with math and deserves a course waiver, allowing him to graduate without having to struggle through another semester of math.

In order to prove how much you need these accommodations, you intend to exaggerate or simulate your math difficulties. Remember **that your simulation must be believable in order to avoid detection.** Make your performance on the following tests resemble as closely as possible what you presume to be the performance of an individual who qualifies for a course waiver based upon a disability in mathematics. Please remember that if you successfully simulate a mathematics learning disability, you will be entered into a lottery for the chance to win a \$50 gift certificate.

Participant Instructions: *Control*

You have been randomly assigned to be a participant in the control condition of this study. You will be asked to complete a variety of tasks today. Your time commitment to this study will not exceed two hours, and depending on your performance, you may be able to complete all tasks in less than two hours. If you demonstrate good effort, score within one standard deviation of the mean for individuals of similar age and education, and are able to complete all tasks within the two-hour limit, you will be entered in a lottery for the chance to win a \$50 gift certificate. For this study, we are interested in studying your optimal performance abilities. **Please give your best effort on all tasks and attempt to get every answer correct.** If, for any reason, you feel uncomfortable or unable to put forth your optimal effort on the following tasks, please inform the evaluator immediately.

Appendix F

Drawing Entry Form

Because you have completed the testing requirements for this study, you are now eligible to be entered into a drawing to win a \$50 gift certificate. This will require you to provide the researcher with some contact information. If you are chosen as the winner, you will be contacted by the researcher no later than May 1, 2005. If you do not wish to disclose this information, or do not wish to participate in the drawing, please inform the research assistant.

Name: _____
(please print)

Phone: _____

E-mail: _____

Appendix G

CENTER FOR APPLIED PSYCHOLOGY Indiana University of Pennsylvania

Client Consent Form

Provision of services - The Assessment Clinic, Family Clinic and Stress and Habit Disorders Clinic are housed within the Center for Applied Psychology (CAP) at Indiana University of Pennsylvania. The CAP offers psychological services provided by advanced psychology doctoral students with supervision by licensed clinical psychologists.

Observation, recording, clinical training and research - The CAP is the primary clinical training site for doctoral students. As such, observation of therapy/testing sessions by the supervisor and supporting clinical team through one-way mirrors and video-recording is an integral part of the clinical work. Without such recordings or observations, only verbal or written reports could be provided to the supervisor. As part of their training, graduate students are also required to present a sample of their clinical work before the Clinical Training Committee. This work sample may include video-taped and written material from various treatment or testing sessions. In addition to the clinical and testing services, the CAP also supports several research projects investigating ways to enhance clinic services. Thus, if you are receiving therapy either through the Family or Stress and Habit Disorders Clinics you may be asked to complete a brief set of questionnaires assessing your views about therapy and the therapist you are seeing. These questionnaires may be completed after each session and some time after your therapy has ended.

Confidentiality - The confidentiality of all materials related to your therapy and/or testing will be protected by the CAP. Clinical information will not be disclosed to anyone outside the Clinical Training Program without your written permission to release such information, except where required by law. It is important to understand that the law requires the CAP to release information when there is suspicion of child abuse or neglect, or when there is an actual threat of a physically violent act that would endanger you or others. Research data will only be reported in pooled form and will not present any information that would identify individual clients.

Agreement - By signing below I certify that I understand the information presented above and agree to: (1) receive psychological services from the CAP; (2) allow video-recording and observation of my sessions by a licensed psychologist and supporting clinical team; (3) allow the therapist to use information from my therapy and/or assessment for the clinical work sample; (4) participate in clinic research, and (5) pay a fee of \$_____ per session/hour, due and payable at the time of each appointment unless otherwise arranged.

I further understand that my therapy and/or testing through the CAP does not depend on my participation in research or having my sessions recorded, and that at any time I may choose to withhold this information without jeopardy. The confidentiality of all materials related to my therapy and/or testing will be protected by the CAP.

This agreement will be construed according to the laws of the State of Pennsylvania.

_____ Signature of Client	_____ Date
_____ Signature of Parent/Guardian	_____ Date
_____ Signature of Witness	_____ Date

Inquiries or concerns should be addressed to Director, Center for Applied Psychology, Indiana University of Pennsylvania, Indiana, PA 15705; telephone (412) 357-6228.

Appendix H

FEE PERMISSION AGREEMENT

This agreement is entered into as of **July 25, 2006** (the "Agreement"), between Harcourt Assessment, Inc., 19500 Bulverde Road, San Antonio, Texas 78259 (herein the "Publisher") and

NAME: Andrea Sanders
ADDRESS: c/o David LaPorte, Ph.D.
 47 Madison Ave. #2
 Madison, New Jersey, 07940

(herein the "Licensee"), WITNESSETH:

WHEREAS the Publisher is the **copyright owner** of the *Wechsler Memory Scale*[®] – *Third Edition (WMS[®]-III)* (herein the "Work(s)"); and

WHEREAS the Licensee wishes to reproduce the **Logical Memory I and II, Recognition and Digit Span Subtests** from the Work(s) for **use in dissertation research on malingering and learning disabilities in the college population** (herein the "Licensed Use").

NOW, THEREFORE, the Publisher and the Licensee agree as follows:

1. The Licensee may either produce, have produced, and/or distribute such reproductions of the Work specified above, solely for the Licensed Use and subject to the terms and conditions of this Agreement.
2. The Work(s) shall be identified by title on any reproduction unless otherwise expressly provided in this Agreement.
3. The Licensed Use specifically excludes the right to print, copy or distribute in any form, or to translate, adapt or revise, or to exhibit, represent, record or reproduce any portion of the Work(s), either separately or as part of any other larger publication, except as otherwise expressly provided herein. Licensee agrees to abide by federal copyright, patent, and trademark laws or such other laws as governed by the Berne Convention, whichever is relevant to Licensee's country.

The Licensee will take all necessary precautions to safeguard all materials by limiting access to only those individuals or agencies with a responsible, professional interest in the security of the materials.

4. It is understood and agreed that no commercial use, other than as described herein, may be made of the Work(s) or the reproduction authorized herein.

- a. In order to assure that the Licensee's procedures and materials used in connection with the Works are in accordance with applicable professional standards and with the high quality of the Works, the Licensee agrees to institute appropriate procedures in its administration, processing, scoring and reporting, including without limitation the following:
 - (i) establishing procedures, substantially similar to those required under APA-AERA-NCME Standards for Educational and Psychological Tests;
 - (ii) ensuring that all written materials, will: (A) be consistent with accepted professional standards including, without limitation, the APA-AERA-NCME Standards for Educational and Psychological Tests; and (B) contain complete identification information including the Test name, the date on which it was given, its edition, its level and form, and appropriate labeling of subtest and total scores.
 - (iii) ensuring availability of qualified personnel to assist users in the proper interpretation and use of the Works and if necessary, the appropriate level of action will be taken with regard to test results.
5. All rights in the Work(s) not granted to the Licensee by this Agreement are expressly reserved to the Publisher.
6. a. The rights granted herein shall be for a period commencing with the date first stated above and terminating **July 24, 2007**, whereupon the Licensed Use shall cease. Licensee must obtain written permission for any extension of this Agreement.
- b. The Publisher may terminate this Agreement with thirty (30) days' written notice to Licensee, or may terminate this Agreement if the Licensee shall fail to cure any material breach hereof, including without limitation a failure to perform its obligations under paragraphs 3 and 4, within thirty (30) days after written notice of such breach is given to the Licensee.
7. Published reports of the Licensed Use shall not include reproduction of actual test items or answers unless separate permission is granted in an addendum to this Agreement.
8. Any reproduction of any portion of the Work(s) or subsequent reference to the Work(s) in reports/articles resulting from the Licensed Use herein shall bear the following notices:

Wechsler Memory Scale® – Third Edition Copyright © 1997 by Harcourt Assessment, Inc. Reproduced with permission. All rights reserved.

“Wechsler Memory Scale” and ***“WMS®-III”*** are trademarks of Harcourt Assessment, Inc. registered in the United States of America and/or other jurisdictions.

9. Notices shall appear on the title page (or reverse side of the title page), of each copy of any reproduction of the Work(s), or, if the Work(s) are reproduced as part of a larger publication, at the foot of the first page on which the Work(s) are reproduced. Minor rearrangements of the above format may be made in publications for purposes of editorial uniformity, but all the components must be included.
10. If this Agreement covers more than one Work, the above model of notice of permission shall be used separately for each separate Work being reproduced, unless a combined form of notice is specifically approved in writing by Publisher.
11. In any published or unpublished reports of the Licensed Use authorized under this Agreement, a specific acknowledgement of the permission shall be made, including reference to the full title of the Work(s), the copyright notice, the author, and the Publisher.
12. **Licensee agrees to pay a non-refundable up-front license fee of One Hundred Twenty Five Dollars (\$125.00) (481 reproductions/administrations x \$0.26 per reproduction/administration), such fee due and payable upon the execution of this agreement.** Publisher shall bill Licensee and Licensee shall pay the fees within thirty (30) days of receipt of an invoice from Publisher. If additional reproductions above those authorized in this Agreement become necessary, Publisher must be contacted in advance.
13. The Licensee shall send the Publisher one (1) copy of the Licensed Use of the Work(s) authorized under this Agreement. Upon reasonable written notice to the Licensee, the Publisher will have the right, not more than once each year, to examine the books and records of the Licensee concerning the Licensed Use of the Work(s), such examination to be during normal business hours and at the place where the Licensee ordinarily maintains its books and records.
14. The rights granted herein are non-exclusive and non-transferable to any third party without written permission from the Publisher.
15. The representative of the Licensee whose signature appears in this Agreement represents and warrants that he has full power to enter into this Agreement.
16. The Licensee acknowledges and agrees that the rights granted under this Agreement by the Publisher do not extend to any material included in the Work(s) which is permissioned from a third party. The Licensee is fully responsible for obtaining any necessary permissions from the copyright holder for any third-party material.
17. The Publisher makes no warranty or representation to the Licensee other than that the Work(s) does/do not infringe upon any third party's intellectual property rights and are suitable as of the date hereof, in accordance with applicable professional educational and psychological standards, for use for the purposes described in the

Publisher's catalogs. Return or refund of all or a portion of the license fees paid during the term of the License CONSTITUTES THE SOLE AND EXCLUSIVE REMEDY OF THE LICENSEE, IN LIEU OF ALL REMEDIES AND DAMAGES, ACTUAL, CONSEQUENTIAL, SPECIAL, INCIDENTAL, OR OTHER in conjunction with a breach of the above warranties and representations.

Except as stated in the previous paragraph, the Publisher assumes no liability under this Agreement for use of the Licensee's or Licensee's customers' use of Publisher's Work(s) or the Licensed Use authorized hereunder. To the extent permitted by law, the Licensee shall hold harmless and indemnify the Publisher against any claim, costs, liability, damage, or expense of the Publisher in connection with any act or failure to act of the Licensee.

18. This Agreement shall become effective only if it is executed by the Licensee within thirty (30) days of the effective date shown above.
19. This instrument contains the entire agreement between the parties and there are merged herein all prior and collateral understandings and agreements. No amendment or modification of this Agreement shall be valid unless in writing and signed by both parties.
20. Regardless of the place of its physical execution or performance, this Agreement shall be governed by and interpreted under the laws of the State of Texas, U.S.A.

DAVID LAPORTE, PH.D.

HARCOURT ASSESSMENT, INC.

Name

Date

Aurelio Prifitera, Ph.D.

Date

Publisher

Printed Name

Title

ANDREA SANDERS

Name

Date

Printed Name

Title



Harcourt Inc.
6277 Sea Harbor Drive
Orlando, FL 32887

Invoice Number	Invoice Date	Account Number
9000185771	10/13/2006	466192
Payment Due By	Amount Due	
11/12/2006	\$ 125.00	

Bill To:

DAVID LAPORTE
ATTENTION: ANDREA SANDERS
47 MADISON AVE #2
MADISON, NJ 07940

Return This Portion With Your Remittance To:

PO BOX 0855
CAROL STREAM, IL 60132-0855

061013 00185771 22 22004661920000 00000125007 0855

**** PLEASE DETACH AND RETURN TOP PORTION WITH YOUR PAYMENT ****

FEIN # 13-1188180



Invoice Number	Invoice Date	Account Number
9000185771	10/13/2006	466192
Page	Payment Due By	Amount Due
1 of 1	11/12/2006	\$ 125.00

Send Orders To: HARCOURT ASSESSMENT SCORING SERVICE CENTER 800-328-5999 FAX: 888-556-2103 8:30-5:00 Central Time		For Inquires Contact: THE BILLING DEPARTMENT 888-782-7949 FAX: 210-339-5706 8:30-5:00 Central Time		Return Address: TO EXPEDITE RETURN CREDIT, PLEASE CALL CUSTOMER SERVICE AT THE NUMBER SHOWN FOR INQUIRIES.	
SF Order Number 106		TPC Order Number 0000193744		Ship To Customer 466192 DAVID LAPORTE 47 MADISON AVE #2 MADISON, NJ 07940	
Purchase Order NONE		Program Code RIGHTS AND PERMISSIONS			
Product	Qty	Description	Unit Price	Unit Discount Amount	Amount
015029977X	1	PERM FEE WMS-R/WMS-III	125.0000		125.00
Logical Memory I and II, Recognition and Digit Span Quantity of 481 @ \$0.25988					

Merchandise Total	State & Local Sales Tax	Shipping & Handling	Amount Due
\$ 125.00	\$ 0.00	\$ 0.00	\$125.00

* THIS IS A SECOND ORIGINAL INVOICE

0003