5-1-2010

Validation study of the planning, attention, simultaneous, and successive (PASS) theory and its relationship to reading achievement in adults

Justin Moore Walker

THE UNIVERSITY OF NORTHERN COLORADO

Greeley, Colorado

The Graduate School

A VALIDATION STUDY OF THE PLANNING, ATTENTION, SIMULTANEOUS, AND SUCCESSIVE (PASS) THEORY AND ITS RELATIONSHIP TO READING ACHIEVEMENT IN ADULTS

A Dissertation Submitted in Partial Fulfillment
of the Requirements for the Degree of
Doctor of Philosophy

Justin Moore Walker

College of Education and Behavioral Sciences
School of Applied Psychology and Counselor Education
School Psychology

May, 2010

This Dissertation by: Justin Moore Walker

Entitled: *A Validation Study of the Planning, Attention, Simultaneous, and Successive (PASS) Theory and Its Relationship to Reading Achievement in Adults*

has been approved as meeting the requirement for the Degree of Doctor of Philosophy in College of Education and Behavioral Sciences in School of Applied Psychology and Counselor Education, Program of School Psychology

Accepted by the Doctoral Committee

____

Achilles N. Bardos, Ph.D., Chair

____

Kathrine M. Koehler-Hak, Ph.D, Committee Member

____

David Gonzalez, Ph.D., Committee Member

____

Marilyn Welsh, Ph.D., Faculty Representative

Date of Dissertation Defense March 31st, 2010

Accepted by the Graduate School

____

Robbyn R. Wacker, Ph. D.
Assistant Vice President for Research
Dean of the Graduate School & International Admissions

ABSTRACT

Walker, Justin Moore. *A Validation Study of the Planning, Attention, Simultaneous, and Successive (PASS) Theory and Its Relationship to Reading Achievement in Adults*. Published Doctor of Philosophy dissertation, University of Northern Colorado, 2010.

This study set out to determine if the Planning, Attention, Simultaneous, Successive (PASS) cognitive processing model, a model previously investigated with children, would hold its factorial structure with adults. A collection of PASS experimental tasks were analyzed through Maximum Likelihood Factor Analysis. A four-factor solution consistent with the theoretical model was found with little variation from the literature. In addition, the extent to which the PASS experimental tasks and composite areas predicted reading achievement was examined through multiple regression. The results suggested that the PASS cognitive processing model provides adequate prediction of academic achievement in adults. The Successive PASS composite area was the strongest predictor of reading achievement, thereby supporting previous studies. This study suggests that a battery of experimental PASS tasks with adults can be used to predict reading achievement and allow future studies to explore the utility of a PASS battery for the purposes of job performance prediction and the application of a cognitive processing measure with adult populations.

ACKNOWLEDGEMENTS

There are many people who contribute in a variety of ways to the completion of a dissertation and in the culmination of many years of dreams, frustration, and accomplishments. It is impossible to thank them all in such a short space and these pages are a great injustice to the level of assistance from those who are named and unnamed. For their time, patience, and encouragement, they deserve so much more.

Of most importance in my success are my parents, Robert and Karen Walker. From day one, I have been blessed with guidance but not restraint, given advice but not requirements, and been comforted without being harbored. From my family I have learned the skills necessary to live my life to the fullest and be the best I can be at all that I try to do.

I have special thanks for my advisor, Dr. Achilles Bardos, as well as Dr. Rik D'Amato for their continuous guidance in my life even prior to my first days at Northern Colorado. I cannot imagine more knowledgeable and capable men exist in the field of school psychology. My greatest appreciation and debt go out to these humble men for their suggestions, guidance, and the many valuable opportunities they have extended me. My professional development is due largely to them both.

Also a special thanks to my remaining committee members, Dr. Kathrine Koehler-Hak, Dr. David Gonzalez, and Dr. Marilyn Welsh. You were caring, supportive, and extremely flexible in all aspects of my time with you. My deepest gratitude goes out to you for the time you have sacrificed to help me accomplish my goal.

I feel it necessary to specifically mention Dr. Jenni Harding-DeKam. Few people have the empathy and intelligence of this woman, and even less would be able to connect with and impact the lives of so many. She truly is a benefit to any institution she is a part of.

A general thanks (but no less important) goes out to my many colleagues. Members of my cohorts at UNC and UF helped me through many difficult days and justified my time in school. The staff at FFC8 took my development to new levels. Those in China inspired me for a lifetime of experiences. I am blessed for having worked with you all.

The rest of my gratitude must be paid to my wife for her patience with a stubborn and determined man. With total sacrifice to her way of life she has followed me as I chased this dream. Sarah - It is through the hard times we had to persevere so that we may share together the many good days to come. Your love, understanding, and dedication have given me something to appreciate and focus more on now that this stage in our lives has come to a close. Let's go out into the world and live the adventure.

LIST OF TABLES

Table		Page
1	Sample Distribution by Gender	70
2	Sample Distribution by Age	70
3	Cross Tabulation of Age and Gender of Participants	71
4	Means, Standard Deviations, and Ranges for GAMA Subjects and GAMA IQ	72
5	Means, Standard Deviations, and Ranges for the Nelson-Denny Reading Test	73
6	Means, Standard Deviations, and Ranges for Raw Scores of the PASS Tasks	73
7	Alpha and Split-half Reliability Coefficients for the PASS Tasks	75
8	Pearson Product-Moment Correlations Among PASS Tasks	77
9	Means and Standard Deviations for Raw Scores and Standard Scores of the PASS Composites	78
10	Pearson Product-Moment Correlations Between the PASS Composites and the PASS Experimental Tasks	79
11	Pearson Product-Moment Correlations Between the PASS Composites	79
12	Pearson Product-Moment Correlations of PASS Tasks with the Nelson-Denny Reading Test Scores	81
13	Pearson Product-Moment Correlation of PASS Areas with the Nelson-Denny Reading Test Scores	82

14	Initial Statistics (Principle Components Analysis)	84
15	Total Variance Explained by Five-Factor Varimax Rotation of PCA	86
16	Orthogonal Solution (Varimax) for the Principle Components Analysis of the Experimental PASS Tasks for Adults	88
17	Orthogonal Solution for the Maximum Likelihood Factor Analysis of the PASS Tasks	91
18	Total Variance Explained by Four-Factor Varimax Rotation of Maximum Likelihood	92
19	Structure Matrix of the Oblique Solution for the Maximum Likelihood Factor Analysis of the PASS Tasks	94
20	Enter Regression Analyses for the PASS Tasks with the Nelson-Denny Reading Test Areas of Vocabulary, Comprehension, Reading Rate, and Total Score	97
21	Stepwise Regression Analyses for the PASS Tasks with the Nelson-Denny Reading Test Areas of Vocabulary, Comprehension, Reading Rate, and Total Score	99
22	Enter Regression Analyses for the PASS Composites with the Nelson-Denny Reading Test Areas of Vocabulary, Comprehension, Reading Rate, and Total Score	101
23	Stepwise Regression Analyses for the PASS Composites with the Nelson-Denny Reading Test Areas of Vocabulary, Comprehension, Reading Rate, and Total Score	102

TABLE OF CONTENTS

Chapter | Page

I. INTRODUCTION………………………………………………………….. 1

A Brief History of Intelligence Measurement
Learning Disabilities
Legal Issues in Assessment
An Alternative
A Description of the CAS
Rationale for the Study
Purpose of the Study
Research Questions
Limitations of the Study
Definitions of Terms

II. REVIEW OF THE LITERATURE…………………………………….. 16

The Need for Alternatives
Luria's Contributions
The PASS Theory
The PASS Theory and Academic Areas
Other Uses of the CAS and PASS Theory
What does the PASS Theory and the CAS Measure?
Conclusion

III. METHODOLOGY…………………………………………………….. 52

Participant Selection
Procedures
Assessment Procedures
Statistical Procedures and Data Analysis

IV. RESULTS…………………………………………………………………… 69

Descriptive Statistics
Correlation Analyses
Factor Analyses
Regression Analyses
Summary

V. DISCUSSION………………………………………………………....... 105

Intent
Summary of the Study
Limitations
Suggestions for Future Research

REFERENCES…………………………………………………………………… 119

APPENDIX A…………………………………………………………………… 138

APPENDIX B.. 152

APPENDIX C.. 154

APPENDIX D.. 156

LIST OF FIGURES

Figure		Page
1	Hierarchy of General Intelligence	3
2	Structural Architecture of Simultaneous Processing	24
3	Example of a Figure Memory Task	60
4	Principle Components Analysis Scree Plot	85

CHAPTER I

INTRODUCTION

Intelligence testing remains an important component in the assessment of children and adults in the field of psychology. However, recent movements in education have threatened the use of traditionally nationally norm-referenced tests, particularly tests measuring cognitive abilities. For example, the Response-to-Intervention (RtI) paradigm suggests a reduction in the need for cognitive testing because ability scores fail to provide interventions to remediate difficulties (Vellutino, Scanlon, Sipay, Small, Pratt, Chen, & Dencklea, 1996; Vellutino, Scanlon, Small, & Fanuele, 2003). As a result, large-scale non-categorical models are already underway (Canter, 1997) reducing the need for diagnostic labeling of disorders. Even with a potential paradigm shift in the field of school psychology, an understanding regarding the proper use of intelligence testing will likely remain an essential skill for practitioners. Unfortunately, the definition of intelligence has different meanings across various practitioners and settings. Thus, a variety of instruments have been developed with multiple underlying theoretical constructs. A complete history of theories of intelligence and the many attempts to develop measures is not warranted here. However, a conceptual overview, including reference to the major theories and instruments in use today, will allow for a framework in which to view newer and less established theories and tests.

A Brief History of Intelligence Measurement

The history of intellectual assessment is long and complex. Beginning in the 1800's, scientists drew connections between a person's mental incapacity and mental illness and began testing for individual differences in problem solving (Sattler, 2001). However, it is only recently that the field of psychology has spearhead initiatives in measuring the constructs of cognitive ability based on theories derived from studies of the brain and learning (Kamphaus, 1993).

Pioneers such as Sir Frances Galton (1822-1911) and Karl Pearson (1857-1936) can be credited for their efforts in applying statistical procedures to the measurement process. However, failure to obtain a consensus on a definition of intelligence opened the door for several theories to emerge. Intelligence then became known as a mental quotient and was defined by dividing an individual's mental age by their chronological age (Sattler, 2001; Terman, 1916). What remained was a way to accurately and reliably measure the term "intelligence."

Single Factor Theories

One such concept to gain favor was the notion of a general intelligence, or "*g*" (Spearman, 1927; Vernon, 1950; Wechsler, 1958). This theory suggests that one's capacity to problem solve is based on a pinnacle of general intelligence, "*g*," and that within this hierarchy of intelligence (see figure 1), specific and broad factors provided the basis for general intelligence (McGrew & Flanagan, 1998). The concept of "*g*" itself lead Spearman (1927) to argue that the concept of mental energy resulted in differences in test scores. Although he was not the first person to state that intellectual abilities in humans could be describe by a single factor, he was the first to employ rigorous empirical and statistical techniques to explore his notions (Cianciolo & Sternberg, 2004).

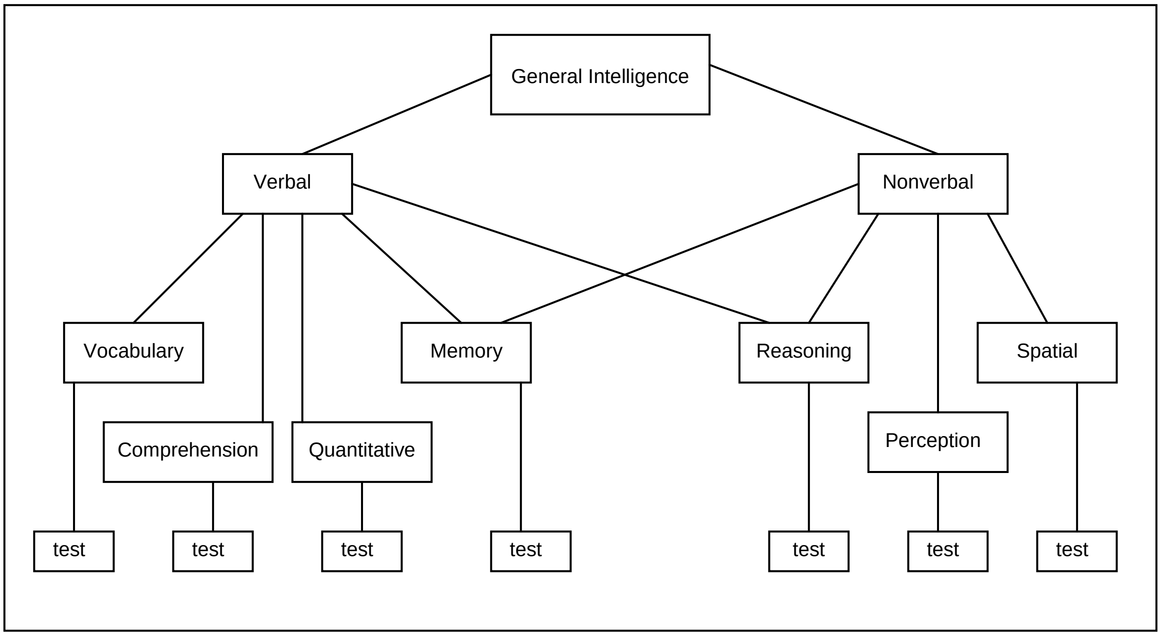

Figure 1. Hierarchy of General Intelligence.

As can be seen in Figure 1, subtests are grouped into different skill categories. Those categories are part of larger concepts, in this case verbal and nonverbal abilities. Together, those abilities join to establish an indicator of intelligence, according to Thurstone (1938).

Multiple Factor Theories

A one factor theory was quickly disputed by others suggesting that many independent faculties make up what can be considered a person's "intelligence" (Sattler, 2001). Thompson (1939) believed that mental energy consisted of many different intellectual abilities. These faculties were referred to as primary mental abilities (Thurstone, 1938). In fact, Thurston was an influential psychologist who disputed Spearman's single-factor theory by suggesting that intelligence is composed of seven distinct, yet interrelated factors. Guliford (1956) followed with a proposal that intelligence contained no less than 120 distinct abilities. Multidimensional views such as the seven modules of intelligence (Gardner, 1983) and a triarchic theory (Sternberg, 1985) have recently become more prevalent in examining intelligence. Although there was not agreement on the number of factors comprising intelligence, researchers opposed the one factor theory of Spearman.

Today, a variety of tests built on these theories not only exist, but many have found utility in both school and clinical settings. In fact, the original uses of some of the most widely utilized measures were to identify children with mental retardation (Sattler, 2001) and to place children in appropriate educational environments (Kamphaus, 1993; Sattler, 1992). In practice, such instruments have been used in varying capacities, although distinguishing cognitive strengths and deficits remains a primary purpose of cognitive assessment.

The French psychologist, Binet, was charged with differentiating children with age-appropriate skills from children with mental retardation. As a result, the subtests of the 1905 Binet-Simon Intelligence Scales (Binet, 1905; 1916) were created. Shortly after in 1916, Terman at Stanford University published an extended, modified, and standardized version of the Binet-Simon scales called the *Stanford Revision and Extension of the Binet-Simon Scales* (referred to as the Stanford-Binet; Sattler; 2001). Later, Yerkes adapted a version of the Stanford-Binet for a group administration with United States Army recruits, thereby becoming the first to use today’s method of converting raw scores to standard scores (Sattler, 2001).

The basis for the current Wechsler scales began as the *Wechsler-Bellevue Intelligence Scale*, *Form 1* in the mid 1930s (Sattler, 2001). David Wechsler, a student of Spearman, had a goal to develop a test that used standard scores to make normative comparisons. Today, the Wechsler scales are the most popular intelligence tests used (Ittenbach, Esters, & Wainer, 1997; Kaufman & Lichtenberger, 2000; Sattler, 2001).

Three major theories drive the application of instruments today. First, the Cattell-Horn-Carroll theory and its relationship to "*g*" will be presented. Known as a hierarchical theory of intelligence, it is a more recent combination of two major theories of intelligence. This explanation is followed by a description of an alternative test of intelligence. The theoretical construct underlying this alternative test will be described in greater detail throughout Chapter II.

Cattell-Horn-Carroll (CHC)

One of the most long-standing and widely used intelligence tests is from the Binet camp (Roid, Shaughnessy, & Greathouse, 2005). The most current measure, the Stanford-Binet Intelligence Scales, Fifth Edition (SB-V; Roid, 2003), is built on the Cattell-Horn-Carroll (CHC) theory of intelligence. The CHC theory is a combination of Horn and Cattell's *Gf-Gc* model (Horn & Cattell, 1966; 1967) and Carroll's Three-Stratum Theory (Carroll, 1993; McGrew, 1997). Carroll (1993), using factor analytic studies, outlined a hierarchal theory of cognitive abilities. The general intelligence factor is Stratum III. The Broad strata (Stratum II) consists of fluid and crystallized intelligence from Horn and Cattell (1966, 1967), general memory and learning, broad visual perception, broad auditory perception, broad retrieval ability, broad cognitive speediness and processing speed. The Narrow strata (Stratum I) consists of 69 specific abilities, each related to a certain Stratum II area (Carroll, 1993).

The *Gf-Gc* theory combines fluid intelligence, or a person's ability to solve new problems which are not influenced by education, with crystallized intelligence, or one's ability to use acquired knowledge to solve problems that are dependent on education and acculturation (Lichtenberger, Broadbooks, & Kaurman, 2000). Expanding on the concept of Spearman's "*g*," Cattell postulated that general intelligence was comprised of fluid intelligence (*Gf*) and crystallized intelligence (*Gc;* Cattell, 1941).

The *Gf-Gc* theory also provides the basis for another particularly widely used measure from both children and adults, the *Woodcock-Johnson Tests of Cognitive Ability – Third Edition* (WJ-III COG; Woodcock, McGrew, & Mather, 2000). The WJ-III COG further groups individuals into three categories of cognitive performance: Verbal Ability, Thinking Ability, and Cognitive Efficiency.

The original Binet scales have undergone criticism (Gould, 1981). Despite nearly a century of research on human abilities, the tests today have changed little since their pioneering predecessors. Because of this limitation, a shift from an empirical to a clinical approach has been taken in testing, as evidenced by the increase in popularity of the Wechsler scales, which focuses on profile analysis for interpretation of an individual's cognitive abilities (Kamphaus, Petoskey, & Morgan, 1997). Unfortunately, this specific approach has not been without criticism itself. It has been suggested that there is a lack of theoretical basis for interpreting test scores with these measures (Harrison, Flanagan, & Genshaft, 1997). Macmann and Barnett (1994) went so far as to say that the Wechsler scales "were not designed with much theory in mind" (p. 224). These attacks remind us of Boring's 1923 definition of intelligence as "the capacity to do well on an intelligence test" (as cited by Guilford, 1973). However, despite these criticisms, the Wechsler scales continue to be the most widely used instruments in intellectual assessment (Ittenbach, Esters, & Wainer, 1997; Kaufman & Lichtenberger, 2000; Sattler, 2001). While Wechsler has produced many measures of intelligence and memory, the *Wechsler Adult Intelligence Scale – Third Edition* (Wechsler, 1997) is the most recent revision of a scale for assessing intelligence in adults. Unfortunately, the Wechsler scales also represent a technology that has changed little since Wechsler introduced his first test in 1939.

Learning Disabilities

Much like the concept of intelligence, the notion of a learning disability has a long history muddled with inconsistent definitions and poor response from educators. Although this is not a study on learning disabilities, it is important to mention that learning disabilities exist in adults and that a way to assess a learning disability is needed. Although this study does not specifically address adults with learning disabilities, the understanding that individuals remain undiagnosed and unsupported in adulthood is pressing.

Beginning several decades ago, national attention was brought to light regarding the presence of learning disabilities. The National Joint Committee on Learning Disabilities (NJCLD) published a position paper on the need for research and program development for adults with learning disabilities (NJCLD, 1985). This paper highlighted the notion that learning disabilities are a lifelong challenge for individuals and that appropriate tools for assessing the impact of learning disabilities on adults are not available. Furthermore, the paper expressed the potential of learning disabilities to impact adults outside of school settings. We have since been reminded of pervasiveness of learning disabilities across the lifespan (NJCLD, 1990) and the need for transition services (NJCLD, 1994).

Recently, students above the age of 25 accounted for almost one-third of the population of students at public 4-year colleges, nearly half the students at public 2-year colleges, and more than half at less than 2-year public colleges (Knapp Kelly-Reid, Whitmore, & Miller, 2007). Yet even in the face of recommendations for accommodations (NJCLD, 1999), our schools of higher education still have not fully understood the significance of the adult population with a learning disability. The growing number of adults in postsecondary institutions increases the need for professionals to be aware of learning disabilities in adults as well as appropriate assessment measures for this population. Similarly, considering the potential impact of having a learning disability while seeking employment, it has become increasingly important to help meet the needs of and support adults with learning disabilities. By appropriately assessing individuals with learning disabilities and

Legal Issues in Assessment

The appropriate use of intelligence measures appears to be an important theme in court proceedings in the history of testing. *Larry P. v. Riles* (1979), *Diana v. State Board of Education* (1970), and *Hobson v. Hansen* (1967) all represent problems encountered education placement and raise questions regarding standardized testing. It has become increasingly clear that traditional measures of intelligence are limited (Reschly & Grimes, 2002). Tests with high verbal loading or with measures of academic achievement built in may be unfair to diverse groups of learners (e.g., language learners, people from low income homes, etc.).

An Alternative

Researchers have argued that it is essential to interpret tests only with the theory by which that test was developed (Naglieri, 1989; Naglieri, Das, & Jarman, 1990). Further, a severe limitation of traditional intelligence tests is that they do not measure specific abilities and therefore do not fuel interventions (Braden, 1997; Naglieri, 1999a). Naglieri (1999a) argues that the Binet and Wechsler tests are built on a technology which is nearing a century old and are therefore not responsive to the intelligence testing needs of today. This continued dissatisfaction with traditional intelligence tests has made room for a theoretical shift in the field. The work of Luria (1966, 1973, 1980, 1982) inspired new considerations regarding human abilities as well as their deficits. By understanding the strengths of a child, remediation and intervention can be more meaningful and effective (Reynolds, Kamphaus, Rosenthal, & Hiemenz, 1997). His work would become the basis for a major cognitive processing test. It is here where the second major theory, the Planning, Attention, Simultaneous, Success (PASS) model of cognitive processes comes in, which will be described in detail in the following chapter. However, one major tool for assessing PASS ability in children today is known as the Das-Naglieri: Cognitive Assessment System.

A Description of the CAS

Recent understanding of human abilities has called for new theories to break way from what has been referred to as the “Wechsler-Binet stronghold” of testing (Naglieri & Kaufman, 2001, p. 151). *The Das-Naglieri: Cognitive Assessment System* (CAS; Naglieri

& Das, 1997a) was created to integrate theoretical and applied knowledge based on previous research. Beginning with the work of A.R. Luria (1966, 1973, 1980) and continuing on to the development of the PASS (Planning, Attention, Simultaneous, and Successive) theory of intelligence (Naglieri & Das, 1988), the CAS strives to replace the term *intelligence* by referring to mental abilities as *cognitive processes* (Naglieri, 1999a). The CAS described hereafter is the current published version (Naglieri & Das, 1997a) but differs somewhat from the experimental battery used in this study.

The CAS is a norm-referenced measure of ability designed to assess children ages 5 through 17 years of age (Naglieri & Das, 1997b). The CAS has four scales: Planning, Attention, Simultaneous, and Successive. Each of these scales is found in the PASS theory of intelligence (Naglieri & Das, 1990). The subtests making up the PASS scales were specifically developed in order to operationalize the PASS theory of cognitive processing (Naglieri, 1999a). A Full Scale score provides the examiner with an estimate of the client's overall cognitive functioning. This score has a mean of 100 and a standard deviation of 15. However, the use of this score when one or more of the PASS scores varies, is not advised (Naglieri & Das, 1997b), and "overemphasis on the Full Scale score is to be especially avoided" (Naglieri, 1999a, p. 26) as it is a psychometric derivative and not part of the theory.

There are 12 subtests on the CAS – 3 falling under each of the 4 PASS scales. The subtests of the CAS are: Planning Scale – Matching Numbers (MN), Planned Codes (PCd), Planned Connections (PCn); the Attention Scale – Expressive Attention (EA), Number Detection (ND), Receptive Attention (RA); the Simultaneous Scale – Nonverbal Matrices (NvM), Verbal-Spatial Relations (VSR), Figure Memory (SR); and the

Successive Scale – Word Series (WS), Sentence Repetition (SR), Speech Rate (SpR) [children aged 5 to 7 years], and Sentence Questions (SQ) [children aged 8 to 17 years].

Another current intelligence test using the CHC model is the Kaufman Assessment Battery for Children – Second Edition (KABC-II; Kaufman & Kaufman, 2004). The KABC-II is sometimes considered an alternative to the more traditional Wechsler and Binet scales (Naglieri, 1999a). The KABC-II appears to contain both Luria's Neuropsychological Model and CHC theory as its underlying construct. It has been named as one of the few tests to break away from the "Wechsler-Binet stronghold" (Naglieri & Kaufman, 2001, p. 151).

Rationale for the Study

For most of the 20th century, and continuing today, intelligence tests have been used to make educational decisions. Many intelligence tests have withstood the test of time with respect to psychometric evaluations in the form of reliability and validity testing (Naglieri, 1999a). Even in the face of a changing paradigm in school psychology and the coming of a Response-to-Intervention (RtI) model, it appears that a measurement of cognitive ability will still exist in assessment procedures. Also, it is evident that the concept of a learning disability affects adult populations as well.

When compared with the most popular tests and theories of intelligence testing (e.g., Stanford-Binet, Wechsler scales, etc.), the PASS theory and the CAS are relatively new. As a result, fewer studies have been conducted surrounding the validity evidence of the PASS than with most accepted instruments. Some studies have been directed towards the theoretical structure of the PASS and its use in the CAS (Keith, Kranzler, & Flanagan, 2001; Kranzler & Keith, 1999; Naglieri, 1999b) while others have concentrated on the relationship or link of the CAS/PASS theory to academic interventions (e.g., Crawford, 2002; Hald, 2000; Naglieri & Das 1987, 1990; Naglieri and Gottling, 1995; Naglieri & Johnson, 2000). Over time, more and more populations will be examined with a PASS perspective of cognitive processes.

Although several researchers have examined the PASS theory with adults (see Davis, 2003; Macdonald, 1994; Maricle, 1994), no formal battery of tasks currently exists. A battery of experimental tasks was used in this study. Many of the tasks are similar to the tasks found in the CAS, but they have been modified with the deletion or addition of items as well as alterations in timing to make the task more suitable for adults.

Purpose of the Study

One such population that has been traditionally left out of the PASS theory is adults. Naglieri (1999a) noted that "the Planning, Attention, Simultaneous, and Successive processes are intended to represent the basic psychological processes in children and adults in a variety of settings" (p. 153). Interestingly, few inquires have been made about the application of the PASS theory beyond the ages measured by the CAS, which are 5-17. Earlier attempts by Maricle (1994) have examined the PASS theory with college students and found that a four-factor solution was upheld. Macdonald (1994) used the PASS theory with adults diagnosed with a learning disability and to predict achievement. This study expanded on the work of Maricle (1994) and Macdonald (1994) by using different experimental subtests of the PASS theory.

Further, this study attempted to include not only college-age students, but older adults as well as adults not attending college in order to generalize the results to a larger population. Although non-college individuals were assessed, large numbers of this group were not obtained. A final component addressed the claims made by Naglieri and Ronning (2000) which suggests that correlations between ability and achievement become greater as children age. Participants were assessed on their ability and achievement levels to determine the PASS theory's utility in predicting achievement in adults.

As more and more people enter college and graduate schools, institutions will be faced with an increase in students needing academic accommodations and services. Further, clinics and universities will face more adults seeking evaluation for attention problems, learning disabilities, and a variety of other issues that, until recently, have been mostly addressed in children. In order to best serve the needs of all learners, the use of the PASS theory must be further examined with adult populations. If the PASS theory is considered appropriate for this population and can be operationalized with the battery of experimental tasks used in this study, it might serve as the foundation for further exploration and the development of an assessment tool for individuals over 17 years of age.

Research Questions

Based upon the preceding discussion and the literature reviewed in Chapter II, the following research questions were investigated.

Q1: What is the factorial structure of the Planning, Attention, Simultaneous, and Successive (PASS) experimental cognitive process tasks with adults?

Q2: What is the degree to which academic performance can be predicted using the experimental tasks of the PASS model?

Limitations of the Study

One obvious limitation is the lack of geographic variability. Due to convenience sampling, most of the participants will reside in the same area as the author. Although some participants may be from other geographic regions of the country, there are not enough participants to demonstrate a comparison. It should be noted that because the participants are adults, and many of them enrolled in college or graduate school, there is a good chance that a wide representation of location (home state) exists. However, because of this homogeneity in location, ethnic diversity among participants is expected to be limited.

For these reasons, this study should only be interpreted as an example of cognitive processing and the PASS theory of adults with these demographic characteristics. Future studies with larger samples and with more diverse sampling procedures will be needed.

Definitions of Terms

Attention. "A mental process by which the individual selectively focuses on particular stimuli while inhibiting responses to competing stimuli presented over time" (Naglieri & Das, 1997b, p. 3). The word Attention will be capitalized in this paper when it is referring to that area within the PASS theory or the CAS instrument (as a scale or a score).

Cognitive Assessment System (CAS). A test designed by Naglieri and Das (1997a) to assess cognitive processes. It is built on the PASS (Planning, Attention, Simultaneous, and Successive) theory of intelligence.

PASS Theory. A theory of human intelligence preferably referred to as a set of cognitive processes, which stems from the work of Luria (1966, 1973, 1980) on the brain's functional units. It contains the process areas of Planning, Attention, Simultaneous, and Successive.

Planning. "A mental process by which the individual determines, selects, applies, and evaluates solutions to problems" (Naglieri & Das, 1997b, p. 2). The word Planning will be capitalized in this paper when it is referring to that area within the PASS theory or the CAS instrument (as a scale or a score).

Simultaneous. "A mental process by which the individual integrates separate stimuli into a single whole or group" (Luria; 1973; Naglieri & Das, 1997b, p. 4). The word Simultaneous will be capitalized in this paper when it is referring to that area within the PASS theory or the CAS instrument (as a scale or a score).

Successive. "A mental process by which the individual integrates stimuli into a specific serial order that forms a chain-like progression" (Naglieri & Das, 1997b, p. 5). The word Successive will be capitalized in this paper when it is referring to that area within the PASS theory or the CAS instrument (as a scale or a score).

CHAPTER II

REVIEW OF THE LITERATURE

The Need for Alternatives

As presented in Chapter I, an alternative is needed to traditional IQ measures. This chapter presents literature based on investigations of alternative measures and their relationships to a variety of academic and non-academic applications. Beginning with a presentation on the shortcomings of the role intelligence plays in reading achievement – which is most relevant to the current study – the chapter expands to issues of IQ assessment and utility with adults. Alternatives are presented and investigated, leading to the need for the current study.

Achievement and Criticisms of IQ Relevancy

There have been countless studies examining the relationship between intelligence (IQ) and academic achievement (Kaufman, 1990). Traditionally, approximately a .50 correlation between IQ and school performance has been well documented (Matarazzo, 1972). This number suggests that an outstanding 75% of the variance in school performance can be attributed to other factors and the correlation has been found to be even lower in college-aged students (Brody, 1985). In addition, Kaufman (1990) cites numerous considerations beyond simple IQ and achievement correlations, such as GPA criterion fluctuation among professors and schools, a restricted range of IQ samples, and other factors like motivation and study skills. Each of these factors play a role in the variation of achievement scores.

Siegel (1988, 1989a, 1989b) has long argued that IQ has no logical or empirical place in the determination of reading disabilities. Others, such as Rispens, van Yperen, and van Dujin (1991) and Fuchs and Young (2006) have examined this relationship between IQ and reading. When abandoning IQ, a limited number of children classified with reading disability are impacted yet, when keeping IQ in the determination of a disability, more high IQ children are classified as reading disabled (Rispens, van Yperen, & van Dujin, 1991). IQ was found to be a better predictor with older students and comprehension; however, the relationship between IQ and reading achievement is not high when looking at young children and phonological processing. This was highlighted in a series of 13 studies examining the relationship between IQ and reading skills (Fuchs and Young, 2006). This finding is especially relevant for the relationship between reading and IQ in adults. Despite the fact that this study examines cognitive processes – not IQ – and reading, the findings indicate that correlations with the adult population need to be investigated.

"Everybody will agree that the capacity to do intellectual work is a necessary and important sign of general intelligence" (Wechsler, 2007,p.8). Wechsler (2007) makes an argument in his book that the early intelligence measures largely excluded or underrepresented adult populations and therefore development and norming of more current measures do not have the history of child intelligence measures. In addition, he also claims that speed is not the best predictor of intelligence in adults, and yet his tests includes several measures of processing speed in addition to a test that has changed little in the 70 years since its inception. Clearly, understanding about the best way to assess and apply adult intelligence scores in real-world situations is lacking.

The ultimate question regarding adult intelligence has to be, “To what extent does adult intelligence indicate success in the adult world?” After all, how intelligence correlates with academic achievement ceases to be a useful predictor for those after university or graduate school, and can never be useful for those who do not attend higher education. A survey conducted examined the usefulness of IQ scores among adult populations and the extent to which IQ tests were being used by practitioners (Harrison, Kaufman, Hickman, & Kaufman, 1988). According to practicing psychologists, 85% of respondents utilized tests to measure a person’s capacity or potential, while only about 45% used tests for educational placement purposes. Shockingly, the use of tests to inform educational and vocational interventions was only 44% and 39%, respectively. When asked to list the strengths if intelligence tests with adults, only 17% said tests were useful in “real-life problem-solving situations, and about 15%, the lowest category, was for tests “relationship to vocational interests and career choice” (Harrison et al., 1988, p.192). These responses indicate that IQ measures have little relevance in the adult world outside of clinical inquiries.

IQ and Occupation

Large discrepancies in IQ scores are found among various professions. It appears that the mean IQ for professional and technical workers is the highest, while unskilled laborers have the lowest IQ, with semiskilled workers falling right at the mean of 100 (Reynolds, Chastain, Kaufman, & McLean, 1987). Furthermore, when large numbers of workers were tested, tremendous gaps in IQ scores were evident among specific occupations. While professionals such as doctors, professors, and scientists obtained IQ scores of 125, tomato peelers scored 55 (Matarazzo, 1972; Jensen, 1980). However, these results beg the question about the strong relationship between IQ and occupational status as being merely an artifact of the relationship between IQ and educational attainment. Because the professions with the highest IQ scores require the most education – and conversely, the professions with the lowest scores require the least formal education – these trends support Brody's claim that years of schooling "is the most important determinant of occupational status in United States society" (1985, p. 361).

Correlations between IQ scores and job title are informational, but the relationship explains little about the usefulness of IQ scores in determining job performance. Hunter (1986) undertook a large effort to analyze data on job performance and intelligence. His coefficients mirrored those obtained by Ghiselli (1966, 1973). But when the same archival data were reexamined by Jenson (1980) coefficients reported by Hunter (1986) were shown to inflate the correlations, and that Ghiselli's (1966, 1973) original estimates of the correlation between intelligence and job proficiency being a relationship of approximately .20 were far more accurate.

The weak link between IQ and reading, as well as the inconsistent use of intelligence measures with adults has lead to a need for reinvestigation of the application of intelligence scores to academic and professional settings, as well as an exploration of evolved measures with adults. The following sections will explore the history of alternative measures and assess their applications.

Luria's Contributions

The work of the Soviet scholar A. R. Luria (1966, 1973, 1980, 1982) provided the conceptual framework behind the PASS theory and the development of the CAS. Naglieri and Das (1990) suggested that intellectual ability is comprised of the components corresponding to Luria's model. Luria claimed that three functional units exist within the brain which work together and are necessary for any mental activity (1973). Although the brain has many interactive functions, each functional area is located in a specific part of the brain, and therefore, provided its own unique contribution to functioning.

The first functional unit of the brain is centered on arousal which allows for attention. Although attention can be controlled voluntarily, cortical arousal provides a biological influence on selective and divided attention. This area is associated with the brain stem, diencephalon, and medial regions of the brain. To be successful with attention, one must focus on a particular stimulus while ignoring competing stimuli (Das, Naglieri, & Kirby, 1994).

The second functional unit is located in the posterior regions of the neocortex and contains the occipital, parietal, and temporal lobes. This area contributes to how a person receives, processes, and retains information from the external world (Das et al., 1994). This processing ability occurs in one of two ways: the integration of synchronous stimuli known as *simultaneous*, or the organization of information in a serial order, which is known as *successive* (Luria, 1966).

The third and final functional unit is responsible for the development of plans, the action of carrying them out, and the verification of the plan's effectiveness (Luria, 1973).

Planning processes are considered distinct from the other described processes because it provides an individual the opportunity to develop, evaluate, and modify problem-solving situations (Das et al., 1994). Planning is considered by some to be the essence of human intelligence (Das, 1984; Arlin, 1977) and is considered the overarching process that unites the other functional unit processes (Das, Naglieri, & Kirby, 1994). This process is regulated by the frontal lobes - primarily the prefrontal region of the brain.

A relationship among each of the functional units is clear. Luria (1973, p. 99) stated, “Each form of conscious activity is always a *complex functional system* and takes place through *the combined working of all three brain units*, each of which makes its own contribution” [emphasis in original]. Both a theoretical and anatomical closeness exists between the first and third functional units (Luria, 1980). Planning relies on attention and therefore a state of maintained arousal. Similarly, the third functional unit (planning) requires the second functional unit to process components of stimuli. Each functional unit relies on the other units in order to perform effectively (Luria, 1980).

The PASS Theory

The model that would eventually become known as the Planning, Attention, Simultaneous, and Successive (PASS) model of cognitive processing (Naglieri & Das, 1988, 1990) has a long history with theoretical underpinnings in the anatomy of the brain. Its beginnings stem from Luria’s (1966, 1973) research on brain functioning and a shift to utilize information processing, as opposed to traditional concepts of intelligence, which began to gain support decades ago (Das, et al., 1975). The PASS theory was first referred to simply as an information processing model (Das, 1973; Das et al., 1975) and evolved into the Information-Integration model (Das, Kirby, & Jarman, 1979). A description of each area comprising the PASS model will be presented, along with research supporting the relationship of the PASS areas with various academic areas.

Luria (1966, 1973, 1980, 1982) referred to three functional units of the brain. The PASS theory measures each of these areas, although Simultaneous and Successive are separated in the PASS theory whereas they are one functional unit in Luria's model (1973). Similar to Luria's claims of interdependency, the PASS theory recognizes each of the four areas as distinct, yet interrelated with other areas. This example explains the intercorrelation among PASS processes:

> In the early stages of reading, a child might use planning processes when making decisions about what to read, finding the first page, and how each word will be decoded. Attention is needed to focus on the appropriate stimuli and ignore distractions. Simultaneous processes are involved in seeing the sentence as a whole, and successive processing is used to decode words and comprehend information based on syntax or ordering of events (Naglieri & Kaufman, 2001, p. 153).

Clearly, all four PASS processes are involved, but without each one working distinctly and shifting to the next necessary process, tasks such as reading could not be achieved. Different processes may be relied on at different times to accomplish specific tasks. This "working constellation" (Luria, 1966, p. 70) of cognitive activity is the essence of the PASS theory. The following brief descriptions of research studies in the PASS areas provided a basic picture of the processes and their relationship with Luria's foundational theory. All Planning, Attention, Simultaneous, and Successive experimental tasks are described in detail in Chapter III.

Research on Simultaneous and Successive Processing

Although separate entities that work together within the PASS theory of cognitive processing, Luria (1966, 1973) conceptualized Simultaneous and Successive process as two distinct abilities within the second functional unit of the brain. The first studies of the PASS theory began with the notion that Simultaneous and Successive processes be included in a model of cognitive abilities (Das, 1972; Das et al., 1975). Factor analytic studies have determined that Simultaneous and Successive factors exit independently (Das, Kirby, & Jarman, 1975; Kirby & Das, 1977).

Simultaneous processing has a strong spatial component, but it may contain both verbal and nonverbal content as well. Similarly, Successive processing has been described as necessary for writing or decoding words because the process involves ordering elements within a stimulus to form a linear, chain-like progression (Naglieri & Das, 1990). Naglieri and Das (1987) claim that Simultaneous processes are related to arithmetic ability while Successive processes are related to reading ability; however, as children grow older, both processes become equally important in reading. The figure below provides a graphic of the interrelated nature of small parts and big ideas, key to the Simultaneous construct.

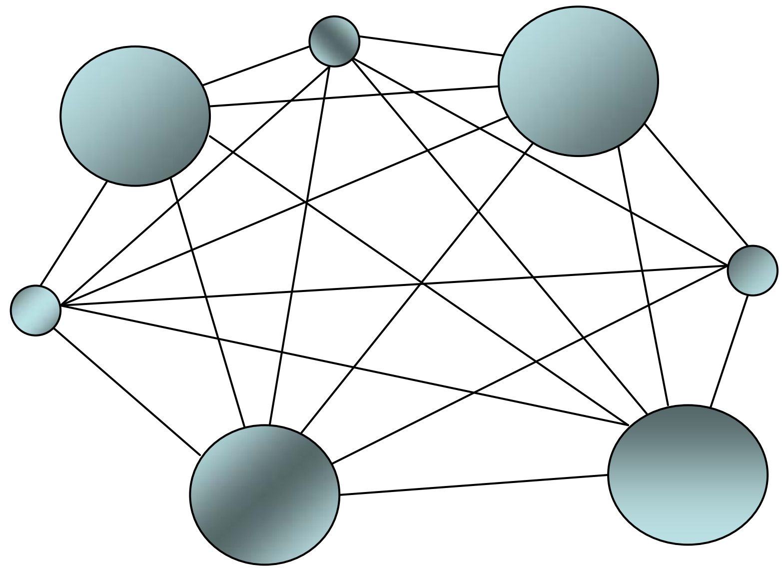

Figure 2. Structural Architecture of Simultaneous Processing.

Research on Planning

Early research (Ashman, 1978; Ashman & Das, 1980) determined the existence of a planning factor and how Planning was related to other factors such as Simultaneous and Successive processing. Several tests, Trail Making, Visual Search, and Planned Composition, were used because these tasks had been identified by Luria (1973) to discriminate between those with and without frontal lobe impairment (Naglieri & Das, 1988; Naglieri, Das, Stevens, & Ledbetter, 1991). These tests require the examinee to devise a strategy to best solve the problem in the most efficient manner. Typically, tests which assess Planning ability are absent from traditional measures of intelligence (Naglieri & Das, 1988, 1990). However, Planning ability is often measured on neuropsychological tests such as the Category Test and the Trail Making Tests of the *Halstead-Reitan Neuropsychological Test Battery* (Reitan & Wolfson, 1993); the *Wisconsin Card Sorting Test* (Heaton, Chelune, Talley, Kay, & Curtis, 1993); and the

Tower test on the *NEPSY* (Korkman, Kirk, & Kemp, 1998).

Research on Attention

Luria determined that arousal is the first functional unit of the brain. This area is responsible for maintaining the proper state of alertness for a task. This attribute also is neglected in the construction of traditional intelligence tests (Naglieri & Das, 1988, 1990). Too much or too little arousal will interfere with one's ability to successfully code and integrate stimuli. These tasks require the "individual to selectively attend to one and not another aspect of a two dimensional stimulus" (Naglieri & Das, 1990, p. 321).

The Cognitive Assessment System

The Das-Naglieri: Cognitive Assessment System (Naglieri & Das, 1997a) is the measure that has been most commonly used to assess the cognitive process of the PASS theory, and its four major scales are named accordingly to coincide with each area of the PASS theory. Since the CAS remains the instrument by which to measure the PASS theory, applications of both the PASS theory and the CAS are discussed interchangeably in the following sections.

The PASS Theory and Academic Areas

The PASS theory and the CAS have been applied in several academic areas. The literature is full of studies using the PASS methodology in a variety of disciplines as well as with different types of learners (Naglieri, 1999a). The CAS has been shown to correlate with achievement at least as well as tests of general intelligence (Naglieri, 1999a). An added advantage of the CAS appears to be that, unlike other traditional measures of intelligence, the CAS does not include achievement-like subtests which would inflate the correlation between tests of ability and achievement (Naglieri & Ford, 2005). The result is that the CAS has established discriminant validity as a measure of cognitive processes and not academic achievement (Powell, 1999).

The analyses of the CAS scale scores have been widely used in research studies, and many of them are described in the following sections. One of the particular advantages of the CAS is that it has been shown to be useful in discriminating populations such as students with and without learning disabilities (Naglieri & Kaufman, 2008). However, the use of profile analysis with the Wechsler measures has come under attack significantly in the literature (e.g., McDermott & Glutting, 1997; Watkins, 2000).

Crawford (2002) used large samples of standardization data to analyze performance profiles of various groups on the CAS. When compared with a non-special education group, children with reading disabilities (RD), attention deficit hyperactivity disorder (ADHD), and mental retardation (MR) all displayed unique PASS composite profile patterns. The RD group experienced significant difficulties with the Successive composite, suggesting the child with RD struggles with processing information in a specific order. Children with ADHD were found to have lower Planning and Attention composite scores than non-special education children. And finally, children with MR were found to have significantly depressed performance on the Simultaneous and Successive subtests. These results indicate support for profile analysis in the discrimination of special education samples.

Furthermore, the CAS has been shown to be relatively independent of language mediation (Powell, 1999). For example, many of the tasks on the CAS do not require verbal responses. In the cases where verbal responses are required, the responses do not require crystallized knowledge or prior experience in answering the question. For the reasons stated above, studies in the following areas may be useful in considering cognitive processing and academic issues with a variety of learners.

Mathematics

The history of mathematics intervention is long and complex. Recently, strategy instruction has become an increasingly sought after method to improve student learning in mathematics. Strategy instruction goes beyond basic drill and practice of equations. The practice relies on students linking new knowledge to their existing knowledge in order to approach more complex problems (Fennema, Carpenter, & Peterson, 1989). When looking at the effectiveness of using strategy instruction to solve mathematical problems, generally positive results have been found across all grade levels (Geary, 2005; Montague, 1997).

One of the advantages of strategy instruction is it lends itself to a theoretical approach. However, research on mathematics achievement using traditional theories (i.e., Cattell-Horn-Carroll) is limited (Proctor, Floyd, & Shaver, 2005). More recently, researchers have attempted to connect working memory to mathematics achievement (Holmes & Adams, 2006). Many studies have focused on a particular aspect of cognitive ability or cognitive processing. The information-processing model of cognition has also become an important concept in the field of instruction (Woodward, 1991). But before credence is lent to strategy instruction as a superior intervention, it needs to be determined if such practices are generalizable to other problems or if the process is similar to rote memorization (Harniss, Stein, & Carnine, 2002).

More work on linking instruction to cognitive process has come from the PASS theory than any other - most likely because the nature of the CAS lends itself more to an instructional component as the CAS defines cognitive ability as cognitive processing. The PASS area of Planning seems to have drawn the most attention in terms of intervention studies in the area of mathematics. This is possibly because Planning is most closely related to mathematical problem solving as students must try to find a solution to apply to a problem, and if none is immediately recalled, they must then formulate a new process and modify it to meet the needs of the problem. The remaining areas, Attention, Simultaneous, and Successive, do not seem as highly correlated to strategy instruction by definition. Further factor analysis may prove convincing for this hypothesis.

The most frequently used procedure with PASS theory is a baseline and intervention model. Students were assessed using the CAS (Naglieri & Das, 1997a) and then tested using a mathematics achievement measure. Strategy instruction is employed, and finally, students are retested with the mathematics achievement measure. Examples of this model are described in the following paragraphs.

Naglieri and Gottling (1995) first utilized this procedure with a small group of students with learning disabilities and then followed up with another study (1997). Students found to be lowest in Planning appeared to make the most gains in achievement. These findings have remained consistent in future studies (Naglieri & Johnson, 2000). However, a criticism of Naglieri and Gottling (1995) is that no control group was used; therefore, success of the intervention alone cannot be definitively stated. Similarly, small sample sizes do not provide a complete picture of the effect of the intervention in the classroom. Results could be a factor of simply receiving intervention rather than a byproduct of the PASS area scores.

Although students with deficits in other areas tend to improve with strategy instruction, only the group of students with Planning deficits consistently has made the largest improvement. Both of these studies (e.g., Naglieri & Gottling, 1995; Naglieri and Johnson, 2000) are reliant on teacher implementation to make the strategy instruction successful.

Hald (2000) found students low in Planning to benefit from cognitive instruction. Using an intervention model called the Planning Facilitation Method (Naglieri, 1998; Naglieri & Gottling, 1995, 1997; Naglieri & Johnson, 1998), Hald alternated the administration of math problems with group discussion and facilitation planning for 53 fourth grade students. Results suggested that students who were low in Planning as well as mathematics achievement benefited more from a planning intervention.

Conversely, students with low mathematics achievement but higher planning skills will benefit more from planning facilitation combined with math error instruction. These findings support the use of interventions focusing on planning skills.

Strategy instruction may not be applicable in all cases. Naglieri and Johnson (2000) found that students with a cognitive weakness in Simultaneous had a negative effect size in mathematics performance. This suggests that not all types of learners will benefit from strategy instruction in the area of mathematics. It also lends support to differentiated instruction as well as assessment to determine the needs of individual learners.

Reading

The correlation between general intelligence and reading achievement has been stated to be low (Vellutino, Scanlon, & Lyon, 2000). Fuchs and Young (2006) recently reviewed literature and found that half of the studies investigated showed intelligence to be a statistically significant predictor of response to reading treatment. In reality, IQ was found to be a better predictor of reading achievement in older children but not as useful with primary children (Fuchs & Young, 2006).

However, other cases have shown the PASS processing scores to be correlated with reading achievement as well (Naglieri & Rojahn, 2004). It appears the PASS model of cognitive processing is more sensitive to distinguishing reading disabilities than are other areas of cognitive assessment.

Studies indicate that Successive processing is necessary for reading achievement (Crawford, 2002; Naglieri & Das 1987, 1990). Powell (1999) set out to determine the relationship between the CAS and reading and how the CAS can be used to identify reading disabilities. In this study, 60 children were being evaluated for special education purposes in three Midwestern states. Powell obtained scores on the *Wechsler Intelligence Scale for Children – Third Edition* (WISC) and the *Woodcock-Johnson Revised Tests of Achievement* (WJ-R) from school files and administered the CAS.

Several of Powell's (1999) findings contributed to the utility of the CAS. First, he found the CAS to be relatively free of language mediation, and therefore different from the Wechsler measure in this way. Additionally, the correlation between the CAS scales and the WJ-R reading cluster scores was weak. This indicated that the CAS is relatively independent of academic achievement, increasing the CAS's discriminant validity as a measure of cognitive processes.

Although he identified relationships between reading scores and the CAS Scale scores, the Successive Processing scale weakly correlated with reading scores. This finding was contrary to the assumptions made that successive processing and word decoding are related (Kaufman & Kaufman, 1983). Corrected correlations were made between the CAS, WISC-III, and WJ-R and these correlations were found to be similar to those reported first by the CAS authors (Naglieri & Das, 1997b).

Other implications of Powell's (1999) study are that it challenges the position stating that the theoretical framework of the PASS theory and the CAS are able to measure the cognitive processes underlying specific academic areas (Das et al., 1994). These findings suggest that clinicians should exercise caution when trying to extensively relate PASS Scale scores to specific academic areas.

Planning facilitation has also been used in conjunction with efforts to improve reading comprehension. Haddad and colleagues (2003) examined the differential effects in relation to the PASS profiles of children. The researchers demonstrated that children who had low scores in Planning had large improvement in reading scores when compared to those who had average scores in Planning. Bardos (1988) conducted a study with a group of 159 elementary children with reading disabilities. Children with reading disabilities performed lower than a control group on the Planning and Attention areas. The Planning component contributed significantly to the discrimination among groups. Attention, however, was not a discriminator (Bardos, 1988). These results are consistent with other works in the area of planning facilitation (Haddad et al., 2003).

On the contrary, Kirby, Booth, and Das (1996) suggested that children with reading disabilities perform lowest on Successive processing tasks which has been supported by others (Crawford, 2002; Naglieri & Das, 1987, 1990). A variety of reading skills and deficits need to be considered when looking at children with reading disabilities. The inconsistency of the findings in these studies may be due to differences among the type of reading disabilities. Now that more is understood about specific learning disabilities, it may be beneficial to revisit these studies and replicate the procedures with different learners. Perhaps defining reading groups by a student performance on a reading test rather than school-based labels might be a better way to define and explore this relationship.

Writing

In order to establish the discriminant ability of the CAS for students with written expression disabilities, Johnson (2001) compared the CAS scale and subtests scores with a measure of academic achievement, the first version of *Wechsler Individual Achievement Test* (WIAT) published in 1992. This study examined the performance of 96 junior high school students, half of whom met the criteria for the presence of a learning disability. Students without a LD must have received a B or higher in their Language Arts class in an attempt to "rule out students who may have undiagnosed learning disabilities" (Johnson, 2001, p. 113). Students were administered the CAS and the Spelling and Written Expression subtests of the WIAT which, when combined, yielded a Writing composite.

The Planning and Attention composites and subtests were found to be highly correlated, reiterating the interrelated nature of the PASS model. The Planning composite and the Written Expression subtest had the highest correlation for the group with LD. In addition, the Attention composite had the highest correlation with the Spelling subtest for the group with LD.

Overwhelmingly, the CAS subtests and composites indicated significant group differences between children with and without LD. The Planning subtests, followed by the Attention subtests were the most significant contributors to the discriminant function. This is interesting because according to others, the Simultaneous and Successive scales should be most relevant with regard to reading and writing skills (Naglieri & Das 1987, 1990). However, the group without LD had significant relationships between the Successive and Simultaneous composites and the WIAT Spelling and Writing composites as suggested by others (Naglieri & Das 1987, 1990). This is a reminder that children with LD may have unique profiles on the CAS.

Johnson's (2001) method of CAS composite classification correctly identified 83% of students without LD and nearly 88% of students with LD in their respective groups. The subtest method of classification correctly classified almost 92% of students without LD and nearly 88% of students with LD.

Germaine (2004) expanded on Johnson's (2001) work by investigating an intervention for increasing writing achievement. Ten children with varying levels of planning ability with written expression deficits were administered the CAS and grouped as being either average in Planning, or high average in Planning. Findings indicated that all students using the selected writing measure improved performance and that the CAS remained a valid discriminator of students with and without written expression deficits (Germaine, 2004). These unique findings by Germaine (2004) and Johnson (2001) support the notion that the areas of the PASS theory contribute in many ways to a person's problem solving.

Many studies have been conducted exploring the PASS areas and their relationship to the academic areas of reading, mathematics, and writing. Several examples of strategy instruction have shown that students who have the lowest Planning scores make the most gains on mathematics assessment (Naglieri & Gottling, 1995; Naglieri and Johnson, 2000). The CAS has also correlated with reading (Naglieri & Rojahn, 2004) and the Successive area appears to be the major predictor of reading scores (Crawford, 2002; Naglieri & Das, 1987, 1990). Finally, students with writing disabilities have different profiles on the CAS than students without writing disabilities (Germaine, 2004; Johnson, 2001).

Other Uses of the CAS and PASS Theory

Not all studies involving the CAS and PASS theory revolve around core academic interventions. Work has been conducted with behavioral issues, learning disabilities, gifted children, college students, and in improving cognitive processes (i.e., Cormier, Carlson, & Das, 1990; Lerew, 2000; Savage & Wolcott, 1994).

The PASS area of Planning has received a lot of attention in the literature. In addition to its utility in reading and mathematics, researchers have even used Planning instruction to improve Planning skills alone. Cormier and colleagues (1990) used strategy instruction to improve student performance on Planning measures. Students low in Planning improved significantly compared to students high in Planning. Results were similar in Kar, Dash, Das, and Carlson (1992). This work was expanded on by Naglieri and Gottling (1995, 1997) who demonstrated that students with learning disabilities benefited from strategy instruction. More recently, students have been shown to make great improvements in the classroom when they began with low Planning skills and those low skills were then remediated (Naglieri & Johnson, 2000).

Bardos (1988) examined the profiles of children with mental retardation (MR) to see if “developmentally handicapped” students different in PASS performance as compared to children with and without a reading disability. The children with MR tended to obtain lower scores on all of the PASS components, which would be expected on other measures as well. The lowest performing area for children with mental retardation was the Planning scale. Similar results were found in subsequent studies, although Simultaneous and Successive scores were lowest in children with mental retardation while Planning and Attention scores were the highest (Naglieri & Das, 1997b).

Additionally, a group of 17 individuals identified as having serious emotional disturbance were given the CAS. Again, the area of Planning was found to be the lowest. Interestingly, Simultaneous and Successive scores were in the average range (Naglieri & Das, 1997b). Planning and Attention scores were found to be lower in groups of children with traumatic brain injury (Naglieri & Das, 1997b).   Low scores in those areas would account for descriptions of these children as having difficulty with tasks such as impulse control, problem solving, and organization (Savage & Wolcott, 1994). Each of these studies has emphasized the importance of understanding planning-type strategy skills.

Attention

Lerew (2000) designed an intervention study to facilitate planning with students known to have an Attention-Deficit/Hyperactivity Disorder (ADHD). This intervention was conducted with a small group of six elementary students from second to fifth grade. The procedures included interventions in mathematics, reading comprehension, and behavior.

A variety of interventions were implemented. For the area of mathematics, Planning facilitation intervention was based on the methods described by Naglieri and Gottling (1995, 1997), Naglieri (1998, 1999) and Hald (2000). Students worked on math problems for 10 minutes, the researcher facilitated discussion for 10 minutes, and then the participants completed 10 additional minutes of mathematics problems. For reading, the research first facilitated a discussion on Planning, and then the student read a passage silently and answered comprehension questions. A behavioral intervention was also put in place. First the researcher read a scenario that involved an elementary school student making a poor decision and the research facilitated discussion. It is not known if the same problems, passages, and scenarios were presented to each age group.

Similar to the prior findings of reading and mathematics studies, Lerew demonstrated that students with low Planning scores improved more than students with high Planning scores. In addition, the intervention improved mathematics and reading performance for all students, although those low in Planning improved the most. Interestingly, the students with high Planning scores improved behavior on a weekly teacher reported measure more than the students with low Planning scores. Although the findings for the academic areas were consistent with previous research, the suggestions about planning skills and behavior extended the research of the PASS theory and behavior issues.

A similar study expanded on the use of cognitive processing and its relation to ADHD. Palencia (2003), using a control group, did not identify group differences on the CAS for the Planning and Attention scales. However, she did highlight some important considerations regarding executive functioning such as planning and attention areas and the relationship of these skills with behavior. This study reminds researchers of the importance of a control group when drawing conclusions about the effectiveness of an intervention (Task Force, 2003).

Recent commentary has suggested the use of measures of psychological processing in assessing attention disorders (Naglieri & Das, 2006). Although Attention Deficit Hyperactivity Disorder –Inattentive type (ADHD-I) and Hyperactive-Impulsive type (ADHD-H) are two ways to categorize people with attention disorder, the underlying processes appear to be quite different. It appears that children with ADHD-H earn average scores on all PASS areas except Planning (Naglieri, Goldstein, & Iseman, 2003; Naglieri, Salter & Edwards, 2004; Paolitto, 1999). This result was replicated with Dutch students as well (Van Luit, Kroesbergen, & Naglieri, 2005). As mentioned earlier, Planning is most closely associated with the third functional unit of the brain described by Luria (1973) and therefore suggests that ADHD-H is relevant to this area.

However, ADHD-I appears more closely related to the descriptions of the first functional unit of the brain (Luria, 1973). Unfortunately, research containing profiles for ADHD-I and PASS theory is limited (Naglieri & Das, 2006). The implications for the study of attention disorders as they relate to cognitive processing are clear. If students differ in their psychological processing skills as a result of an attention disorder, instruction can be constructed in unique ways to meet the needs of both types of students.

Although the 66 children tested using the CAS in another study were not sub-categorized to the extent described above, they did display lower scores in Planning and depressed scores in Attention. Simultaneous and Successive scores, however, were average (Naglieri & Das, 1997b).

Learning Disabilities

It also appears that the PASS theory is applicable to students with general learning disabilities (LD) and is relevant to revisions in IDEIA law (Naglieri & Conway, 2009). Pelletier (1996) attempted to validate the PASS theory using the Standardization Edition of the *Das-Naglieri: Cognitive Assessment System* (Das & Naglieri, 1993) in elementary students with and without learning disabilities. Forty of the 123 participants were determined to have a learning disability; however, these participants were from three different states and the criteria for learning disability greatly differed among the states.

Pelletier (1996) found significant differences between the group with learning disabilities and the regular education group on the PASS tasks. Students with LD scored nearly one standard deviation lower than the regular education group on all of the subtests. She also used a discriminate analysis procedure to identify children with learning disabilities using the PASS model. This method correctly identified 82% of the subjects: 75% of the children in the LD group and 85% of children in the regular education group were correctly classified. *The Children's Category Test* (CAT) was added to see if additional measures added to the discriminative ability of the CAS. Results suggested that the ability of the CAS to discriminate students with and without LD did not increase with the addition of the CAT. Pelletier (1996) also found that the most influential composites in discriminating the control group from the group with learning disabilities were Attention and Successive composites. Students with LD performed lowest on the Expressive Attention subtest.

Some considerations regarding Pelletier's (1996) study are present. First, children with learning disabilities vary by age with regard to personal performance on tests. The results from this study may only be considered for younger elementary children while other studies may provide validation of the PASS theory with older children with learning disabilities. As mentioned above, the array of states participating in the study fall short of accurately representing the country and yet differences in LD classification vary across states, limiting the external validity of findings.

Students with learning disabilities/speech impairments (LD/SI) were examined using the CAS (Brams, 1999). Findings suggest that three scales (Planning, Simultaneous, and Successive) can be useful in discriminating among students with LD/SI. Although the Attention scale was not found to be useful in identifying achievement problems, Brams (1999) suggested that it was useful in remediation efforts.

Researchers have criticized the practice of determining the presences of a learning disability based on an individual's subtest pattern (Naglieri, 1989; Naglieri, Das, & Jarman, 1990). In order to determine if profile analysis on multidimensional cognitive measures was a useful practice, Huang (2004) conducted a cluster analysis with regular and special education student scores from the standardization data of the CAS (Das & Naglieri, 1987a). The results indicated that 72% of the individual profiles were unique.

These results provide conflicting accounts on whether profile analysis on the CAS can be an appropriate method for distinguishing LD from regular education students. Huang (2004) suggested that individual LD profiles which were considered to be common with the regular education sample (28%) may indicate that some students are struggling with academics but may not be a true student with a learning disability.

As the definition of what constitutes a learning disability continues to be revised, it will be important to replicate these studies with various groups. Children with math and reading learning disabilities may appear quite different, as evidenced by Bardos (1988) and Kirby et al. (1996). Future work should continue to accurately define students with specific learning disabilities and apply measures of cognitive profiling to different groups.

Giftedness

The utility of the CAS with gifted adolescents has been explored (Stanley, 1995). The PASS structure was upheld when 100 gifted adolescent participants completed the CAS. Similarly, the PASS model proved to be an effective predictor or academic achievement.

Historically, minority children have been underrepresented in gifted programs, calling for fairness in assessment (Ford, 1998). Due to the cultural bias of verbal items on traditional intelligence tests, gifted minority children are more likely to be identified correctly if they are assessed with non-biased tests like the CAS (Naglieri, 1999a). Although only 11% of students participating in Stanley's (1995) study were of ethnic minority, findings suggest that the PASS model is useful with academically gifted students including those who are of a minority group. Further, the PASS model proved to predict academic achievement on measures such as the ACT and SAT (Stanley, 1995).

Naglieri and Kaufman (2001) highlighted the importance of considering an instrument when assessing gifted youth. They identified a young girl who obtained a Full Scale IQ score of 123 on a Wechsler measure. When measured with the CAS, the same student obtained scores of 139, 124, 129, 131 on the Planning, Attention, Simultaneous, and Successive scales of the CAS, respectively. Her Full Scale was 141, significantly higher than on the Wechsler scale. The CAS authors opine “the broad scope of cognitive functions measures [by the CAS] may identify a greater variety of gifted children than has been identified by more traditional tests” (Naglieri & Das, 1997b, p. 10). However, with only one case study fueling this claim, more research is needed in this area.

However, a group of 173 students identified as gifted were administered the CAS. The average Full Scale standard score and the Simultaneous and Successive Scales were greater than one standard deviation above the mean. This is likely because the Simultaneous and Successive scales are most similar to traditional IQ measures. However, the Planning and Attention Scales were only about two-thirds of a standard deviation above the mean. These results indicate that students identified as being gifted may not have uniformly higher profiles on the PASS scales than their peers (Naglieri & Das, 1997b).

Careful consideration regarding the cases described above suggests more deliberation needs to be given to gifted assessment. Further, Naglieri and Kaufman (2001) suggested that traditional measures, such as the Wechsler scales, do not measure abilities such as creativity, yet, creativity is often included in the definition of giftedness. With the suggestion that creativity and Planning are conceptually related (Stanley, 1995), it seems inappropriate to use traditional measures which do not measure Planning skills, and are therefore insensitive to creativity.

The findings of studies with the CAS suggest that an individual’s cognitive processing abilities determine how a particular student will benefit from a specific instruction. More work is needed in determining the usefulness of strategy instruction with various types of learners and with students with and without specific learning disabilities.

Intelligence and the PASS Theory with Adults

Intelligence, or cognitive processing ability, as a concept does not disappear when an individual becomes 18 years of age. Similarly, a person with a learning disability during childhood does not automatically rid themselves of a disability simply by becoming an adult. Because many states have relied on a discrepancy model – a particular difference in scores on an ability measure and an academic achievement measure – to determine the presence of a learning disability, cognitive measures have also been applicable to adults.

Several measures have been produced by psychologists such as Kaufman and Wechsler. First, the *Kaufman Adolescent and Adult Intelligence Test* (KAIT; Kaufman & Kaufman, 1993) can be used with individuals from age 11 to 85 or over. The KAIT is a combination of several theoretical perspectives, although it is grounded in the Horn and Cattell (1966) model. Other models – Luria's (1980) definition of planning and Piaget's (1972) stage of formal operations contributed to the development of the test.

Unlike the above mentioned test, Wechsler did not base his measures on a theory (except for perhaps Spearman's g) but rather constructed his tests for clinical and practical purposes (Kaufman & Lichtenberger, 1999). Wechsler's contributions were significant in that he assessed individuals on both Verbal and Performance scales feeling that individuals who spoke English well needed to be assessed with English-speaking items. Irregardless, the Wechsler scale is one of the longest standing and most widely used adult intelligence measure (Daniel, 1997).

Naglieri (1999a) noted that "the Planning, Attention, Simultaneous, and Successive processes are intended to represent the basic psychological processes in children and adults in a variety of settings" (p. 153). The PASS theory of cognitive processing is said to be well established with children. However, given the descriptions of Luria's theory and the PASS theory, one would assume cognitive processing skills are present in adults as well. Yet after several decades of research and the publication of the Cognitive Assessment System, surprisingly little literature addresses the theory with adults.

One such attempt to confront this issue has been the work of Maricle (1994). A sample of 111 undergraduate students was given an experimental battery of the PASS theory. The primary purpose was to explore the factorial structure of the PASS cognitive processes tasks with college students. A secondary purpose was to identify the degree to which academic performance could be predicted using a PASS model. Finally, Maricle (1994) was curious about the advantages of using a PASS model rather than a Wechsler scale in predicting academic performance.

Using a Maximum Likelihood (Joreskof & Lawley, 1968) factor analysis, Maricle (1994) demonstrated a four factor solution which is consistent with most exploratory studies (Naglieri, Das, Stevens, & Ledbetter, 1991; Naglieri, Prewett, & Bardos, 1989; Warrick, 1989). Maricle (1994) was the first to use an exploratory study to provide factorial support for all four cognitive processing components of the PASS theory with an adult population. The factor loadings found differed from previous factor analytic studies using similar tasks (Naglieri, Das, Stevens, & Ledbetter, 1991).

The Simultaneous and Successive factors and their respective tasks were clearly defined. The Design Construction, Simultaneous Verbal, Figure Memory, and Matrices tasks fell on the Simultaneous factor. Meanwhile, the Sentence Repetition, Sentence Questions, and Word Series tasks best fit the Successive factor (Maricle, 1994).

However, in contrast to previous research (Naglieri, Das, Stevens, & Ledbetter, 1991; Naglieri, Prewett, & Bardos, 1989; Warrick, 1989), distinct Planning and Attention factors were not as clear. The Visual Search, Planned Connections, Matching Numbers, and Planned Codes tasks composed the Planning factor. However, two tasks which have been said to fall on the Attention factor – Receptive Attention and Number Finding – were more strongly related to the Planning factor, suggesting that strategy selection, which is a key aspect of planning, was more important in solving these tasks than attention was for undergraduate students. Finally, the Attention factor was composed of the Expressive Attention and Auditory Selective Attention tasks.

Maricle (1994) also addressed the shortage of literature regarding the PASS components and the correlation with achievement in adult populations. She found that the PASS model adequately predicted academic achievement as measured by Scholastic Aptitude Test (SAT) and the American College Test (ACT) scores. Furthermore, Simultaneous processing was the best predictor of SAT verbal and math scores which has been supported by other researchers (Wachs & Harris, 1986). The PASS model proved to be as good of a predictor of academic success as the Wechsler scale. However, neither the PASS model nor the Wechsler scale was an adequate predictor of grade point average (Maricle, 1994).

At the same time, pioneering work regarding the PASS model and adults with learning disabilities was being undertaken. Macdonald (1994) attempted to validate the PASS model for use with adults who have learning disorders. Like Maricle (1994), Macdonald was interested in the relationship between PASS processes and academic achievement.

A group of 70 adults who had been diagnosed with learning disabilities were administered a group of tasks recommended by Das and colleagues (1994) which measured PASS processes. Using multiple regression analyses, results indicate that the tasks used in measuring the PASS processes contributed to the prediction of academic achievement in adults with learning disabilities. Furthermore, the PASS tasks were commensurate with the Wechsler tasks in predicting academic achievement (Macdonald, 1994), despite the fact that the PASS tasks were designed to be an alternative to the more content-laden measures of intellectual ability (Das et al., 1994).

Davis (2003) also examined profiles of college students with learning disabilities in order to examine gender differences in cognitive processing. A group of students from a college in the mid-west who were identified as having a learning disability voluntarily participated. Davis adapted tasks from the CAS to form an adult battery which he administered to 69 college students with learning disabilities and 109 college students without learning disabilities. However, these students did not attend school at the same institution. Topics such as demographics, school and social experiences, SES, were not mentioned as part of the analysis and leave questions about how the results can be generalized to either university. Similarly, Davis (2003) reminds us how differences in definition of LD vary across states, thereby limiting the external validity of any single-state study of students with LD. Furthermore, Davis used experimental PASS tasks which had not undergone factorial studies. After the tasks were altered to be appropriate for adults, it is unknown if the tasks still would measure the same constructs as when they were created.

A Multivariate Analysis of Variance (MANOVA) was used to compare gender and students with and without LD. However, no ipsative differences in the profiles of males or females were found, supporting the rising literature against profile analysis (e.g., McDermott & Glutting, 1997; Watkins, 2000). Although Davis found no significant differences between PASS processes based on gender, when compared across groups with and without LD, differences within gender occurred. Males without LD scored significantly higher on the PASS processing composite levels of Planning, Attention, Simultaneous, and Successive as well as a number of subtests than did males with LD. Results were similar for females without LD compared to females with LD.

Davis found nearly equal performances among male and female adults in the area of Planning, and suggested that when females outperform males prior to age 17, development is a factor. It remains to be proven with other empirical research if early onset of puberty may lead to accelerated frontal lobe development in females. However, if male and female adults, on average, score similar, earlier discrepancies may be a result of development rather than ability. Future studies are needed in this area.

What does the PASS Theory and the CAS Measure?

Despite the many studies supporting the use of the PASS theory with exceptional populations, not all reviews of the model have been favorable. The PASS scales were intended for differential diagnosis and the identification of strengths and weaknesses

(Naglieri & Das, 1997b). But this notion has received ongoing challenges in the literature.

The first such criticism came from Kranzler and Keith (1999). The authors conducted a Confirmatory Factor Analysis (CFA) from the standardization data and determined the CAS does not measure four separate factors, questioning the construct validity of the measure. In their model, the Planning and Attention factors were indistinguishable. By using a third-order model, Successive was the only clearly distinguishable factor. The second-order model, which reflected the implied theoretical model of the CAS, was not supported in the results and that a model supporting *g*, similar to other established intelligence tests, had a better fit. They further cautioned against using the CAS for differential diagnosis (1999).

This article was quickly disputed by PASS supporters. Naglieri (1999b) highlighted many of the findings in Kranzler and Keith (1999) to be supportive of the structure and intent of the PASS theory and the CAS (Naglieri & Das, 1997a). Naglieri (1999b) also pointed out that some of the conclusions drawn by Kranzler and Keith were from subtests that never actually were published in the current CAS instrument. Naglieri (1999b) disputed the claim that Planning and Attention are indistinguishable (Kranzler & Keith, 1999) and reminded readers that since the establishment of the PASS theory based on Luria (1966), these two factors are reliant on each other and are expected to be correlated to some extent (Naglieri et al., 1990). The argument from PASS supporters appeared to be that there was an acceptable overlap of the Planning and Attention scales based on Luria’s theory while others like Kranzler and Keith were not satisfied and were convinced it was actually one factor.

In addition, previous claims about the PASS model itself were addressed by Naglieri (1999b). He explained that Kranzler and Keith (1999) made erroneous claims about the structure of the CAS and that their conclusions were made because the latter were ignorant of the mathematical process designed to obtain the FS score. Furthermore, the CAS was shown to be broader in scope than other tests and useful in differential diagnosis (Naglieri, 1999b). Keith and Kranzler (1999) responded to Naglieri's (1999b) arguments and by refuting points from earlier work (Kranzler & Keith, 1999), suggested that Naglieri was not able to adequately address important concerns about his test and theory. Kranzler, Keith, and Flanagan (2001) then followed up with a bold study. Based on their results from 1999, the authors suggested the CAS scales do not truly measure the constructs which were intended by Naglieri and Das (1997a), but rather measure several constructs associated with the popular CHC theory.

Kranzler et al. (2001) ran a series of factor analyses with the CAS and the Woodcock-Johnson Tests of Cognitive Ability (WJ III; Woodcock et al., 2000) and found some interesting results. First, they stated that the Planning and Attention scales of the CAS were strictly a measure of processing speed. Their analysis demonstrated an extremely high correlation of each scale with the WJ III area of processing speed. This finding contradicts Naglieri's claims where he stated that "the suggestion that Planning and Attention scales are measures of processing speed is simply not supported by theory nor by research" (Joseph, 1999, p.8).

Furthermore, Kranzler et al. (2001) suggested that the CAS area of Successive Processing is actually a measure of short-term memory. Analyses revealed that the CAS Successive factor and the WJ III *Gsm* (short-term memory) were not statistically different, and posited that these two factors are statistically indistinguishable. Das et al. (1994) noted that "the successive component may relate to a limited extent with" short-term memory subtests on the Wechsler scales (p.127). Again, Kranzler et al. (2001) produced statistical evidence to reject any notion that the CAS Successive factor and the WJ III short-term memory factor are different.

As was noted in Kranzler and Keith (1999), one hypothesis consistent with CHC theory is that a psychometric *g* underlies all cognitive tests. Kranzler et al. (2001) believed this to hold true with the CAS as well. Again, the FS score on the CAS was highly correlated with the WJ III *g* and that the two were statistically indistinguishable. Furthermore, the authors suggested that the CAS *g* is not even the best estimate of *g*, but rather the Simultaneous Scale does a better job of estimating g (Kranzler & Keith, 1999). The results indicate that the FS and Simultaneous Scale scores of the CAS appear to be almost equally loaded on psychometric *g* and therefore appear to be equivalent measures of psychometric *g* (Kranzler et al., 2001).

Although the authors of the CAS suggest that the PASS model precludes the use of a composite score such as the Full Scale (Naglieri & Das, 1990), a Full Scale score appears on the CAS and is probably used frequently by practitioners. One of the particular advantages of the CAS is that it can be used at a processing measure and hopefully leads practitioners to a better understanding about how a person solves problems. After all, if IQ scores have "little direct educational impact," the CAS would be no better than traditional measures of g in helping solve academic problems in the classroom (Braden, 1997, p. 244).

Because of the presence of a Full Scale score, the structural fidelity of the CAS was brought into question but appears to be limited to several authors (Kranzler & Keith, 1999; Kranzler et al., 2001). Perhaps one of the reasons a three-factor solution has been deemed appropriate is because many of the Planning and Attention tasks have a timed component. Therefore, processing speed may be the overriding component which ties Planning and Attention together. There appears to be validity evidence both for and against the PASS theory as a model of cognitive processing.

Conclusion

The literature provides convincing need for a reexamination of traditional intelligence measures and the use of the PASS theory as an alternative to other established theories. This unique approach to cognitive functioning stems from the neuropsychological work of Luria (1966) and the functional units of the human brain. Replacing the concept of IQ with cognitive processing based on theoretical constructs lends credence to the use of the PASS theory with a variety of individuals today.

There appears to be conflicting information about the underlying skills measured by the CAS and PASS theory and their relationship to academic achievement. The area of Successive processing and reading seems to be one such example under debate. Further research may be needed to determine the claims made by Kranzler and Keith (1999) and Kranzler et al., (2001) suggesting that the CAS and PASS theory are measures of *g* rather than a unique measure of cognitive processing. With these challenges comes reservation when using a theory or a test. However, like traditional Wechsler measures, the CAS and PASS theory rely on research to dispute such attacks. Despite various definitions regarding the presence of a learning disability, studies have shown the PASS theory and the CAS to be reliable predictors of cognitive functioning and academic achievement.

What remains to be seen is the use of the PASS theory with adult populations. Although several studies (Maricle, 1994; Macdonald, 1994) have included adult populations in the PASS model, a wide range of ages and validation of the factor structure has yet to be established. This study will expand on the work of Maricle (1994) by using new experimental PASS tasks. In addition, many of Maricle's (1994) participants were college freshmen. This study intends to sample college students of all ages as well as older adults. Since the publication of Cognitive Assessment System (Naglieri & Das, 1997a), more research and a wider variety of tasks is now available. Unlike the work of Davis (2003) and Macdonald (1994), this study will not look at adults with a learning disability. In addition, neither of those studies validated the use of the PASS theory with adults and therefore left the factor structure of experimental PASS tasks in question. Perhaps with a standardized, norm-referenced measure of PASS cognitive processing in adults, the field of psychology will be able to best serve the adult population in a variety of ways. A battery may serve to assist in fueling interventions at the university level and exploration could be done in the area of job prediction.

CHAPTER III

METHODOLOGY

Participant Selection

Participants for this study were recruited in two different ways. From 2000-2002, a group of graduate students under the guidance of a research advisor submitted a proposal to the Institutional Review Board (IRB) at the University of Northern Colorado in Greeley, Colorado, which was granted according to their guidelines to conduct research with human participants. Approval from the Department of Psychology was granted for the researchers to use the undergraduate psychology subject pool as a basis for recruiting participants. A renewal of the IRB and a total of 47 subjects were assessed in the first phase of the project.

In 2006-2007, the IRB was renewed and it was decided that the sample can include adults willing to participate in the study from outside the undergraduate student body such as graduate students and other adults (i.e., friends and family members of graduate students at the University of Northern Colorado). This was done in an attempt to expand the age range of participants beyond the traditional college age in order to draw conclusions about the results. The author collected data from another 74 participants, bringing the total sample size to 121. Approval for this study was requested and granted from the University of Northern Colorado’s (UNC) Institutional Review Board (IRB).

Adult participants both attending UNC and not enrolled in college were asked to participate in the study. Finally, a proposal was submitted to the Department of Psychological Sciences, requesting use of the undergraduate subject pool to solicit participants, which was granted. The undergraduate participants received participation credit in their introductory psychology class and other undergraduate students received extra credit in the abnormal psychology course. Graduate students and friends and family members of graduate students participated in the study voluntarily and did not receive any compensation for their participation.

The adult sample consisted of 121 subjects – 53 were male (43.8%), 61 were female (50.4%), and the remaining 7 were of unknown gender (5.8%) due to missing data. The breakdown of gender of participants is displayed in Table 2.

Means and standard deviations of the subject performance across the various tasks suggested a preliminary age trend with five age categories which included participants across: 18-19, 20-30, 31-40, 41-49, and 50 and above years old. As seen in Table 3, the 18-19 group comprised a large number of the participants (n=56, 46.3%) while the 20-30 age group accounted for 51 participants (42.1%). The 31-40 age group had 4 participants (3.3%), while the 41-49 had only 1 participant (.8%). Finally, the 50 and up category accounted for 2 participants (1.7%). Again, from the archival data, information on the age of 7 participants (5.8%) was unavailable. Considering the unknown participants were recruited from the undergraduate subject pool, it can be assumed that a large number of these 7 participants would be in the 18-19 or 20-30 age groups and of traditional university age; however, because there is no certainty regarding their ages, they have been classified as unknown. The mean age was 21.6 years old with a standard deviation of 5.9 years and a range of 36 years. Tables displaying the demographic information of the participants in this study are presented in Chapter IV.

Procedures

All participants were administered a battery of 13 experimental tasks adapted with changes from the Standardization version of the Cognitive Assessment System (Das-Naglieri: Cognitive Assessment System; Das & Naglieri, 1987a, 1987b, 1993), as well as two additional tasks: the *General Ability Measure for Adults* (GAMA; Naglieri & Bardos, 1997) and Crack the Code. Both of these additional tasks served as subtests for the PASS theory. In addition, all participants were administered the *Nelson-Denny Reading Test* (NDRT; Brown et al., 1993a) to obtain a measure of academic achievement.

Testing for this study was conducted in two phases. First, participants were administered the achievement portion of the test (the NDRT), as well as two subtests for the cognitive processing portion (Crack the Code and GAMA), in a group format. Approximately 5-10 participants at a time met in a classroom and worked individually on these measures, which are described below. Because the nature of the GAMA, NDRT, and Crack the Code allow administration in group format, several students worked in one classroom but attempt the tasks individually. The researcher read directions to all participants, administered testing materials, and supervised the testing session. Group administration of these tasks took approximately 1 hour and 15 minutes. Individual sessions were also conducted for all remaining PASS experimental subtests according to the individual participant's scheduling needs. The examiner scheduled a time to meet individually with the participant in order to administer the PASS experimental battery. The approximate time to administer the individual portion of the subtest took an average of 1 hour and 10 minutes.

Participants were administered the subtests assumed to load on the Planning factor first, then Simultaneous subtests, then Attention subtests, and finally, Successive subtests as according to the suggestions of the current CAS (Naglieri & Das, 1997a).

Assessment Procedures

The Planning, Attention, Simultaneous, Successive (PASS) information processing model (Das & Naglieri, 1987, 1989) is assessed with a measure originally called the *Das-Naglieri: Cognitive Assessment System* (Das & Naglieri, 1987, 1993). This study slightly modified many of the subtests found in the standardization edition of the CAS (*Das-Naglieri: Cognitive Assessment System – Standardization edition*; Das & Naglieri, 1993). Several of the standardization edition tasks evolved into the current subtests of the CAS (Naglieri & Das, 1997a). A series of 14 experimental tasks were administered in this study. Some of these tasks have been implemented and described in previous studies (Naglieri & Das, 1990; Naglieri, Das, & Jarman, 1990). Modification of tasks that were used in this study included the deletion of easier items, the addition of harder items, and alterations to the timing of items.

The following descriptions of the experimental tasks used in this study will be presented according to their PASS model categorization. First, Planning tasks will be presented, followed by the Attention tasks, then Simultaneous tasks, and finally the Successive tasks. Included in the Simultaneous section is the General Ability Measure for Adults (GAMA; Naglieri & Bardos, 1997) which was used as a Simultaneous task. After a description of this PASS battery, the Nelson-Denny Reading Test (Brown, Fishco, & Hanna, 1993a) will be presented.

Planning

Planning tasks require the individual to develop a plan of action, evaluate and monitor their decision, and revise or reject the selected method of problem solving (Naglieri, 1999a). These tasks are relatively simple and most people would be expected to get them correct if time were not an issue. However, these tasks require the individual to develop a problem-solving approach quickly and efficiently (Naglieri & Das, 1990).

Matching Numbers. The subject must find and circle two numbers that are the same in a row of numbers. There are eight rows per page, and six numbers in each row. The number pairs range from two to six digits in length. This is a timed task. The examinee has 150 seconds to complete the first three items and is given 180 seconds to complete the last item. To be successful, the examinee needs to develop and utilize an efficient system for determining which two numbers in each row are identical. The performance is timed and the number of rows with both matching numbers correct is recorded for each of the four pages. This subtest was developed by Das and Naglieri (1987) and has been found to load on the Planning factor (Naglieri & Das, 1989; Naglieri et al., 1991).

Planned Codes. This is a timed paper and pencil subtest that involves coding symbols to letters. In this task, the examinee must pair four letters (A, B, C, D) with different letter codes (XO, OX, OO, XX) which are presented at the top of the page. The remainder of the page contains rows of the four letters with empty boxes below them. The object is to fill in as many boxes as possible with the correct code. Planned Codes differs from the Coding subtest of the Wechsler scales in that the examinee can complete the task in any way they desire. For the first page of items, the boxes are arranged vertically. All of the A's are in the first column, the B's in the second and so on. On the second page, the boxes are arranged somewhat diagonally, and the X's and O's corresponding to the letters change, which is slightly different than the current version (Naglieri & Das, 1997a). The examinee has 60 seconds to complete each of the code problems presented to them. The time it takes to complete each page along with the number of correct codes (maximum 56 per page) is recorded. Planned Codes was developed by Naglieri and Das (1988). This task has been shown to load on the Planning factor in several studies (Naglieri & Das, 1988; Naglieri et al., 1989; Naglieri et al., 1991).

Trail Making. This task asks the examinee to develop an effective method of connecting sequential stimuli. This subtest is similar to *Trails Making Test A* and *Trails Making Test B* (Army Individual Test Battery, 1944). Also known as the Planned Connections task (Naglieri & Das, 1997a) this subtest has been modified and used in a variety of instances (e.g., Reitan, 1955; Spreen & Gaddes, 1969, cited in Naglieri, Prewett, & Bardos, 1989). Trail making-type tasks have been widely used as measures of planning processing ability (Lezak, 1995).

The first two items on this task require the subject to connect a series of numbers in correct numerical sequence by alternating between a series of letters in correct alphabetical sequence (i.e., 1, A, 2, B…etc.). The last item requires the examinee to connect the numbers again in numerical sequence, but they must connect the letters in reverse alphabetical order (i.e., 1, H, 2, G, 3, F….etc.).

Unlike the Planned Connections task (Naglieri & Das, 1997a) which asks the examinee to start by making a trail with only numbers, that task has been eliminated and only the items containing a mix of alpha and numeric characters have been included for the adults. Also, previous batteries have not used the reverse alphabetical order item.

Crack the Code. This subtest was described in Das et al. (1994) as a Planning test. In that work, the subtest contains a series of colored chips, and the examinee must determine the correct order. However, for this study, an adapted form of Crack the Code was used. The physical test was not available and a paper and pencil adaptation allowed for a more simplistic test battery as well as a group administration option. A series of shapes are presented on paper, and feedback is given to the examinee who must determine the correct order of shapes. This test has a 15 minute time limit and an item is scored correct if all of the symbols are in the correct position.

Simultaneous

In Simultaneous processing tasks, an individual must see how processes are interrelated (Naglieri, 1999a). To arrive at the correct solution, the individual will have to recognize smaller pieces of a problem and determine how those components contribute to a whole (Naglieri & Das, 1990).

Verbal Spatial. First used by Warrick (1989), this subtest is also known as Simultaneous Verbal (Das et al., 1994; Naglieri & Das, 1997a; Warrick, 1989) and has been found to load on the Simultaneous factor (Naglieri & Das, 1990). The task presents six illustrations on a page, and the subject is asked to choose the one option which correctly answers the question printed at the bottom of the page. The question is also read allowed by the examiner. Several of the easiest items were dropped from the previous version of this task (Das & Naglieri, 1993), in order to create the current experimental subtest. The task consists of 18 items, each with a time limit of 30-seconds.

The test is discontinued if the subject fails four consecutive items. The time for each question, response, and number correct are recorded.

Design Construction. In this subtest, the subject is presented with a series of colored tiles and asked to construct the tiles in a manner which reflects the design on a presented stimulus. It is similar to the Block Design subtests of the Wechsler scales. The subject is given 12 blue and white square tiles, 6 of which are white on one side and blue on the other, and 6 more which are half blue and half white (on one side the split is diagonal, on the other the color split is vertical). This task has time limits ranging from 60-seconds to 180-seconds, depending on the difficulty of the items. The task is discontinued when the examinee fails four consecutive items. The time to complete each item and the number of items correct are recorded. Design Construction is not a subtest on the current version of the CAS (Naglieri & Das, 1997a). It was developed by Das and Naglieri (1987) as an attempt to measure simultaneous processing and has been used in other experimental studies with adults (Davis, 2003, Maricle, 1994). It has been shown to load on the simultaneous factor (Naglieri et al., 1991).

Figure Memory. This subtest originally was found on Ilg's and Ames' (1964) *Figure Copying Test* and is similar to the *Group Embedded Figures Test* (Ottman, Raskin, & Witkin, 1971) and the *Children's Embedded Figures Test* (Witkin & Goodenough, 1976). Since then, the task has been adapted by Das and collegues (1979) and is used on the current CAS (Naglieri & Das, 1997a). Many research studies have confirmed that Figure Memory loads on the Simultaneous factor (Bardos, 1988; Naglieri, Prewett, & Bardos, 1989; Warrick, 1989).

In this task, a stimulus design is exposed for five seconds, then the design is removed and the examinee is presented with a response book. The examinee is asked to trace the shape he or she saw amidst a group of other lines which contain the original stimulus shape (see Figure 3). This task, consisting of 26 items, is scored pass-fail, and the test is discontinued after four consecutive failures. These items are similar to items on the current addition of the CAS (Naglieri & Das, 1997a) although this experimental battery uses several different figures and is shorter than the published version.

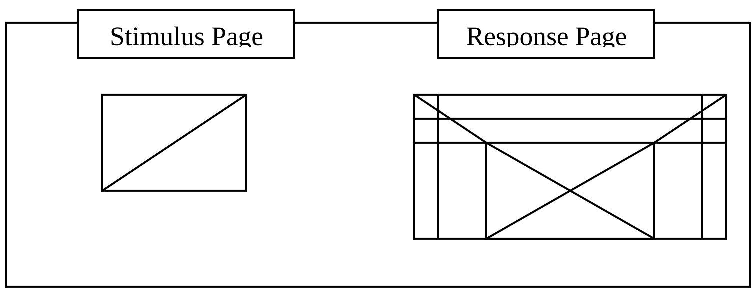

Figure 3. Example of a Figure Memory Task.

GAMA. The General Ability Measure for Adults (GAMA; Naglieri & Bardos, 1997) is a standardized, norm-referenced measure designed to evaluate intellectual ability in adults by using abstract designs. The GAMA IQ has a mean of 100 and a standard deviation of 15 and the 4 subtest scaled scores have a mean of 10 and a standard deviation of 3. The GAMA minimizes verbal and motor requirements and can be administered individually or in a group setting quickly and easily. Some uses of the GAMA include: a tool for career counseling decisions or counseling evaluations, a part of a psychological evaluation, and use for brief assessment in public schools, colleges, businesses, and industry.

The four performance areas on the GAMA are the Matching, Analogies, Sequences, and Construction subtests. The Matching items require the examinee to match a stimulus picture to one of six options that is identical in size, shape, color, and configuration. In the Analogies subtests, the examinee must determine the relationship between two abstract figures and then select a pair of figures among the options with the same conceptual relationship. The Sequences items must examine the pattern of change among the stimuli and select the option that fits the pattern. Finally, in the Construction subtest, the examinee determines how several shapes can be combined to produce one of the designs provided in the options (Naglieri & Bardos, 1997). On the current version of the CAS, this subtest is similar to Nonverbal Matrices (Naglieri & Das, 1997a). Other tests considered to be similar to the GAMA are the *Raven's Coloured Progressive Matrices* (Raven, 1956) and Naglieri's (1985) *Matrix Analogies Test*. The GAMA is being used as a Simultaneous task due the similarity of its items with Nonverbal Matrices. The reliability of the GAMA IQ ranges from .79 to .90 (Naglieri & Bardos, 1997).

Attention

Attention tasks require focused, selective, sustained, and effortful activity from an individual (Naglieri, 1999a). Often, these tasks will present a competing stimulus that is as salient as the target stimulus (Naglieri & Das, 1990). Selective attention requires the individual to inhibit responses of certain stimuli while allocating focus towards others. Sustained attention suggests effort varies over time as does performance.

Expressive Attention. This task is a shortened version of the *Stroop Color Word Test* (Golden, 1978; Stroop, 1935) and was modified by Das and Naglieri (1987). It has been used in addition to other experimental tasks that measure the PASS theory of processing (Price, 1987). This task has been found to load high on the Attention factor (Bardos, 1988; Naglieri, Prewett, & Bardos, 1989; Warrick, 1989).

This subtest is divided into three separate tasks. On the first task, the subject simply reads a list of words that are colors (i.e., red, green, yellow, blue) as quickly as possible. During the second task, the subject looks at a page of blocks which are colored, and he or she names the colors as quickly as possible. In the final task, a list of words is presented (i.e., red, yellow, blue, green); however, the words are printed in different colors than the word reads. For example, the word "red" is printed in green color. The subject must name the color the word is printed in as quickly as possible. The examiner records the time needed to read each stimulus and number correct.

Visual Selective. Also known as Number Finding (Das et al., 1994; Maricle, 1994) and Number Detection (Naglieri & Das, 1997a), this task has been described as an attention task (Naglieri & Das, 1990) and supported as so in the research (Warrick, 1989). This task is similar to the *Visual Search and Attention Test* (Trenerry, Crosson, DeBoe, & Leber, 1990) which also requires visual scanning and identification.

The subject's task is to underline numbers on each page that match the stimuli presented at the top of each page. On the first page, the subject is asked to circle the numbers 1, 2, or 3 when it is in printed in bold-faced type and the numbers 4, 5, or 6 when printed in open faced type. On the second page, the subject must again search for numbers that match the stimuli at the top of the page. However, for this portion, the numbers alternate between open and bold faced print in a specific order. There are 15 rows of numbers for each page. This task is timed and the number correct is recorded. The examinee is given 150 seconds to complete each of the items.

This task is similar to Number Detection on the CAS (Naglieri & Das, 1997a); however, on the CAS, items include simply searching for open faced numbers. This portion has been eliminated to make the task more challenging for adults.

Auditory Selective Attention. In this subtest, the participant is asked to listen to a 5-minute tape recording and identify target words from a list of stimulus words. These readings are divided into five one-minute sections. During each minute, the subject is asked to tap his or her hand on the table when a specific word is mentioned by a specific person. Words include types of furniture and types of animals and are read by either a man or a woman. This task was described by Das and colleagues (1994) although it was slightly different. In that description, and man and a woman named colors and fruits and the subject was asked to tap his or her hand when the appropriate combination arose. For this experiment, the number of correct responses, errors, and omissions for each section are recorded. This task was not included on the current version of the CAS (Naglieri & Das, 1997a). The stimuli used for this experimental task was an adaptation from a task by Posner (1970) and is similar to the auditory attention task on the NEPSY (Korkman et al., 1998). The subtest is divided into five one-minute intervals although the tape continues to play throughout and there is no break. The score is recorded for each minute and is comprised of the number of correct responses and the number of errors made.

Successive

This area of the PASS theory requires individuals to arrange things “in a strictly defined order (Luria, 1966, p. 78). The subject often has to reproduce a sequence of events or perform tasks that require events to be performed with linearity (Naglieri & Das, 1990). Successive processing requires immediate verbal recall.

Word Series. This test is similar to the Digit Span subtest of the WISC-IV and WAIS-III (Wechsler, 1997). However, instead of using numbers, Word Series, also known as Word Recall (Das et al., 1994) presents a group of single syllable words to the examinee. Word Series is an immediate verbal memory test. Words are presented at a rate of one per second, and the examinee is asked to repeat the words back to the examiner in the same order in which they were presented. Word groups range from two words to nine words in a series. The test is discontinued when the examinee fails four consecutive items. This is an untimed test, and each set of words is scored correct or incorrect. The examinee must repeat each word in order to receive credit. No partial credit is awarded for some words or all words in incorrect sequence. The raw score is the number of successful strings repeated without error. Although this experimental test uses similar words as are found on the CAS (Naglieri & Das, 1997a), the experimental battery includes more items and more sets of longer stings of words.

This task has been repeatedly shown to load on the Successive factor (Das et al., 1979; Naglieri & Das, 1987; Naglieri et al., 1989). It has been used repeatedly as a Successive task due to the linearity of items (Das et al., 1994).

Sentence Repetition. During this task, the examinee listens to non-meaningful sentences that contain color words instead of content words (e.g., "the red is graying") which become progressively longer. Then the examinee is asked to repeat the sentence back out loud exactly as it was presented by the examiner. This task contains 21 questions, and the examinee is required to repeat the sentence exactly to receive full credit. Again, these sentences are similar to those found on the Sentence Repetition portion of the CAS (Naglieri & Das, 1997a), but the experimental battery includes additional items. The task is discontinued if the examinee fails four consecutive items. The examinee must repeat the sentence back exactly with all of the presented words in the correct order. Again, no partial credit is given and items are scored as 1-correct or 0-incorrect. The raw score is total number of sentences repeated back without error. This test is similar in format to the *Sentence Repetition* test developed by Spreen and Strauss (1991) and in context to the *Silly Sentences* test (Botwinick & Storandt, 1974).

Sentence Questions – Auditory. Research suggests that this subtest loads on the successive factor (Naglieri, Prewett, & Bardos, 1989; Warrick, 1989) and is considered a marker for successive processing (Das et al., 1994). In this task, the examiner presents the same questions as the previous task. However, in Sentence Questions, the examinee is not required to repeat the question again. This time, he or she is asked to answer the question (e.g., "The brown tanned the blue. What did the brown do?" Answer: "Tanned the blue.") Success on this task requires comprehension of the syntax of the sentence. The subject must correctly answer the question to receive credit. The task is discontinued if the examinee fails four consecutive items. Items are scored as 1-correct or 0-incorrect and the raw score is the total number of items answered correctly.

Sentence Questions – Written. The exact same questions from Sentence Questions – Auditory are presented to the participant in written form. The participant must write his or her answer in the space provided. The subject must correctly answer the question to receive credit. The task is discontinued if the examinee fails four consecutive items. Items are scored as 1-correct or 0-incorrect and the raw score is the total number of items answered correctly. Previous studies have not addressed the difference between these subtests when answered in written form versus obtaining and responding in an auditory manner.

Data exist for subtest reliabilities. With regard to the national standardization sample of the CAS (Naglieri & Das, 1997a) with children, there were some discrepancies in the reliability findings. The Planning tasks of the CAS had reliabilities of.75 (Matching Numbers), .82 (Planned Codes), and .77 (Planned Connections) (Naglieri & Das, 1997b). Crack the Code is not a task found on the CAS. The Attention tasks of Expressive Attention and Number Detection (Visual Selective) had reliabilities of .80 and .77, respectively. Auditory Selective Attention is not a subtest of the CAS. Verbal-Spatial Relations and Figure Memory, which are Simultaneous tasks on the CAS, have reliabilities of .83 and .89, respectively. Three of the tasks, Sentence Questions (SQ), Sentence Repetition (SR), and Word Series (WS) are found on the CAS. The reliabilities are .84 (SQ), .84 (SR), and .85 (WS). Sentence Questions on the CAS is the same as Sentence Questions (Aud) on the experimental adult version. Sentence Questions (Written) is not a task on the current version of the Cognitive Assessment System. It needs to be noted that these reliabilities are the result of tasks that have been derived and experimented over several years, and chosen to be on the published CAS battery. The CAS was also normed on a large number of participants, all of them under the age of 18.

Achievement

This study also sought to obtain a measure of achievement from the participants for the purpose of comparing cognitive process scores with academic achievement. In this case, the *Nelson-Denny Reading Test* was used.

Nelson-Denny Reading Test. The Nelson-Denny Reading Test (NDRT; Brown et al., 1993a) is a measure of reading vocabulary and comprehension. The Vocabulary section consists of 80 items, each with 5 answer choices. The Comprehension section contains 7 reading passages for a total of 38 questions, each with 5 answer choices. The NDRT can be administered in approximately 45 minutes. It has been used as a screener for placement decisions and advising situations and has shown limited diagnostic functions. The Nelson-Denny Reading Test is not appropriate for determining the presence of reading disabilities (Brown, Fishco, & Hanna, 1993b).

Nearly 22,000 students from high school, two-year, and four-year colleges comprised the standardization sample. This sample was representative of four geographical regions of the United States and approximated the 1980 US Census (Brown et al., 1993b).

Statistical Procedures and Data Analysis

Descriptive statistics were generated from the adult participants to provide the particular characteristics of the sample population. The data were analyzed with respect to the research questions presented in Chapter I. The research questions and the proposed method for each are provided below.

Q1: What is the factorial structure of the Planning, Attention, Simultaneous, and Successive (PASS) cognitive process tasks with adults?

Exploratory factor analyses was conducted to address this question and to determine whether or not the PASS cognitive processing model can be extended to adults. Both Principle Components Analysis and Maximum Likelihood were used with both orthogonal and oblique rotations and compared with previous studies. It is hypothesized based on previous literature that a four-factor solution will emerge with the tasks grouping on the Planning, Attention, Simultaneous, and Success factors as they did in the *Das-Naglieri: Cognitive Assessment System – Standardization edition*; Das & Naglieri, 1993. However, because the standardization edition was used with children while the current study was with adults, it was unknown beforehand exactly how the tasks would load when administered to an adult population.

Q2: What is the degree to which academic performance can be predicted using the experimental tasks of the PASS model?

Multiple regression procedures were applied to the 14 experimental tasks, the GAMA, four PASS composites, and the Nelson-Denny Vocabulary, Comprehension, Reading Rate, and Total Score. The enter and stepwise methods were used to explore the predictive utility of the PASS tasks and composite areas. In both the enter and stepwise methods, the PASS tasks were used as predictor variables to determine the relationship with the dependent variables of the Nelson-Denny Reading Test (i.e., Vocabulary, Comprehension, Reading Rate, and Total Score).

Detailed descriptions of the statistical procedures used are presented in Chapter IV of this work.

CHAPTER IV

RESULTS

The primary goal of this study was to extend the age range of the PASS theory to adulthood and explore whether some proposed tasks can be utilized to operationalize the PASS theory with an adult population. The second objective was to examine the extent to which the PASS factors predicted academic achievement. This chapter is divided into five sections: (a) descriptive statistics, (b) correlation analyses, (c) factor analyses, (d) regression analyses, and (e) a summary of the statistical results as they relate to the research questions proposed in Chapter III of this study. Statistical analyses were performed using SPSS Version 17 for Windows (SPSS Inc, 2008) statistical software.

Descriptive Statistics

The adult sample consisted of 121 subjects – 53 were male (43.8%), 61 were female (50.4%), and the remaining 7 were of unknown gender (5.8%) due to missing data. The breakdown of gender of participants is displayed in Table 1.

Means and standard deviations of the subject performance across the various tasks suggested a preliminary age trend with five age categories which included participants across: 18-19, 20-30, 31-40, 41-49, and 50 and above years old. As seen in Table 2, the 18-19 group comprised a large number of the participants (n=56, 46.3%) while the 20-30 age group accounted for 51 participants (42.1%). The 31-40 age group had 4 participants

(3.3%), while the 41-49 had only 1 participant (.8%). Finally, the 50 and up category accounted for 2 participants (1.7%). Again, from the archival data, information on the age of 7 participants (5.8%) was unavailable. An analysis of the means of subtests were analyzed by age and no significant differences in performances by age groups were found, excluding the need to analyze task by age groups.

Table 1

Sample Distribution by Gender

Gender	Frequency	Percent
Male	53	43.8
Female	61	50.4
Unknown	7	5.8

Table 2

Sample Distribution by Age

Age	Frequency	Percent
18-19	56	46.3
20-30	51	42.1
31-40	4	3.3
41-49	1	0.8
50 and up	2	1.7
Unknown	7	5.8

Table 3

Cross Tabulation of Age and Gender of Participants

Age	Male	Female	Total
18	12	13	25
19	16	15	31
20	4	10	4
21	7	10	17
22	2	4	6
24	1	0	1
25	2	1	3
26	4	3	7
27	1	1	2
28	0	1	1
33	1	1	2
34	1	0	1
36	0	1	1
42	1	0	1
54	1	1	2
Total	53	61	114

The means, standard deviations, and ranges for the General Ability Measure for Adults (GAMA) are presented in Table 4. The GAMA was used as one of the experimental tasks with adults and the PASS theory. The participants in this study produced slightly higher means and slightly lower standard deviations in the four GAMA subareas than those reported in the GAMA manual for the entire sample (Naglieri & Bardos, 1997). However, this population produced a slightly higher GAMA IQ mean with a smaller standard deviation indicating a possible sampling of slightly above average nonverbal intelligence. This may be due to the large amount of participants being enrolled in college. Additionally, Table 5 displays the means, standard deviations, and ranges for the Nelson-Denny Reading Test used in this study.

The raw score and scaled score means and standard deviations for each of the 14 remaining experimental tasks are presented in Table 6. Raw scores were subsequently converted to standard scores a mean of 10 and a standard deviation of 3 to examine their factorial structure and regression analyses.

Table 4

Means, Standard Deviations, and Ranges for GAMA Subjects and GAMA IQ

GAMA Area	Mean	Standard Deviation	Range
Matching	10.4	2.7	3-15
Analogies	11.9	2.5	5-17
Sequencing	12.1	2.5	5-19
Construction	11.2	2.6	6-18
GAMA IQ	108.3	10.8	71-132

Table 5

Means, Standard Deviations, and Ranges for the Nelson-Denny Reading Test

ND Area	Mean	Standard Deviation	Range
Vocabulary	220.3	21.2	140-258
Comprehension	217.3	19.7	156-250
Reading Rate	201.6	19.6	160-261
Total Score	215.9	24.0	110-257

Table 6

Means, Standard Deviations, and Ranges for Raw Scores of the PASS Tasks

PASS Task	Mean	SD	Range
Matching Numbers	40.0	10.1	15.0-56.4
Planned Codes	10.0	2.1	6.1-22.8
Trail Making	134.3	46.3	63-317
Crack the Code	5.0	2.2	0-10
Verbal Spatial	11.7	3.7	1-17
Design Construction	9.9	2.6	2-12
Figure Memory	17.5	4.9	2-25
Expressive Attention	10.0	2.4	1-13
Visual Selective	20.0	3.7	11.1-40.2
Auditory Selective Attention	53.8	12.7	-2-74
Word Series	14.8	3.8	7-25
Sentence Repetition	12.2	2.6	5-19
Sentence Questions (Auditory)	13.3	3.0	5-20
Sentence Questions (Written)	18.2	2.3	11-21

As shown in Table 7, reliability for the PASS experimental tasks was conducted in one of two ways. First, for test items scored pass or fail, Cronbach's Alpha of internal consistency is displayed. For subtests with multiple pages, split-half reliabilities calculated by the Spearman-Brown formula are displayed. Reliabilities ranged from extremely low ($\alpha = .146$) to acceptable ($r = .789$) (Nunnally & Bernstein, 1994). With regard to the national standardization sample of the CAS (Naglieri & Das, 1997a) with children, there were some discrepancies in the reliability findings. The Planning tasks of the CAS had reliabilities of.75 (Matching Numbers), .82 (Planned Codes), and .77 (Planned Connections) (Naglieri & Das, 1997b). In the adult version, however, the Trail Making task differs somewhat from that of the CAS Planned Connections task (see Chapter 3 for a description). Crack the Code is not a task found on the CAS. The Attention tasks of Expressive Attention and Number Detection (Visual Selective) had reliabilities of .80 and .77, respectively. Auditory Selective Attention is not a subtest of the CAS. Verbal-Spatial Relations and Figure Memory, which are Simultaneous tasks on the CAS, have reliabilities of .83 and .89, respectively. Three of the tasks, Sentence Questions (SQ), Sentence Repetition (SR), and Word Series (WS) are found on the CAS. The reliabilities are .84 (SQ), .84 (SR), and .85 (WS). Sentence Questions on the CAS is the same as Sentence Questions (Aud) on the experimental adult version. Sentence Questions (Written) is not a task on the current version of the Cognitive Assessment System.

Table 7

Alpha and Split-Half Reliability Coefficients for the PASS Tasks

Composite	Task	Reliability Coefficient
Planning Tasks	Matching Numbers	.641**
	Planned Codes	.680**
	Trail Making	.659**
	Crack the Code	.646*
Attention Tasks	Expressive Attention	.763**
	Visual Selective	.425**
	Auditory Selective Attention	.789**
Simultaneous Tasks	Verbal Spatial	.408*
	Design Construction	.577*
	Figure Memory	.576*
Successive Tasks	Word Series	.607*
	Sentence Repetition	.411*
	Sentence Questions (Auditory)	.146*
	Sentence Questions (Written)	.654*

* Alpha
** Split-Half

Correlation Analyses

A variety of correlation analyses were conducted. First, Table 8 contains the inter-correlations of the experimental PASS tasks. Correlations deemed significant at $p < .01$ were many and ranged from weak (.24 to .39) to moderate (.41 to .59). Closer analyses did not reveal consistent patterns among the subtests. The GAMA correlated significantly with all subtests except for Word Series and Sentence Repetition. This finding is interesting because previous studies (Naglieri & Das, 1987; Naglieri, Prewett, & Bardos, 1989) suggest that a Simultaneous task would correlate most highly with Successive tasks than other tasks as both simultaneous and successive processing relate to the coding of information. However, in general, the subtests of each of the PASS areas appeared to correlate well with other subtests of the same area.

To confirm this observation a Pearson Product-Moment correlation was conducted with each of the experimental PASS tasks and the PASS composite area scores. Table 9 displays the means and standard deviations for the four PASS areas. Next, Table 10 presents the Pearson Product-Moment correlations between the experimental tasks and the four PASS areas of Planning, Attention, Simultaneous, and Successive. Due to the fact that a PASS area already contains all subtest scores that make up the area the observed correlations are slightly inflated. However, after examining the relationship between the PASS tasks and PASS areas, in general the tasks correlated highly and significantly with the PASS area to which they belong and correlated weakly and insignificantly to the other areas. As stated in Chapter III, mean score distributions across age were conducted. No significant differences among age were found for any of the tasks, so no partial correlations were conducted.

With the exception of Trail Making, the other Planning tasks correlated moderately (.51 to .69) with the Planning composite area. The correlation between the Attention tasks and the Attention area was moderate to strong (.67 to .78). The Simultaneous tasks and the Simultaneous areas also correlated moderately to strongly (.69 to .75). The strongest group was the Successive, which tasks correlated moderate to strongly (.61 to .80) with the Successive area.

Table 8

Pearson Product-Moment Correlations Among PASS Tasks

	MN	PC	TM	CTC	VS	DC	FM	GAMA	EA	VSel	ASA	WS	SR	SQA	SQW
MN	1.0														
PC	.26**	1.0													
TM	-.19*	-.44**	1.0												
CTC	.28**	.28**	-.13	1.0											
VS	.26**	.11	-.26**	.30	1.0										
DC	.33**	.20*	-.26**	.21*	.32**	1.0									
FM	.24**	.14	-.10	.16	.27**	.36**	1.0								
GAMA	.35**	.29**	-.25**	.46**	.39**	.35**	.41**	1.0							
EA	.39**	.24**	-.14	.18*	.38**	.20*	.10	.37**	1.0						
VSel	.31**	.22*	-.22*	.09	.15	.10	.13	.27**	.30**	1.0					
ASA	.25**	.10	-.19*	-.01	.31**	.12	.15	.27**	.31**	.37**	1.0				
WS	.03	.00	-.15	.08	.37**	.15	.17	.21*	.07	-.11	.11	1.0			
SR	.04	.04	-.24**	.11	.33**	.19*	.13	.12	.04	-.05	.22*	.59**	1.0		
SQA	.13	-.04	-.19*	.12	.47**	.22*	.28**	.27**	.15	.00	.24**	.45**	.51**	1.0	
SQW	.08	.10	-.280**	.23*	.24**	.09	.15	.31**	.20	-.03	.13	.33**	.19*	.30**	1.0

*   p <.05
** p <.01
Note: MN=Matching Numbers; PC=Planned Codes; TM=Trail Making; CTC=Crack the Code; VS=Verbal Spatial; DC=Design Construction; FM=Figure Memory; GAMA=General Ability Measure for Adults; EA=Expressive Attention; VSel=Visual Selective; ASA=Auditory Selective Attention; WS=Word Series; SR=Sentence Repetition; SQA=Sentence Questions (Auditory); SQW=Sentence Questions (Written)

Interestingly, the Trail Making task correlated significantly with the other three PASS areas, but not Planning. In the CAS, Planned Connections, which is similar to Trail Making, correlated moderately with all four PASS areas (Naglieri & Das, 1997b). The GAMA correlated moderately with the other three PASS areas (though correlated the strongest with Simultaneous). Finally, supporting the findings of Naglieri and Das (1987) and Naglieri, Prewett, and Bardos (1989), the Planning tasks correlated with the Attention scale, while the Simultaneous tasks correlated better with the Successive tasks (see Table 11) although Planning had a stronger correlation with Simultaneous than Attention, contrary to what is expected from previous research. The CAS Interpretive Handbook (Naglieri & Das, 1997b) demonstrates that Planning and Attention are more highly correlated than Planning and the Simultaneous or Successive area.

Table 9

Means and Standard Deviations for Raw Scores and Standard Scores of the PASS Composites

	Raw Scores		Standard Scores	
PASS Composites	Mean	SD	Mean	SD
Planning	40.0	5.9	100	15
Attention	29.4	6.5	100	15
Simultaneous	39.5	9.0	100	15
Successive	40.4	9.1	100	15

Table 10

Pearson Product-Moment Correlations Between the PASS Composites and the PASS Experimental Tasks

Task	Planning	Attention	Simultaneous	Successive
Matching Num.	.68**	.42**	.41**	.10
Planned Codes	.51**	.24**	.25**	.03
Trail Making	.15	-.25**	-.30**	-.29**
Crack the Code	.69**	.10	.39**	.18
Verbal Spatial	.19*	.36**	.69**	.45**
Design Const.	.23*	.18*	.71**	.22*
Figure Memory	.25*	.17	.71**	.25**
GAMA	.41**	.40**	.75**	.31**
Expressive Attn.	.33**	.66**	.37**	.15
Visual Selective	.19*	.78**	.23*	-.06
Aud. Sel. Attn.	.07	.78**	.29**	.24**
Word Series	-.03	.02	.31**	.81**
Sentence Repetition	-.04	.10	.29**	.80**
Sent. Ques. (Aud.)	.02	.15	.44**	.80**
Sent. Ques. (Wrt.)	.03	.08	.29**	.62**

*   p <.05
** p <.01

Table 11

Pearson Product-Moment Correlations Between the PASS Composites

Composite	Planning	Attention	Simultaneous	Successive
Planning	1.00			
Attention	.249**	1.00		
Simultaneous	.367**	.386**	1.00	
Successive	.001	.140	.437**	1.00

*   p <.05
** p <.01

The relationship between the PASS experimental tasks and the areas of the Nelson-Denny Reading Test are shown in Table 12. Most of the relationships were weak. However, there were some correlations that were significant at the $p < .01$ level. Crack the Code and Sentence Questions (Written) correlated significantly with Nelson-Denny Vocabulary and Comprehension. There was a significant correlation with the Verbal Spatial task with the Vocabulary, Comprehension, and Total Score. The GAMA, the Sentence Repetition task, and the Expressive Attention task correlated significantly with Comprehension. None of the PASS experimental tasks correlated significantly with Nelson-Denny Reading Rate.

In contrast, as shown in Table 13, all four of the PASS areas correlated significantly with Nelson-Denny Comprehension. Only the Simultaneous and Successive areas correlated significantly with Vocabulary, and none of the PASS areas correlated with Reading Rate or Total Score. These correlations are considered weak to moderate (.23 to .38).

It is important to recognize the limits of the fundamental process of correlations. Although the Pearson-Product Moment correlations give an indication as to the strength of the relationship, be it positive or negative, it cannot be used to imply causation between two variables. Due to the third-variable problem, or tertium quid (Field, 2005), it is impossible to say what may be effecting the value of the correlation. The third-variable problem recognizes the possibility of other measured or unmeasured variables contributing to the results, limiting statisticians from making direct conclusions about correlation.

Table 12

Pearson Product-Moment Correlations of PASS Tasks with the Nelson-Denny Reading Test Scores.

	Nelson-Denny Area			
Pass Task	Vocabulary	Comprehension	Reading Rate	Total Score
Matching Numbers	.10	.16	.12	.02
Planned Codes	.04	.09	.16	-.04
Trail Making	-.17	-.10	-.18*	-.06
Crack the Code	.24**	.34**	.19*	.21*
Verbal Spatial	.32**	.40**	.18*	.34**
Design Construction	.12	.08	.03	.01
Figure Memory	.03	.05	-.02	-.03
GAMA	.19*	.28**	.09	.16
Expressive Attention	.13	.25**	.05	.23*
Visual Selective	.10	.16	.10	.09
Aud. Sel. Attention	.02	.16	.02	.19*
Word Series	.21*	.23*	.06	.12
Sentence Repetition	.17	.33**	.20*	.20*
Sent. Ques. (Auditory)	.23*	.28**	.17	.18*
Sent. Ques. (Written)	.25**	.28**	.18*	.18*

* p <.05
** p <.01

Table 13

Pearson Product-Moment Correlations of PASS Areas with the Nelson-Denny Reading Test Scores.

	Nelson-Denny Area			
Pass Task	Vocabulary	Comprehension	Reading Rate	Total Score
Planning	.10	.24**	.13	.06
Attention	.10	.25**	.07	.22*
Simultaneous	.23**	.28**	.10	.17
Successive	.29**	.38**	.21*	.23*

* p <.05
** p <.01

Factor Analyses

The first purpose of this study was to determine how an experimental battery of PASS tasks with adults would look when subjected to a factor analysis. Until now, the results of statistical procedures have been reported in respect to each experimental PASS task falling under the PASS area that the literature has proven it belongs. For the next section of this paper, the factors to which each experimental task falls will be examined to answer the following research question:

Q1: What is the factorial structure of the Planning, Attention, Simultaneous, and Successive (PASS) cognitive process tasks with adults?

The exploratory factor analysis for this study was conducted first through Principle Components Analysis (PCA). Although PCA and factor analysis are two different statistical procedures, PCA has been deemed psychometrically sound and considerably less complex than factor analysis. PCA provides an exact mathematical transformation of the data (Rummel, 1970) and is deemed the preferable choice for an empirical summary of these data sets (Tabachnick & Fidel, 2007). In PCA, the first component accounts for the largest amount of variance in the sample. The second component then accounts for the next largest amount of variance that is uncorrelated with the first component. Each of the following components then account for less and less of the variance, and all of these components are uncorrelated with each other.

The Keiser-Meyer-Olkin Test of Sampling Adequacy statistic was .76 and Bartlett's Test of Sphericity was significant at less than $p < .01$, indicating that this analysis was appropriate for the data (Pallant, 2001). The results of the Principle Components analysis are presented in Table 14. PCA uses total variance to determine the number of factors that best fit these data. Each component is listed in the first column. The eigenvalue column represents the total variance explained by each factor. The next column indicates the percentage of the total variance that can be attributed to each factor (% of Var). The final column displays the total variance explained by that factor and those that come before it.

As shown in Table 14, 27.1% of the variance is accounted for by one factor in the initial solution. The second factor is responsible for another 13.4% of the variance. A total of 63.6% of the variance is attributable to the first five factors. The remaining 9 factors together accounted for only 34.4% of the variance.

It should be noted that using the Kaiser (1958) criterion of keeping eigenvalues of 1 or larger tends to overestimate the number of factors that should be kept (Fabrigar, Wegener, MacCallum, & Strahan, 1999). Another way of examining these data were by the use of Cattell's (1966) scree test method. Figure 4 presents the Principle Components analysis scree plot. This visual shows a distinct break after the second factor, and a subtle break after the fourth or fifth component, suggesting that four or perhaps five components should be retained.

Table 14

Initial Statistics (Principle Components Analysis)

Component	Eigenvalue	% of Var	Cum %
1	4.063	27.089	27.089
2	2.015	13.433	40.522
3	1.281	8.539	49.062
4	1.161	7.742	56.803
5	1.015	6.769	63.573
6	.838	5.585	69.157
7	.738	4.920	74.077
8	.633	4.219	78.296
9	.615	4.098	82.394
10	.560	3.734	86.127
11	.545	3.635	89.762
12	.465	3.097	92.895
13	.428	2.854	95.713
14	.370	2.466	98.178
15	.273	1.822	100.00

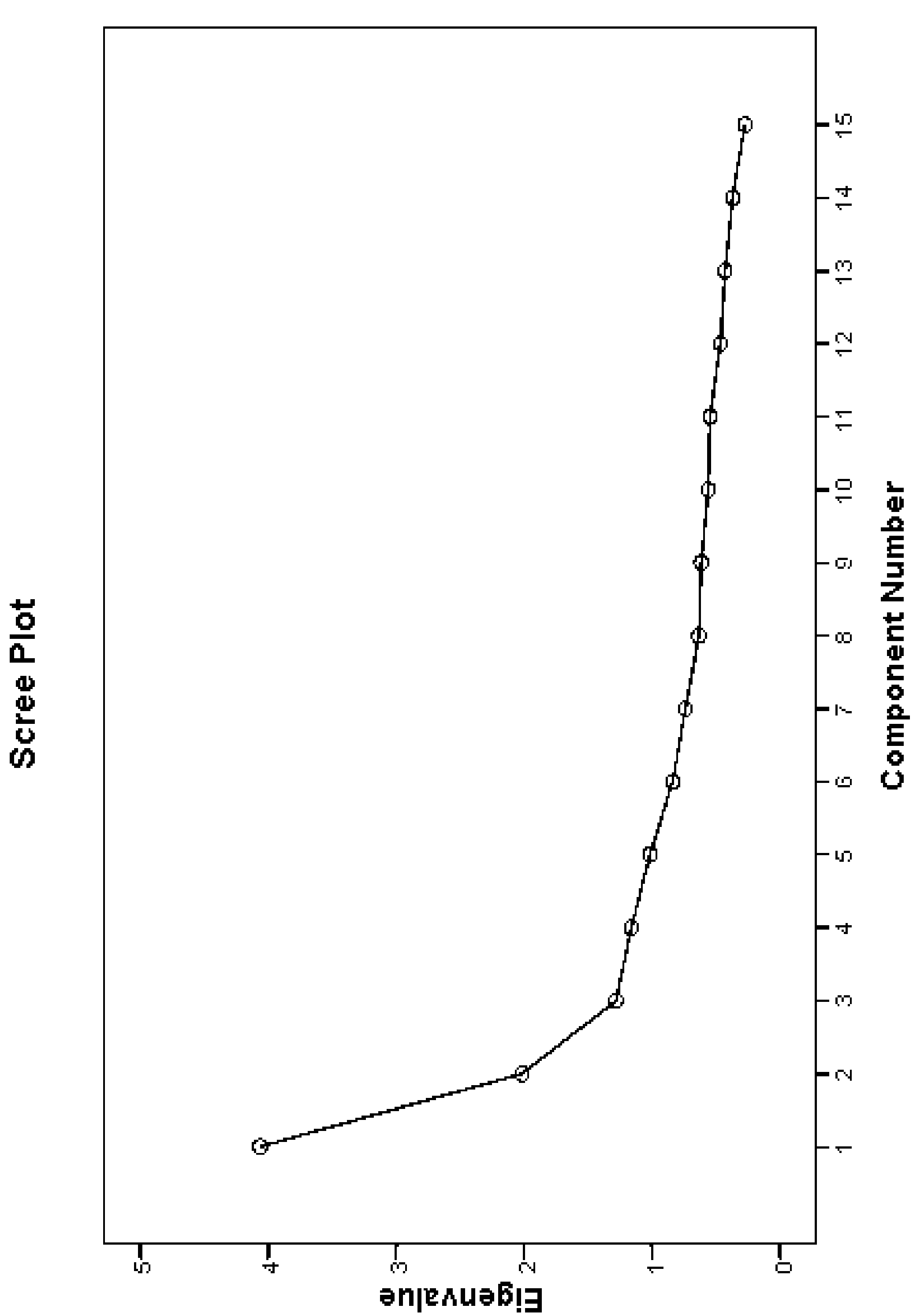

Figure 4. Principle Components Analysis Scree Plot

An orthogonal rotation is appropriate when it is believed that the factors are theoretically independent of one another, and because this was an exploratory study, the first analysis considered the variables as if they truly are independent. Although a Quartimax rotation leads to easier interpretation, it tends to load the variables onto one factor. Therefore, a Varimax rotation, which spreads the strongest loadings onto more factors, was used (Tabachnick & Fidel, 2007). The Varimax rotation was developed by Kaiser (1958). Varimax is a preferred procedure because it tends to load a small number of variables on to one factor, and the factors are made up of a small number of large loading and a large number of zero, or small loadings. Additionally, this form of rotation is simplified because each original variable tends to be associated with one (or a very small number) of factors, and each factor represents only a small number of variables.

Table 15

Total Variance Explained by Five-Factor Varimax Rotation of PCA

Component	Total	% of Var	Cum %
1	2.537	16.915	16.915
2	2.032	13.545	30.461
3	1.763	11.754	42.215
4	1.719	11.458	53.673
5	1.485	9.900	63.573

Table 15 shows that approximately 17% of the total variance is attributed to the first of 5 factors. Factor 2 accounted for 13% of the variance while Factors 3 and 4 accounted for 11.8% and 11.5% of the variance, respectively. Lastly, Factor 5 contributed to 9.9% of the variance. The preceding paragraph describes the composition of tasks within each factor.

Table 16 demonstrates how each of the PASS tasks loaded on 1 of 5 factors as selected by the Kaiser criterion. Factor 1 included the Successive tasks of Sentence Repetition, Word Series, Sentence Questions (Auditory) and Verbal Spatial. Although the other traditionally Successive task of Sentence Questions (Written) loaded on Factor 1, it loaded more heavily on Factor 3. Perhaps Factor 1 can best be described as responding to oral directions.

Factor 2 had the most task loadings (i.e., 6), though only 4 tasks (Auditory Selective Attention, Visual Selective, Expressive Attention, and Matching Numbers) loaded highest on Factor 2. These are traditionally Attention tasks, with the exception of Matching Numbers that has been identified as a planning task in the Das-Naglieri CAS Standardization edition (Das & Naglieri, 1993).

Factors 3, 4, and 5 were more of an eclectic mix of tasks. The GAMA, Sentence Questions (Written), and Crack the Code all loaded most heavily on Factor 3. One similarity of these tasks is that they are all on paper and non-verbal. Factor 4 contained high loadings (.74) for Design Construction and Figure Memory, traditionally Simultaneous tasks. Finally, Planned Codes and Trail Making loaded highly on Factor 5 and not at all on any other factor. Planned Codes and Trail Making also loaded distinctly and alone on a 4th factor across more than one age range of the CAS in exploratory factor analysis (Naglieri & Das, 1997b). Please note that because less than 20 variables were used, loadings were set to be greater than .30 as to ease in interpretation of the loadings (Stevens, 1996).

Table 16

Orthogonal Solution (Varimax) for the Principle Components Analysis of the PASS Tasks for Adults

	Factor				
	1	2	3	4	5
Sentence Repetition	.801				
Word Series	.794				
Sentence Questions (Auditory)	.746				
Verbal Spatial	.506	.360	.355		
Auditory Selective Attention		.755			
Visual Selective		.723			
Expressive Attention		.646	.430		
Matching Numbers		.476		.429	
Crack the Code			.751		
Sentence Questions (Written)	.420		.597		
GAMA		.306	.592	.407	
Figure Memory				.744	
Design Construction				.741	
Trail Making					-.819
Planned Codes					.778

Note: Loadings set to greater than .30

As can be seen in Table 16, several of the PASS tasks load on more than one factor. Because a clean factor structure – a structure where variables load strongly on only one component (Thurstone, 1947) - was not obtained with the Varimax rotation of the Principal Components analysis (which again assumes orthogonality), the next step was to explore the 2, 3, and 5 factor solutions as suggested by the scree plot (Figure 4) and the Kaiser criterion (Table 14). Maximum Likelihood, a statistical method for fitting a model to these data (Joreskof & Lawley, 1968), was conducted to explore these options. A two-factor solution was relatively useless for interpretation. All of the PASS tasks loaded on Factor 1, with the exception of Visual Selective and Planned Codes. No useful interpretations of this structure can be made based on the nature of these tasks compared to others on Factor 1, and literature does not support a two-factor solution. The scree plot (see Figure 4) suggestion of two factors likely underestimates the number of appropriate factors. Because it is preferable to overestimate the number factors rather than underestimate the number (Fabrigar, et al., 1999), this option was discarded.

Because the PASS theory suggests a four-factor solution, based on the scree plot results, 3- and 5-factor solutions were also analyzed. The three-factor solution came closest to representing the four PASS areas. On the first factor, all Successive tasks loaded along with Verbal Spatial – a Simultaneous task. All of the Attention tasks loaded alone on Factor 3. Factor 2 was a combination of the Planning tasks and the Simultaneous tasks (minus Verbal Spatial).

Even though the Kaiser method of eigenvalues over 1 can misrepresent the true number of factors (Fabrigar, et al., 1999), a five-factor solution was explored by conducting a Maximum Likelihood factor analysis (describe later in this chapter). Only three tasks - Sentence Questions (Written), GAMA, and Word Series - loaded on the first factor, and even then, two of the three tasks loaded more strongly on other factors, leaving only Sentence Questions (Written) on Factor 1. The same was true of Factor 4, where only Planned Codes retained its highest loading on this factor. Crack the Code was the only task to load highest on Factor 5. Sentence Repetition, Word Series, and Visual Selective comprised Factor 3, lending little interpretability to this factor (i.e., two untimed Successive tasks and one timed Simultaneous task). The remaining tasks all loaded on Factor 2 and consisted of a blend of the PASS areas. Because a five-factor solution placed one task on each of three factors, three on another, and the rest grouped together, this solution was also discarded for being unhelpful in determining how these tasks relate.

Next, a Maximum Likelihood was conducted by setting the number of factors a priori which is consistent with the PASS theory. The results of the four-factor Maximum Likelihood analyses as suggested by the four PASS areas are presented in Tables 17, 18 and 19. Table 17 presents the results of the Varimax rotation, which provides the orthogonal solution of the Maximum Likelihood factor analysis.

Table 17

Orthogonal Solution for the Maximum Likelihood Factor Analysis of the PASS Tasks

Tasks	Factor I	Factor II	Factor III	Factor IV
Sentence Repetition	.777			
Word Series	.722			
Sent. Ques. (Auditory)	.653			
Verbal Spatial	.446			
Sent. Ques. (Written)	.314			
GAMA		.698		
Crack the Code		.574		
Figure Memory		.430		
Design Construction		.397		
Matching Numbers		.393	.390	
Aud. Sel. Attention			.647	
Visual Selective			.569	
Expressive Attention		.346	.450	
Planned Codes				.758
Trail Making				-.522

Note: Loadings set to greater than .30

As can be seen in Table 17, Successive Tasks (plus Visual Selective) comprised Factor 1 and accounted for 23% of the variance (see Table 18). Next, the GAMA, Figure Memory, and Design Construction (the Simultaneous tasks) load on Factor 2, along with Crack the Code and Matching Numbers (Planning Tasks). This factor accounted for another 10% of the variance. Matching Numbers also loaded on Factor 3, but loaded slightly stronger on Factor 2 and was paired with another Planning task. Factor 3 was comprised of the Attention tasks (Auditory Selective Attention, Visual Selective, and Expressive Attention) and was the only factor to include all and only the same PASS areas. This factor explained only 4.5% of the variance. Finally, Planned Codes and Trail Making alone made up Factor 4 and explained 4% of the variance, bringing the total variance explained by the four-factor solution to 42.5%.

Table 18

Total Variance Explained by Four-Factor Varimax Rotation of Maximum Likelihood

Component	Total	% of Var	Cum %
1	3.485	23.231	23.231
2	1.519	10.125	33.356
3	0.714	4.759	38.115
4	1.719	4.334	42.449

The Keiser-Meyer-Olkin Test of Sampling Adequacy statistic was .76 and Bartlett's Test of Sphericity was significant at less than $p < .01$, indicating that this analysis was appropriate for these data (Pallant, 2001). However, the orthogonal rotation's limitation is that it ignores the reality that two or more of the extracted factors are correlated (Kieffer, 1998). In this case, overwhelming amounts of literature (see Das, Naglieri, & Kirby, 1994; Maricle, 1994; Naglieri & Das, 1997a; Naglieri, Prewett, & Bardos, 1989) suggest that the PASS tasks fall into four distinct areas. Therefore, an oblique solution was also sought for comparison using the Promax rotation which produces relatively efficient oblique solutions. The results of the Promax rotation are presented in Table 19.

The oblique rotation produced a similar factor structure to that of the orthogonal rotation in Table 17. Both the regression coefficient and the correlation coefficient represent the relationship between a variable and a liner model (Field, 2005). Here, the regression coefficient (as found in the pattern matrix) and the correlation coefficient (as found in the structure matrix) were examined and were found to be quite similar. In such cases, the matrix with the most interpretable results are presented, which in this study, was the correlation coefficient (structure matrix). As can be seen in Table 19, the Successive tasks again comprised Factor 1, and Verbal Spatial fell on this factor as well. However, Verbal Spatial – a Simultaneous task on the CAS - loaded nearly as highly on Factor 2 which is where the remaining Simultaneous tasks (GAMA, Figure Memory, and Design Construction) fell. Interestingly, on the current version of the CAS, the Verbal Spatial task loaded on the Simultaneous factor, but the loadings were lowest at young ages and highest at the upper ages. It should be assumed that the loading would only increase into adulthood, but this was not the case. Two Planning tasks, Crack the Code and Matching Numbers, also loaded on Factor 2. Factor 3 remained the Attention tasks of Auditory Selective Attention, Visual Selective, and Expressive Attention. Again, the Planned Codes and Trail Making tasks alone made up Factor 4.

Table 19

Structure Matrix of the Oblique Solution for the Maximum Likelihood Factor Analysis of the PASS Tasks

Task	Factor I	Factor II	Factor III	Factor IV
Sentence Repetition	.775			
Word Series	.728			
Sent. Ques. (Auditory)	.678			
Verbal Spatial	.497	.482	.389	
Sent. Ques. (Written)	.342	.340		
GAMA		.756	.380	
Crack the Code		.585		
Matching Numbers		.456	.449	
Figure Memory		.454		
Design Construction		.440		
Aud. Sel. Attention			.662	
Visual Selective			.605	
Expressive Attention		.415	.502	
Planned Codes		.339		.796
Trail Making				-.544

Note: Loadings set to greater than .30

Both the orthogonal and oblique rotations of the Maximum Likelihood factor analysis produced similar results. However, these results were inconsistent with previous findings. Verbal Spatial did not load highest on the Simultaneous factor, although despite the fact that its highest loading was with the Successive tasks, it did load almost as well with the Simultaneous tasks. The most discrepant of the findings was the Planning tasks of Crack the Code and Matching Numbers. Both of these tasks loaded on a factor with the Simultaneous tasks. Postulations for these differences are explored in Chapter 5.

Regression Analyses

To determine the extent to which the experimental tasks and the composite areas of the PASS model predict achievement in reading, multiple regression analyses were performed. The Nelson-Denny Reading Test was utilized as a measure of reading achievement, and the areas of Vocabulary, Comprehension, Reading Rate, and Total Score were explored. The following statistical analyses were conducted to answer the second research question:

> Q2: What is the degree to which academic performance can be predicted using the experimental tasks of the PASS model?

Multiple regression is an extension of correlations on a regression line, although in the case of multiple regression the value of one variable can be predicted by two or more variables (Brace, Kemp, & Snelgar, 2006). Both the enter and stepwise methods were used in this study. In the enter, or simultaneous method, the entire set of predictor variables enter the equation at once. Each variable is then evaluated as if it entered the equation after all the other predictor variables had been entered. On the other hand, in the stepwise regression procedure, the independent variables are entered into the equation on the basis of its correlational strength with the dependent or criterion variable. The remaining variables are then examined, and based on their correlations, the variable with the highest partial correlation is inserted into the equation. This process continues until the remaining variables fail to provide a significant contribution to the regression equation.

Tables 20 and 21 display the enter and stepwise regression analyses for the PASS tasks with the areas of the Nelson-Denny Reading Test (Vocabulary, Comprehension, Reading Rate, and Total Score). Criterion in the left column is the Nelson-Denny area being predicted. The next column (Predictor) represents the PASS tasks that are predicting the Nelson-Denny area. In the third column (B), is a measure of how strongly each predictor variable influences the criterion variable. The standardized equivalent of B, Beta, is presented in the fourth column. The T indicates if the B-Value differed significantly from 0. Below each section is an R^2 value. Within the multiple regression process, the coefficient of determination (known as the R-squared value) is used to explain the amount of variance in one variable that is accounted for by another. This value represents the amount of variance in the criterion variable that is accounted for by the model.

According to the enter regression procedure displayed in Table 20, the total variance explained by the PASS tasks consisted of 18.9% for Vocabulary, 32.6% for Comprehension, 15.2% for Reading Rate, and 21.8% for the ND Total Score. The stepwise regression analysis found in Table 21 determines which individual variables contribute the most to the prediction of the criterion variables. Apparent from Table 21, 13.4% of the variance of Vocabulary was attributable to Verbal Spatial and Sentence Questions (Written). This was significant at the $\underline{p} < .01$ level. Three tasks combined to explain 25.7% of the variance in Comprehension – Verbal Spatial, Crack the Code, and Sentence Repetition – also significant at the $\underline{p} < .01$ level. Only 4% of the variance in

Reading Rate was explained by Sentence Repetition ($p < .05$). And finally, Verbal Spatial accounted for 11.6% of the variance of the Nelson-Denny Total Score ($p < .01$).

Table 20

Enter Regression Analyses for the PASS Tasks with the Nelson-Denny Reading Test Areas of Vocabulary, Comprehension, Reading Rate, and Total Score

Criterion	Predictor	B	Beta	T
Vocabulary	Matching Numbers	.012	.002	.016
	Planned Codes	-.490	-.064	-.600
	Trail Making	-.413	-.059	-.541
	Crack the Code	1.010	.133	1.237
	Verbal Spatial	1.515	.222	1.893
	Design Construction	.133	.020	.194
	Figure Memory	-.700	-.104	-1.010
	GAMA	.020	.003	.024
	Expressive Attention	-.129	-.014	-.132
	Visual Selective	.928	.138	1.333
	Aud. Sel. Attention	-.951	-.140	-1.336
	Word Series	.408	.061	.510
	Sentence Repetition	.152	.022	.180
	Sent. Ques. (Auditory)	.458	.069	.594
	Sent. Ques. (Written)	1.085	.150	1.458

$R^2 = .189$, $F(15,105) = 1.64$

Criterion	Predictor	B	Beta	T
Comprehension	Matching Numbers	.049	.008	.079
	Planned Codes	-.006	.000	-.008
	Trail Making	.752	.115	1.163
	Crack the Code	1.366	.193	1.971
	Verbal Spatial	1.583	.249	2.331*
	Design Construction	-.521	-.084	-.896
	Figure Memory	-.698	-.111	-1.185
	GAMA	.423	.067	.607
	Expressive Attention	.560	.067	.677
	Visual Selective	.865	.138	1.464
	Aud. Sel. Attention	-.264	-.042	-.437

(table continues)

Table 20 (continued)

	Word Series	-.379	-.061	-.559
	Sentence Repetition	1.814	.281	2.542*
	Sent. Ques. (Auditory)	.147	.024	.225
	Sent. Ques. (Written)	1.129	.168	1.787

$R^2 = .326$, $F(15,105) = 3.39$, $p < .01$

Reading Rate	Matching Numbers	.530	.082	.759
	Planned Codes	.757	.107	.977
	Trail Making	-.225	-.035	-.312
	Crack the Code	.652	.093	.842
	Verbal Spatial	.871	.137	1.148
	Design Construction	-.418	-.068	-.643
	Figure Memory	-.705	-.113	-1.073
	GAMA	-.234	-.037	-.301
	Expressive Attention	-.736	-.088	-.797
	Visual Selective	.652	.105	.988
	Aud. Sel. Attention	-.670	-.106	-.993
	Word Series	-.945	-.152	-1.247
	Sentence Repetition	1.306	.204	1.638
	Sent. Ques. (Auditory)	.610	.099	.853
	Sent. Ques. (Written)	1.005	.150	1.425

$R^2 = .152$, $F(15.105) = 1.25$

Total Score	Matching Numbers	-.972	-.123	-1.184
	Planned Codes	-1.094	-.126	-1.203
	Trail Making	.127	.016	.150
	Crack the Code	1.500	.174	1.649
	Verbal Spatial	2.062	.266	2.314*
	Design Construction	-.520	-.069	-.681
	Figure Memory	-.789	-.103	-1.022
	GAMA	.101	.013	.111
	Expressive Attention	1.372	.135	1.264
	Visual Selective	.373	.049	.481
	Aud. Sel. Attention	.656	.085	.838
	Word Series	-.599	-.079	-.672
	Sentence Repetition	1.190	.152	1.270
	Sent. Ques. (Auditory)	-.160	-.021	-.186
	Sent. Ques. (Written)	.749	.091	.904

$R^2 = .218$, $F(15,105) = 1.96$, $p < .05$

* $p < .05$

Table 21

Stepwise Regression Analyses for the PASS Tasks with the Nelson-Denny Reading Test Areas of Vocabulary, Comprehension, Reading Rate, and Total Score

Criterion	Predictor	B	Beta	T
Vocabulary	Verbal Spatial	1.874	.274	3.105**
	Sent. Ques.(Wrt)	1.342	.185	2.102*
R^2 = .134, F(2,118) = 9.11, p <.01				
Comprehension	Verbal Spatial	1.647	.259	2.953**
	Crack the Code	1.695	.240	2.878**
	Sentence Repetition	1.407	.218	2.590*
R^2 = .257, F(3,117) = 13.52, p <.01				
Reading Rate	Sentence Repetition	1.282	.200	2.225*
R^2 = .040, F(1,119) = 4.95, p <.05				
Total Score	Verbal Spatial	2.638	.340	3.946**
R^2 = .116, F(1,119) = 15.573, p <.01				

* p < .05
** p < .01

A multiple regression was also conducted with the PASS composite areas and the Nelson-Denny areas. For the purposes of this study, the experimental tasks were grouped according to the literature pertaining to factor analysis of the PASS tasks. The following groupings were used: Planning – Matching Numbers, Planned Codes, Planned

Connections, Crack the Code; Attention – Expressive Attention, Visual Selective, Auditory Selective Attention; Simultaneous – Design Construction, Figure Memory, Verbal Spatial, and the GAMA; Successive – Word Series, Sentence Questions (Aud), Sentence Questions (Wrt), Sentence Repetition. The factor analysis confirmed some of these groupings although a few tasks did not load best on the areas above. A limitation of this study is that the theoretical PASS areas – not those determined by the factor analysis – were used to conduct the multiple regression analysis.

The enter method results are displayed in Table 22. The PASS areas only explained 10% of the variance of the Vocabulary tests ($p < .05$). However, 21.7% of the variance of Comprehension was explained by the PASS areas ($p < .01$). The amount of variance explained by the PASS areas for Reading Rate was not significant. Finally, 8.9% of the variance in Total Score was explained by the PASS areas at the $p < .05$ level. As has been found with IQ, Comprehension has a higher association with IQ – in this case cognitive processing – with older individuals compared to young children (Fuchs & Young, 2006).

Table 23 displays stepwise regression analyses for the PASS composite areas and the Nelson-Denny areas. The Successive area was a clear contributor. Of the variance in Vocabulary, 8.4% was explained by the Successive area ($p < .01$). For Comprehension, 19.6% of the variance was accounted for by the Successive and Planning areas ($p < .01$). The Successive and Attention areas contributed 8.9% of the variance in Total Score ($p < .01$). The Successive area attributed 4.3% of the variance in Reading Rate at the $p < .05$ level.

Table 22

Enter Regression Analyses for the PASS Composites with the Nelson-Denny Reading Test Areas of Vocabulary, Comprehension, Reading Rate, and Total Score

Criterion	Predictor	B	Beta	T
Vocabulary	Planning	.121	.055	.589
	Attention	.042	.020	.208
	Simultaneous	.199	.094	.836
	Successive	.521	.246	2.463*
R^2 = .100, F(4,116) = 3.22, p <.05				
Comprehension	Planning	.407	.200	2.202*
	Attention	.295	.149	1.664
	Simultaneous	-.010	-.005	-.046
	Successive	.704	.357	3.833**
R^2 = .217, F(4,116) = 8.02, p <.01				
Reading Rate	Planning	.302	.149	1.503
	Attention	.064	.033	.334
	Simultaneous	-.144	-.073	-.638
	Successive	.459	.234	2.294*
R^2 = .063, F(4,116) = 1.951				
Total Score	Planning	.018	.007	.073
	Attention	.447	.186	1.922
	Simultaneous	.011	.005	.041
	Successive	.489	.203	2.026*
R^2 = .089, F(4,116) = 2.83, p <.05				

* p < .05
** p < .01

Table 23

Stepwise Regression Analyses for the PASS Composites with the Nelson Denny Reading Test Areas of Vocabulary, Comprehension, Reading Rate, and Total Score

Criterion	Predictor	B	Beta	T
Vocabulary	Successive	.614	.290	3.301**
R^2 = .084, F(1,119) = 10.896, p <.01				
Comprehension	Successive	.741	.376	4.551**
	Planning	.479	.235	2.849**
R^2 = .196, F(2,118) = 14.428, p <.01				
Reading Rate	Successive	.405	.206	2.300*
R^2 = .043 F(1,119) = 5.292, p <.05				
Total Score	Successive	.493	.205	2.309*
	Attention	.455	.190	2.136*
R^2 = .089, F(2,118) = 5.75, p <.01				

* p < .05
** p < .01

Summary

The results presented in this chapter will be summarized in respect to the research questions presented in Chapter 1.

> Q1: What is the factorial structure of the Planning, Attention, Simultaneous, and Successive (PASS) cognitive process tasks with adults?

The results of a Principle Components analysis suggested that two or three factors (by scree plot) or five factors (by the Kaiser criterion of egienvalues) are present. Each of these options were rejected because they were not interpretable. A four-factor solution was discussed in regards to previous factor analytic studies (Naglieri, Braden, & Gottling, 1993; Naglieri, Welch, & Braden, 1994; Naglieri, Das, Stevens, & Ledbetter, 1991; Naglieri, Prewett, & Bardos, 1989) and the theoretical model. However, the factor structure was somewhat different than previous findings. In previous studies (Naglieri, Das, Stevens, & Ledbetter, 1991; Naglieri, Prewett, & Bardos, 1989; Warrick, 1989) the Planning and Attention tasks separated into distinct factors. Although the Planning and Attention tasks separated in this study, the Planning tasks did not remain together on a single factor. The Attention tasks alone factored together while the Successive tasks also formed their own factor but included Verbal Spatial (a Simultaneous task). Two Planning tasks comprised a factor without interference of other tasks, but a mix of Simultaneous and Planning tasks composed the final factor. Among experimental studies with adults (Miracle, 1994), this study had more success in keeping the Successive and Attention tasks together, but less in grouping the Planning and Simultaneous tasks on distinct factors. When considering a battery of tasks for use with adults, tasks in the Planning and Simultaneous areas that did not load together on single factors need to be reexamined. It is possible that some of these tasks that have historically been found to load on specific factors with children will not fit when used with adults.

Q2: What is the degree to which academic performance can be predicted using the experimental tasks of the PASS model?

Several of the PASS experimental tasks were able to predict reading achievement on the Nelson-Denny Reading Test areas. Verbal Spatial and Sentence Questions (Written) significantly predicted Vocabulary, while Verbal Spatial, Crack the Code, and

Sentence Repetition predicted Comprehension, and Verbal Spatial alone predicted Total Score. Sentence Repetition also predicted Reading Rate. The four PASS areas were also used to predict reading achievement. The Successive area significantly predicted Vocabulary, as did the Successive and Planning areas for Comprehension, while the Successive and Attention areas significantly predicted Total Score. The Successive area also predicted Reading Rate.

CHAPTER V

DISCUSSION

This chapter reviews the intent of this study and summarizes the major findings while suggesting implementation of the results. A discussion of the limitations is then presented along with suggestions for future research and practice.

Intent

The history of intelligence testing is long and heavily researched. In the last 100 years, numerous theories and methods of assessing intelligence have been tried and revised. In that time, research has examined the constructs of intelligence measures and their usefulness in the real world by how they predict a variety of areas from academic achievement to job performance. Traditionally, the relationship between intelligence and academic achievement has been moderate (Matarazzo, 1972), yet intelligence quotients have played a major – and possibly inappropriate - role in the identification of learning disabilities (Fuchs and Young, 2006; Rispens, et al., 1991; Siegel, 1988, 1989a, 1989b). If intelligence tests include achievement-like subtests, then a discrepancy between intelligence and achievement makes it difficult to identify the underlying skills and processes which are lacking. Similarly, traditional measures have also failed to fuel interventions (Vellutino et al., 1996; Vellutinoet al., 2003), calling for a need to use alternative forms of assessment when investigating academic problems.

An investigation of the Planning, Attention, Simultaneous, and Successive theory (PASS; Naglieri & Das, 1988) based on historical neuropsychological studies (Luria, 1966, 1973, 1980) suggests that a series of cognitive processes can replace the term intelligence and better serve in identifying cognitive strengths and weaknesses as well as fuel interventions. Over 20 years of research and application have led to the current study. Although the volumes of research are plentiful on the utility of the PASS theory, few studies have investigated the usefulness of this theory with adults. This study's purpose was to determine the answers to two questions in regard to the PASS area and adults. First, would a series of experimental PASS tasks provide a similar factor structure as has been historically found with children? Second, would these PASS areas do an adequate job of predicting reading achievement?

Summary of the Study

This study examined the performance of 121 adults, 53 males (43.8%) and 61 females (50.4%) (7 participants were of unknown gender), on an experimental battery of the 4 cognitive processing components (Planning, Attention, Simultaneous, and Successive) PASS tasks. Participants ranged in age from 18 to 54 and completed 15 experimental tasks along with the Nelson-Denny Reading Test as a measure of academic achievement. Many of the PASS tasks were administered individually, although several experimental tasks and the reading measure were administered in a group format. Factor analyses were conducted to determine the grouping of experimental PASS tasks, and a series of multiple regression analyses examined the relationship between cognitive processing and academic achievement.

Principle Components analysis was initially used to examine the factor structure of these data. Based on the scree plot, a two-factor solution was suggested as well as the possibility of a four- or five-factor solution. According to the eigenvalues, a five-factor solution was also produced. Both of these suggestions were discarded because they did not yield an interpretable solution. In addition, a three-factor solution was examined and found to be closest to the traditional PASS theory of 4 factors, although the Planning and Simultaneous tasks were mixed together, contrary what has been established in previous cases (Naglieri & Das, 1997b).

Maximum Likelihood factor analysis (Joreskof & Lawley, 1968) was used to extract a four-factor solution according to the PASS theory and previous studies (Naglieri et al., 1993; Naglieri, Welch, & Braden, 1994; Naglieri et al, 1991; Naglieri et al., 1989). Both orthogonal and oblique rotations were conducted and compared to a prior study of the PASS theory with adults (Maricle, 1994). The oblique rotation was appropriate due to the interrelated nature of the theoretical model (Das et al., 1979; Das et al., 1994; Naglieri et al., 1989) while an orthogonal solution provided comparison with previous factor analytic studies (Naglieri et al., 1991; Warrick, 1989).

The factor structure produced was similar to previous studies (Das et al., 1994; Maricle, 1994; Naglieri & Das, 1997a; Naglieri et al., 1989) although provided an entirely unique loading. A Planning factor and an Attention factor were clearly delineated in the sense that these two factors held only Planning tasks or Attention tasks, although the Planning factor only had two tasks (Trail Making and Planned Codes) on it where as the other two Planning tasks (Crack the Code and Matching Numbers) were mixed with the Simultaneous tasks. A Successive factor emerged with all of the

Successive tasks but with the addition of one task that was traditionally viewed as Simultaneous task. Verbal Spatial loaded with the Simultaneous tasks although it loaded highest with the Successive tasks. The Simultaneous factor was a mix of Simultaneous tasks with the addition of a task that was traditionally viewed as a Planning task. Matching Numbers loaded with the Simultaneous tasks, as did Crack the Code. Compared to Maricle's (1994) findings, a similar factor structure was produced with regard to the Successive and Attention factor. Maricle found two Attention Tasks to load on the Planning factor. The current study was more successful in having a clear Attention factor and a mostly Successive factor. This findings indicate that although various PASS tasks support a four-factor model in adults, a consistent battery of tasks have yet to emerge as worthy of future exploration of the utility of a PASS model with adults.

A closer analysis of the tasks warrants consideration. Planned Codes and Trail Making clearly loaded alone on a Planning factor, just as all of the Attention tasks loaded together on what would be called an Attention Factor, and the Successive tasks also grouped together on their own factor. However, Verbal Spatial, a task that should load on the Simultaneous factor (Naglieri & Das, 1990), loaded highest with the Successive tasks. Perhaps the requirement for the examinee to follow the order of directions makes this task look like a Successive task. Verbal Spatial also loaded nearly as high on the factor with the remaining Simultaneous tasks, which is similar to how the task loads on the current version of the CAS (Naglieri & Das, 1997b).

The two Planning tasks of Crack the Code and Matching Numbers loading on the Simultaneous factor was troublesome. Clearly, the literature supports Matching Numbers as loading on the Planning factor (Naglieri & Das, 1989; Naglieri et al., 1991). However, Crack the Code was also supposed to be a Planning task (Das et al., 1994). Perhaps a reasonable explanation for loading comes from the differences in the researched task as compared to the task of the same name in the current study. In the previous study, colored chips were used, and a planning strategy was needed to uncover the correct pattern of chips. The current study required that the examinee use a paper and pencil to solve the problem, possibly requiring reading skills and other approaches. The definition of Simultaneous processing may provide rationale for the factor loading of Crack the Code - "A mental process by which the individual integrates separate stimuli into a single whole or group" (Luria, 1973; Naglieri & Das, 1997b, p. 4). Examinees have to determine the order of shapes by utilizing clues in Crack the Code. Contrary to the game-like version (Das et al., 1994) where the examinee would select a strategy to solve the problem, in the current study the advice to help solve the task was given already. This task is an example of using parts of a problem (i.e., suggestions) to find the whole (i.e., order of shapes), which is closest to a Simultaneous task, which may explain why the task loaded higher with other Simultaneous tasks than it did the Planning tasks. Despite the difference in factor loadings, a four-factor solution continues to be the most interpretable among PASS task performance with children, adolescents, and adults.

Stemming from Maricle (1994), this study upheld a four-factor solution for experimental PASS tasks with adults. However, like Maricle (1994), the PASS experimental tasks did not load on to factors as predicted by the childhood model (Das & Naglieri, 1987, 1993; Naglieri & Das, 1997a). This suggests that although the PASS tasks appear to load on similar factors when administered to both adults and children, a "clean" loading with adults has yet to be achieved. Until a group of tasks can be assembled that have high reliability and follow the Planning, Attention, Simultaneous, and Successive structure, further exploration is needed with experimental tasks and adults.

The history of the Planning, Attention, Simultaneous, and Successive processes predicting academic achievement, specifically in the areas of reading and math, is extensive (Bardos, 1988; Crawford, 2002; Hald, 2000; Kirby & Das, 1977; Naglieri & Das, 1987, 1990; Naglieri & Gottling, 1995; Naglieri & Johnson, 2000; Naglieri & Rojahn, 2004; Powell, 1999). Yet, only a few studies (Maricle, 1994; Wachs & Harris, 1986) have examined the correlations between the PASS components and academic achievement in adult populations.

Correlational analyses suggest a relationship among specific PASS areas and reading domains. First, the PASS areas all significantly correlated with the Comprehension area, supporting Fuchs and Young's (2006) claim that "intelligence" or rather as measured here, cognitive processing in adults, is related to comprehension. This finding suggests that comprehension in adults is more closely linked to cognitive processing skills than IQ is to early reading skills such as phonological processing in young children. Regression analysis of the PASS tasks together show that Comprehension was the only area significantly predicted by this experimental battery. The PASS tasks are able to explain variance in Comprehension scores, but not the other Nelson-Denny areas. Individually, Verbal Spatial was the task which contributed the most in terms of predictive utility for the Vocabulary and Comprehension areas.

With respect to Reading Rate, Sentence Repetition was the only experimental PASS task to predict this area. However, it is essential to note that Sentence Repetition had one of the lowest internal consistency reliability coefficients. Without adequate reliability, conclusions about how useful this particular experimental task is in predicting the reading rate of adults are limited.

The results of this study suggest that the PASS areas provide adequate prediction of academic achievement in adults as measured by the areas of the Nelson-Denny Reading Test. Previous indicators have shown that around 25% of the variance in reading scores is attributable to IQ (Matarazzo, 1972). Because the PASS tasks do not use achievement-like subtests, the relationship between PASS areas and achievement scores are often more meaningful than other tests which do include achievement-like tasks. A similar correlation on tasks with achievement-like tasks and a PASS battery would indicate that in the PASS battery, this correlation is actually an artifact of the relationship between academic skills and underlying cognitive processes and not an overlap between what is being measured as "intelligence" and what is truly an academic skill.

This study found that the PASS experimental tasks accounted for about 22% of variability in Comprehension, which is comparable to Matarazzo's (1972) findings. It appears that a battery of experimental PASS tasks can serve as an adequate predictor of reading comprehension in adults. Although the PASS tasks examined here did nearly as good of a job predicting reading comprehension skills in adults, 78% of the variance in comprehension is still attributable to other factors. Further exploration in the selection of PASS tasks with adults is needed to determine if more variability in reading comprehension, and other components of reading, can be explained by a cognitive processing model.

The Successive area also significantly correlated with all of the Nelson-Denny Reading Test areas as was expected, given the research indicating the role of the Successive area in reading achievement (Crawford, 2002; Kaufman & Kaufman, 1983; Naglieri & Das, 1987, 1990). Regression analyses indicated that the Successive area was key in predicting the various components of reading. The Successive area alone predicted Vocabulary while the Successive and Planning areas predicted Comprehension scores. The Successive and Attention areas predicted Total Score while the Successive area also predicted Reading Rate.

The Successive cognitive processing area has been found to be highly related to reading ability. Students with reading disabilities perform lowest on Successive processing tasks (Crawford, 2002; Kirby et al., 1996; Naglieri & Das, 1987, 1990). Because the Successive area was found in every model that significantly explained variance among the Nelson-Denny reading areas, this study supports previous findings suggesting the importance of Successive processing skills in reading performance for adults as it does for children. However, due to the interrelated nature of the PASS areas, the other composite areas (i.e., Planning, Attention, and Simultaneous) contribute some variability to reading skills.

Limitations

Wechsler (2007) cites limitations in selecting tests for both adult and child measures. One example of a test used with children and adults is a task known as digits forward. In this task, the examinee repeats a string of digits spoken by the examiner.

The string of digits becomes increasingly longer over time. It has been used repeatedly on measures of intelligence. After repeating 6 or 7 digits, further success on the test has a "negligible correlation" with performance, and even then, it is among the poorest predictors of intelligence. Wechsler also cites processing speed as perhaps an inadequate predictor of intelligence in adult populations. An additional stonewall is that with some subtests, adult subjects are able to answer every question or respond to nearly every item in a subtest correctly. This was true of Sentence Questions (Written) and Design Construction in this study. When constructing a test battery for adults, careful consideration needs to be given to the selection of items. The author must determine which items to illuminate because they are too easy for adults as well as add items to increase the ceiling potential of the task. Whenever a task is altered, the author risks changing enough of the task so that it no longer maintains the same factor loading as the test with children produced. In this study, it is postulated that Crack the Code was altered enough from its original form that it became a Simultaneous task instead of a Planning task.

A major limitation of this study was the representativeness of the sample. Since the sample was voluntary rather than random, generalizability of the findings might be appropriate for a pilot project but need to be judged accordingly. Originally, the intent of the researcher was to broaden the scope of the population by including participants of ages beyond traditional college age. However, convenience sampling proved to provide easier access to participants in the 18-22 age range. Many of the participants were accessed from the undergraduate psychology department subject pool. Others volunteered through undergraduate classes or athletic teams. Resources to collect participants outside of the university setting were limited. In order to determine if the small amount participants in the age range of 30-50 provided different scores than those of the 18-29 group, an analysis of mean scores was conducted, and the scores on subtests did not differ significantly across age. Although scores across age ranges were not different for older participants, the large number of participants of traditional college age (18-22) weights the findings somewhat toward the younger population.

Because the factor analyses did not produce exactly the same loadings of the tasks as found in previous research, a limitation exists in using those PASS areas to predict reading achievement. The PASS tasks were placed in their respective PASS composite areas based on the literature in order to conduct the regression analyses, and this was determined prior to running the factor analysis. In this study, the Planning composite area was comprised of four tasks, for example. However, after the factor structure, only two tasks remained loaded together. Therefore, the findings can say that the traditional Planning tasks as defined by the literature predict reading achievement to a certain extent, but Planning as defined in this study has not been used to predict academic achievement. Future studies will be needed to determine the factor loadings of these and alternative tasks, as well as using the findings from factor studies to form PASS areas to predict achievement.

The population examined in this study had a slightly higher IQ as measured by the GAMA than would be expected in the general population. Although scores ranged from 71 to 132, the mean IQ score was 108, suggesting delimitation in drawing conclusions to populations with differing cognitive abilities. Similarly, there was a wide range of scores for the PASS areas.

Finally, the reliabilities of the PASS experimental tasks ranged from extremely low ($\alpha = .146$) to acceptable ($r = .789$) (Nunnally & Bernstein, 1994). Although slightly lower reliabilities might be found in an exploratory study, several tasks (such as Sentence Repetition and Sentence Questions (Auditory) were extremely low. Future studies would need to assess tasks that can provide adequate reliability coefficients for decision making. PASS experimental tasks that fail to provide adequate reliability with adult populations will need to be excluded.

Suggestions for Future Research

There are several steps to be taken with regard to the PASS theory and adults. First and foremost, a reliable battery of tasks that fit the theoretical factor structure of the PASS theory need to be normed on a large sample of participants. This battery needs to improve on the reliability coefficients revealed in this study and determine which tasks are adequate for adult populations. Also, a proposed experimental battery needs to be normed on participants of a variety of ages. Once a concrete battery of tasks has been established, numerous studies will be able to utilize a PASS battery with adults, from academic achievement, to discriminating among groups of people with various disabilities, and on to prediction of job performance.

In the past, a major component of intelligence tasks has been how they predict performance on academic achievement measures. One of the areas of largest research is that of intelligence and reading; however, traditional measures of intelligence have been found to be poor predictors of reading response-to-instruction in children (Stuebing, Barth, Molfese, Weiss, & Fletcher, 2009). In this study, a cognitive processing approach used the PASS composite areas to examine prediction of reading achievement in the

Vocabulary, Comprehension, and Total Score of the Nelson-Denny Reading Test with an adult population and found the PASS tasks and composite areas to provide adequate prediction to the comprehension component of reading. However, this study only examined reading for the achievement measure. It would be preferable to use a more current and comprehensive measure of achievement to determine how the PASS cognitive processing skills of adults are related to all areas of achievement - not just reading skills. After all, studies have examined the relationship of the PASS areas and mathematics, writing, attention, and giftedness in children. More work is needed to examine the relationship of the PASS tasks and other academic and non-academic domains in adults.

With a response-to-intervention model dictating a more problem-solving approach in schools, intelligences tests have taken a backseat to observational data and research-based intervention implementation. However, it is worth considering that a response-to-intervention approach is not used often, if at all, in post-secondary schooling, and may never be used as a way to problem-solve academic problems for adults. Therefore, future research would be beneficial in looking at how a cognitive processing model with adults could serve as an alternative to traditional methods of assessment in college-age and non-traditional adult students. While traditional intelligence tests have been criticized for failing to fuel interventions (Vellutino et al., 1996; Vellutino et al., 2003), the PASS theory has demonstrated using cognitive processing scores to inform the selection of interventions in math (ex., Hald, 2000), reading (ex. Crawford, 2002)., writing (ex., Johnson, 2001), and in other areas such as ADHD (ex., Lerew, 2000) and giftedness (ex., Pelletier, 1996), as well as with adult populations (ex., Macdonald, 1994; Maricle, 1994).

If measures of “ability” continued to be relied on to inform educational decisions in a university setting, it seems rational that a test of cognitive processing that can provide suggestions for remediating an academic or behavioral deficit replace traditional tests.

Similarly, a cognitive processing approach, such as the PASS theory, may be even more useful in predicting job performance than more traditional intelligence tests. Traditional measures of intelligence have not been used extensively to help in career exploration or prediction of job performance (Harrison et al., 1988). When they have, results suggest that IQ is not a strong predictor of job performance (Ghiselli, 1966, 1973; Hunter, 1986; Jenson, 1980). These findings beg the question of what can be done better to inform occupational decision making. Because the PASS areas are built on Luria’s (1966, 1973, 1980, 1982) units of the brain, more information about how problems are solved may help identify better indicators of future occupational preference. Would a test of cognitive processing provide more useful information about a candidate’s potential to apply certain skill areas to a task? Exploration of a PASS battery with adults could answer this question. With PASS profiles that have been obtained from workers in various professions, useful information may be garnered as a result of understanding which specific processes are being put to work in various professions. This may allow employers to help select candidates for jobs or promotions. Again, this line of inquiry can only be undertaken with the establishment of a reliable, well-normed battery of PASS tasks in the adult population.

Conclusion

This study set out to determine first and foremost if a battery of experimental PASS tasks given to an adult population would maintain the same theoretical factor structure as the published version used with children. Evidence suggests that these tasks still fit best on a four-factor model, although a consistent loading of tasks has yet to be established with an adult population as it has with child participants. In addition, the PASS tasks and composite areas demonstrated some success in predicting the scores of a reading test, and comprehension appears to be the reading area that is best predicted by PASS tasks and composite areas. Future research is needed to help develop a reliable battery of tasks that best fit the PASS theoretical model and contribute to the prediction of academic areas.

A battery of PASS tasks could prove very useful with an adult population. Because the PASS model goes beyond merely the assessment of cognitive processes and provides information on how to best remediate cognitive processing deficits (Das, Naglieri, & Kirby, 1994), a published battery could be utilized in both clinical and general populations for ability assessments, academic achievement, job performance, and other yet to be researched areas.

References

Arlin, P. K. (1977). Piagetian operations in problem finding. *Developmental Psychology, 13*, 297-298.

Army Individual Test Battery (1944). *Manual of directions and scoring*. Washington, D.C.: War Department, Adjutant General's Office.

Ashman, A. F. (1978). The relationship between planning and simultaneous and successive synthesis (University of Alberta, Edmonton, 1978). *Dissertation Abstracts International, 49-09A*, 2584.

Ashman, A. F., & Das, J. P. (1980). Relation between planning and simultaneous-successive processing. *Perceptual and Motor Skills, 51*, 371-382.

Binet, A. (1905). New methods for the diagnosis of the intellectual level of subnormals. *L'Année Psychologique, 12*, 191-244.)

Binet, A. (1916). New methods for the diagnosis of the intellectual level of subnormals. In E. S. Kite (Trans.), *The development of intelligence in children*. Vineland, NJ: Publications of the Training School at Vineland. (Originally published 1905 in *L'Année Psychologique, 12*, 191-244.)

Bardos, A. N. (1988). *Differentiation of normal, reading disabled and developmentally handicapped students using Das-Naglieri's Cognitive Processing Teaks.* Ohio State University doctoral dissertation.

Botwinick, J., & Storandt, M. (1974). *Memory related functions and age*. Springfield, IL: C. C. Thomas.

Brace, N., Kemp, R., & Snelgar, R. (2006). *SPSS for psychologists*. New York: Macmillan.

Braden, J. P. (1997). The practical impact of intellectual assessment issues. *School Psychology Review, 26*, 242-248.

Brams, A. G. (1999). *Utility of the Das-Naglieri: Cognitive Assessment System in the discrimination of elementary school children with learning disabilities and speech impairments*. Published Doctor of Philosophy dissertation, University of Northern Colorado.

Brody, N. (1985). The validity of tests of intelligence. In B. B. Wolman (Ed.), *Handbook of intelligence* (pp. 353-389). New York: Wiley.

Brown, J. I., Fishco, V. V., & Hanna, G. (1993a). *Nelson-Denny Reading Test*. Chicago: Riverside Publishing Company.

Brown, J. I., Fishco, V. V., & Hanna, G. (1993b). *Nelson-Denny Reading Test-Interpretation Manual*. Chicago: Riverside Publishing Company.

Canter, A. S. (1997). The future of intelligence testing in the schools. *School Psychology Review, 26*, 255-261.

Carroll, J. B. (1993). *Human cognitive abilities: A survey of factor-analytic studies.* Cambridge, England: Cambridge University Press.

Cattell, R. B. (1941). Some theoretical issues in adult intelligence testing. *Psychological Bulletin*, *38*, 592.

Cattell, R. B. (1966). The scree test for the number of factors. *Multivariate Behavioral Research, 1*, 245-276.

Cianciolo, A. T., & Sternberg, R. J. (2004). Intelligence: A brief history. Malden, MA: Blackwell Publishing.

Cormier, P., Carlson, J. S., & Das, J. P. (1990). Planning ability and cognitive performance: The compensatory effects of a dynamic assessment approach. *Learning and Individual Differences, 2,* 437-449.

Daniel, M. H. (1997). Intelligence testing: Status and trends. *American Psychologist, 52,* 1038-1045.

Das, J. P. (1972). Patterns of cognitive ability in nonretarded and retarded children. *American Journal of Mental Deficiency, 77,* 6-12.

Das, J. P. (1973). Structure of cognitive abilities: Evidence for simultaneous and successive processing. *Journal of Educational Psychology, 65,* 103-108.

Das, J. P. (1984). Aspects of planning. In J. R. Kirby (Ed.), *Cognitive strategies and educational performance* (pp. 13-31, 35-50). New York: Academic Press.

Das, J. P., Kirby, J. ., & Jarman, R. F. (1975). Simultaneous and successive processes: An alternative model for cognitive abilities. *Psychological Bulletin, 82*, 87-103.

Das, J. P., Kirby, J. R., & Jarman, R. F. (1979). *Simultaneous and successive cognitive process*. New York: Academic Press.

Das, J. P., & Naglieri, J. A. (1987a). *Das-Naglieri: Cognitive Assessment System: Experimental Test Battery*. Unpublished manuscript.

Das, J. P., & Naglieri, J. A. (1987b). *Das-Naglieri: Cognitive Assessment System: Administration Manual – Tryout Edition.* USA: Psychological Corporation.

Das, J. P., & Naglieri, J. A. (1993). *Das-Naglieri: Cognitive Assessment System: Standardization edition*. Chicago: Riverside Publishing Company.

Das, J. P., Naglieri, J. A., & Kirby, J. R., (1994). *Assessment of cognitive processes: The PASS theory of intelligence*. New York: Allyn & Bacon.

Diana, v. State Board of Education, Civ. Act. No. C-70-37 (N.D. Cal., 1970, *further order,* 1973).

Fabrigar, L. R., Wegener, D. T., MacCallum, R. C., & Strahan, E. J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological Methods, 4*, 272-299.

Fennema, E., Carpenter, T. P., & Peterson, P. L. (1989). Learning mathematics with understanding: Cognitively guided instruction. In J. Brophy (Ed.), Advances in research on teaching (pp.195-221). Greenwich CT: JAI Press.

Field, A. (2005). *Discovering statistics using SPSS*. 2nd Edition. London: Sage Publications.

Ford, D. Y. (1998). The underrepresentation of minority students in gifted education: Problems and promises in recruitment and retention. *Journal of Special Education*, *32,* 4-14.

Fuchs, D., & Young, C. L. (2006). On the irrelevance of intelligence in predicting responsiveness to reading instructions. *Exceptional Children, 73,* 8-30.

Ghiselli, E. E. (1966). *The validity of occupational aptitude tests.* New York: Wiley.

Ghiselli, E. E. (1973). The validity of aptitude tests in personal selection. *Personnel Psychology*, *26*, 461-477.

Golden, C. J. (1978). *Stroop color and word test: A manual for clinical and experimental uses*. Wood Dale, IL: Stoelting.

Gould, S.J. (1981). *The mismeasure of man*. New York: W.W. Norton & Company.

Guilford, J. P. (1973). Theories of intelligence. In B. B. Wolman (Ed.), *Handbook of general psychology*. Englewood Cliffs, NJ: Prentice-Hall.

Guliford, J. P. (1956). The structure of intellect. *Psychological Bulletin, 53,* 267-293.

Haddad, F.A., Garcia, Y.E., Naglieri, J. A., Grimditch, M., McAndrews, A., & Eubanks, J. (2003). Planning facilitation and reading comprehension: Instructional relevance of the PASS theory. *Journal of Psychoeducational Assessment, 21,* 282-289.

Hald, M. (2000). *A PASS cognitive processes intervention study in mathematics.* Unpublished doctoral dissertation, University of Northern Colorado.

Harniss, M. K., Stein, M., Carnine, D. (2002). Promoting mathematics achievement. In M. R. Shinn, H. M. Walker, and G. Stoner (Eds.), *Interventions for academic and behavior problems II: Preventive and remedial approaches* (pp. 243-294). Bethesda: NASP Publications.

Harrison, P. L., Flanagan, D. P., and Genshaft, J. L. (1997). An integration of contemporary theories, tests, and issues in the field of intellectual assessment. In D. P. Flanagan, J. L. Genshaft, & P. L. Harrison (Eds.), *Contemporary intellectual assessment: Theories, tests, and issues*. New York, NY: Guilford.

Harrison, P. L., Kaufman, A. S., Hickman, J. A., & Kaufman, N. L. (1988). A survey of tests used for adult assessment. *Journal of Psychoeducational Assessment, 6,* 188-198.

Heaton, R.K., Chelune, G.J., Talley, J.L., Kay, G.G., & Curtis, G. (1993). *Wisconsin Card Sorting Test (WCST). Manual revised and expanded*. Odessa, FL: Psychological Assessment Resources.

Hobson v. Hansen, 269 F. Supp. 401, 514 (D.D.C. 1967), *aff'd sub nom,* Smuck v. Hobson, 408 F.2d 175 (D.C. Cir. 1969).

Holmes, J., & Adams, J. W. (2006). Working memory and children's mathematical skills: implications for mathematical development and mathematics curricula. *Educational Psychology, 26,* 339-366.

Horn, J. L., & Cattell, R. B. (1966). Refinement and test of theory of fluid and crystallized intelligence. *Journal of Educational Psychology, 57,* 253-270.

Horn J. L. & Cattell, R. B. (1967). Age differences in fluid and crystallized intelligence. *Acta Psychologica, 26*, 107-129.

Hunter, J. E. (1986). Cognitive ability, cognitive aptitudes, job knowledge, and job performance. *Journal of Vocational Behavior, 29*, 340-362.

Ilg, F. L., & Ames, L. B. (1964). *School readiness: Behavior tests used at the Gesell Institute*. New York: Harper and Row.

Ittenbach, R. F., Esters, I. G., & Wainer, H. (1997). The history of test development. In D. P. Flanagan, J. L. Genshaft, & P. L. Harrison (Eds.), *Contemporary intellectual assessment: Theories, tests, and issues*. New York, NY: Guilford.

Jensen, A. R. (1980). *Bias in mental testing*. New York: The Free Press.

Joreskof, K. G., & Lawley, D. N. (1968). New methods in maximum likelihood factor analyses. *British Journal of Mathematical and Statistical Psychology, 21,* 85-96.

Joseph, L. M. (1999). An interview with Dr. Jack A. Naglieri: Intelligence, intelligence testing and the Cognitive Assessment System (CAS). *NASP Communiqué, 28,* 8-10.

Kaiser, H. F. (1958). The varimax criterion for analytic rotation in factor analysis. *Psychometrika, 23*, 187-200.

Kamphaus, R. W. (1993). *Clinical assessment of children's intelligence*. Needham Heights, MA: Allyn and Bacon.

Kamphaus, R. W., Petoskey, M. D., & Morgan, A. W. (1997). A history of intelligence test interpretation. In D. Flanagan, J. Genshaft, and P. Harrison (Eds.), *Contemporary Intellectual Assessment: Theories, Tests, and Issues*. New York: Guilford Press.

Kar, B. C., Dash, U. N., Das, J. P., & Carlson, J. S. (1992). Two experiments on the dynamic assessment of planning. *Learning and Individual Differences, 5*, 13–29.

Kaufman, A. S. (1990). *Assessing adolescent and adult intelligence*. Needham, MA: Allyn and Bacon.

Kaufman, A. S., & Kaufman, N. L. (1983). *Kaufman Assessment Battery for Children Interpretive Manual*. Circle Pines, MN: American Guidance System.

Kaufman, A. S., & Kaufman, N. L. (1993). *Manual for Kaufman Adolescent & Adult Intelligence Test (KAIT)*. Circle Pines, MN: American Guidance Service.

Kaufman, A. S., & Kaufman, N. L. (2004). *Kaufman Assessment Battery for Children, Second Edition, Manual.* Circle Pines, MN: AGS Publishing.

Kaufman, A. S., & Lichtenberger, E. O. (1999). *Essentials of WAIS-III assessment*. New York: John Wiley & Sons, Inc.

Kaufman, A. S., & Lichtenberger, E. O. (2000). *Essentials of WISC-III and WPPSI-R assessment*. New York: John Wiley & Sons, Inc.

Keith, T. Z. & Kranzler, J. H. (1999). The absence of structural fidelity precludes construct validity: Rejoinder to Naglieri on what the Cognitive Assessment System does and does not measure. *School Psychology Review, 28* , 303-321.

Keith, T. Z., Kranzler, J. H., & Flanagan, D. P. (2001). What does the Cognitive Assessment System (CAS) measure? Joint confirmatory factor analysis of the CAS and the Woodcock-Johnson Tests of Cognitive Ability (3rd Edition). *School Psychology Review, 30,* 89-119.

Kieffer, K. M. (1998). *Orthogonal versus oblique factor rotation: A review of the literature regarding the pros and cons.* Paper presented at the Annual Meeting of the Mid-South Educational Research Association (27th, New Orleans, LA, November 4-6).

Kirby, J. R., Booth, C. A., & Das, J. P. (1996). Cognitive processes and IQ in reading disability. *The Journal of Special Education, 29,* 442-456.

Kirby, J. R., & Das, J. P. (1977). Reading achievement, IQ and simultaneous-successive processing. *Journal of Educational Psychology, 69,* 564-570.

Knapp, L.G., Kelly-Reid, J. E., Whitmore, R. W., & Miller, E. S. (2007). *Enrollment in postsecondary institutions, fall 2005; Graduations rates, 1999 and 2002 cohorts; and financial statistics, fiscal year 2005.* United States Department of Education: National Center for Education Statistics.

Korkman, M., Kirk, U., & Kemp, S. (1998). *NEPSY: A developmental neuropsychological assessment*. San Antonio, TX: Psychological Corporation.

Kranzler, J. H., & Keith, T. Z. (1999). Independent confirmatory factor analysis of the Cognitive Assessment System (CAS): What does the CAS measure? *School Psychology Review, 28,* 117-144.

Kranzler, J. H., Keith, T. Z., & Flanagan, D. P. (1999). What does the Cognitive Assessment System (CAS) measure? Joint confirmatory factor analysis of the CAS and the Woodcock-Johnson Tests of Cognitive Ability (3^{rd} Edition). *School Psychology Review, 30,* 89-119.

Larry P. v. Riles, 343 F. Supp. 1306 (D.C. N.D. Cal., 1972), *aff'd.*, 502 F.2d 963 (9^{th} Cir. 1974), *further proceedings*, 495 F. Supp. 926 (D.C. N.D. Cal., 1979), *aff'd.*, 502 F.2d 693 (9^{th} Cir. 1984).

Lerew, C. D. (2000). *The use of a cognitive strategy as an academic and behavioral intervention for children with attention-deficit/hyperactivity disorder*. Published Doctor of Philosophy dissertation, University of Northern Colorado.

Lezak, M. D. (1995). *Neuropsychological assessment* (3^{rd} ed.). New York: Oxford University.

Lichtenberger, E. O., Broadbooks, D. Y., & Kaufman, A. S. (2000). *Essentials of cognitive assessment with KAIT and other Kaufman measures.* New York: John Wiley & Sons, Inc.

Luria, A. R. (1966). *Human brain and psychological process*. New York: Harper and Row.

Luria, A. R. (1973). *The working brain. An introduction to neuropsychology*. New York: Basic Books.

Luria, A. R. (1980). *Higher cortical functions in man* (2^{nd} ed.). New York: Basic Books.

Luria, A. R. (1982). *Language and cognition*. New York: Wiley.

Macdonald, G. C. (1994). Planning-attention-simultaneous-successive cognitive processes of adults with learning disabilities and their relationship to academic achievement, study skills, and compensatory strategies. Published Doctor of Philosophy dissertation, University of Northern Colorado.

Macmann, G. M., & Barnett, D. W. (1994). Some additional lessons form the Wechsler scales: A rejoinder to Kaufman and Keith. *School Psychology Quarterly*, *9,* 223-236.

Maricle, D. E. (1994*). A validation study of the planning, attention, simultaneous, successive processing model with college students*. Published doctoral dissertation. University of Northern Colorado.

Matarazzo, J. D. (1972). *Wechsler's measurement and appraisal of adult intelligence (5th ed.)*. New York: Oxford University Press.

McDermott, P. A. & Glutting, J. (1997). Informing stylistic learning behavior, disposition, and achievement through ability subtests-or, more illusions of meaning? *School Psychology Review*, *26,* 163-175.

McGrew, K. S. (1997). Analysis of the major intelligence batteries according to a proposed comprehensive Gf-Gc framework. In D. P. Flanagan, J. L. Genshaft, & P. L. Harrison (Eds.), *Contemporary intellectual assessment: Theories, tests, and issues* (pp. 151-180). New York, NY: Guilford.

McGrew, K. S., & Flanagan, D. P. (1998). *The intelligence test desk reference (ITDR): Gf-Gc cross-battery assessment.* Needham Heights, MA: A Viacom Company.

Naglieri, J. A. (1985). *Matrix Analogies Test.* San Antonio, TX: The Psychological Corporation.

Naglieri, J. A. (1989). A cognitive processing theory for the measurement of intelligence. *Educational Psychologist, 24,* 185-206.

Naglieri, J. A. (1999a). *Essentials of CAS assessment*. New York: John Wiley & Sons, Inc.

Naglieri, J. A. (1999b). How valid is the PASS theory and CAS? *School Psychology Review, 28*, 145-162.

Naglieri, J. A., & Bardos, A. N. (1997). *General Ability Measure for Adults (GAMA).* Minnetonka, NM: National Computer Systems.

Naglieri, J. A., Braden, J., & Gottling, S. (1993). Confirmatory factor analysis of the Planning, Attention, Simultaneous, Successive (PASS) cognitive processing model for a kindergarten sample. *Journal of Psychoeducational Assessment, 11,* 259-269.

Naglieri, J. A., & Conway, C. (2009). The Cognitive Assessment System. In J. A. Naglieri and S. Goldstein's (Eds.). *Practitioner's guide to assessing intelligence and achievement* (pp. 27-59). Hoboken, NJ: Wiley & Sons, Inc.

Naglieri, J. A., & Das, J. P. (1987). Construct and criterion-related validity of planning, attention, simultaneous, successive (PASS) cognitive processing model. *Journal of Psychoeducational Assessment, 5,* 353-363

Naglieri, J. A., & Das, J. P. (1988). Planning-Arousal-Simultaneous-Successive (PASS): A model for assessment. *Journal of School Psychology, 26,* 35-48.

Naglieri, J. A., & Das, J. P. (1990). Planning, attention, simultaneous, and successive cognitive processes as a model for intelligence. *Journal of Psychoeducational Assessment, 8,* 303-337.

Naglieri, J. A., & Das, J. P. (1997a). *Das-Naglieri Cognitive Assessment System*. Itasca, IL: Riverside Publishing.

Naglieri, J. A., & Das, J. P. (1997b). *Cognitive Assessment System: Interpretive Handbook*. Itasca, IL: Riverside Publishing.

Naglieri, J. A., & Das, J. P. (2006). Are intellectual processes important in the diagnosis of ADHD? *ADHD Report, 14,* 1-6.

Naglieri, J. A., Das, J. P., & Jarman, R. F. (1990). Planning, attention, simultaneous, and successive cognitive process as a model for assessment. *School Psychology Review, 19,* 423-442.

Naglieri, J. A., Das, J. P., Stevens, J. J., & Ledbetter, M. F. (1991). Confirmatory factor analysis of planning, attention, simultaneous, and successive cognitive processing tasks. *Journal of School Psychology, 29,* 1-17.

Naglieri, J. A., & Ford, D. Y. (2005). Increasing minority children's participation in gifted classes using the NNAT: A response to Lohman. *Gifted Child Quarterly, 49,* 29-26.

Naglieri, J. A., Goldstein, S., Iseman, J. S., & Schwebach, A. (2003). Performance of children with Attention Deficit Hyperactivity Disorder and Anxiety/Depression on the ISC-III and Cognitive Assessment System (CAS). *Journal of Psychoeducational Assessment, 21*, 32–42.

Naglieri, J. A., & Gottling, S. H. (1995). A study of planning and mathematics instruction for students with learning disabilities. *Psychological Reports*, *76,* 1343-1354.

Naglieri, J. A., & Gottling, S. H. (1997). Mathematics instruction and PASS cognitive processes: An intervention study. *Journal of Learning Disabilities*, *30,* 513-520.

Naglieri, J. A., & Johnson, D. (2000). Effectiveness of a cognitive strategy intervention in Improving arithmetic computation based on the PASS theory. *Journal of Learning Disabilities, 33,* 591-597.

Naglieri, J. A., & Kaufman, J. C. (2001). Understanding intelligence, giftedness, and creativity using the PASS theory. *Roeper Review*, *23*, 151-156.

Naglieri, J. A., & Kaufman, J. C. (2008). IDEIA 2004 and specific learning disabilities: What role does intelligence play? In E. Grigorenko (Ed.), *Educating individuals with Disabilities: IDEIA 2004 and beyond* (pp. 165-195). New York: Springer.

Naglieri, J. A., Prewett, P. N., & Bardos, A. N. (1989). Evidence for planning, attention, simultaneous, and successive cognitive processes. *Journal of School Psychology, 27,* 347-364.

Naglieri, J. A., & Ronning, M. E. (2000). The relationship between general ability using the N-NAT and SAT Reading Achievement. *Journal of Psychoeducational Assessment*, *18,* 230-239.

Naglieri, J. A., & Rojan, J. (2004). Construct Validity of the PASS theory and the CAS: Correlations with achievement. *Journal of Educational Psychology*, *96,* 174-181.

Naglieri, J. A., Salter, C. J., & Edwards, G. H. (2004). Assessment of ADHD and reading disabilities using the PASS theory and cognitive assessment system. *Journal of Psychoeducational Assessment*, *22,* 93–105

Naglieri, J. A., Welch, J. A., & Braden, J. (1994). Factor structure of Planning, Attention, Simultaneous, Successive (PASS) Cognitive processing tasks and the Wechsler PIQ for a hearing impaired sample. *Journal of School Psychology, 32*, 371-384.

NJCLD. (1985). *Adults with learning disabilities: A call to action*. A position paper of the National Joint Committee on Learning Disabilities, February 10, 1085. The Orton Dyslexia Society, Baltimore, MD.

NJCLD. (1990). *Learning disabilities: Issues on definition*. Collective perspectives on issues affecting learning disabilities. Austin, TX; Pro-Ed Publications.

NJCLD. (1994*). Secondary to postsecondary education transition planning for students with learning disabilities*. Austin, TX; Pro-Ed Publications.

NJCLD. (1999). *Learning disabilities: Issues in higher education*. Austin, TX; Pro-Ed Publications.

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory (3rd Ed.)*. New York:

McGraw-Hill.

Ottman, P. K., Raskin, E., & Witkin, H. A., (1971). *Group Embedded Figures Test*. Palo Alto, CA: Consulting Psychologists Press.

Pallant, J. (2001). *SPSS survival manual*. Maidenhead, PA: Open University Press.

Paolitto, A.W. (1999). Clinical validation of the Cognitive Assessment System with children with ADHD. *ADHD Report, 7*, 1–5.

Pelletier, S. L. F. (1996). *A validation of the planning-attention-simultaneous-successive model of cognitive processing in children with and without learning disabilities.* Published Doctor of Philosophy Dissertation. University of Northern Colorado.

Piaget, J. (1972). Intellectual evolution from adolescence to adulthood. *Human Development*, *15,* 1-12.

Powell, S. D. (1999). *Assessing learning disabilities in reading: A validity study of the Cognitive Assessment System*. Published Doctor of Philosophy Dissertation, University of Northern Colorado.

Price, P. (1987). Validity of the planning, attention, simultaneous and successive cognitive processing tasks. *Dissertation Abstracts International*, *49,* (02), 240A.

Proctor, B.E., Floyd, R.G., & Shaver, R.B. (2005). CHC Broad cognitive ability profiles of low math achievers. *Psychology in the Schools, 42,* 1-12.

Raven, J. C. (1956). *Coloured Progressive Matrices: Sets A, Ab, B.* London: H. K. Lewis.

Reitan, R. M. 1955. An investigation of the validity of Halstead's measures of biological intelligence. *Archives of Neurology and Psychiatry***,** 73, 28–35.

Reitan, R. M., & Wolfson, D. (1993). *The Halstead-Reitan Neuropsychological Test Battery: Theory and clinical interpretation*. Tucson, AZ: Neuropsychology Press.

Reschly, D. J., & Grimes, J. P. (2002). Best practices in intellectual assessment. In A. Thomas and J. Grimes (Eds.), *Best practices in school psychology* (pp. 1337-1372). Bethesda, MD: National Association of School Psychologists.

Reynolds, C. R., Chastain, R. L., Kaufman, A. S., & McLean, J. E. (1987). Demographic characteristics and IQ among adults: Analysis of the WAIS-R standardization sample as a function of the stratification variables. *Journal of School Psychology*, *25,* 323-342.

Reynolds, C. R., Kamphaus, R. W., Rosenthal, B. L., & Hiemenz, J. R. (1997). Application of the Kaufman Assessment Battery for Children (K-ABC) in neuropsychological assessment. In C. R. Reynolds & E. Fletcher-Janzen (Eds.), *Handbook of clinical child neuropsychology* (2nd ed.) (pp. 252-269). New York: Plenum Press.

Rispens, J., van Yperen, T. A., & van Duijn, G.A. (1991). The irrelevance of IQ to the definition of learning disabilities: Some empirical evidence. *Journal of Learning Disabilities, 24,* 434-438.

Roid, G. H. (2003). *Stanford-Binet Intelligence Scales, Fifth Edition*. Itasca, IL: Riverside Publishing.

Roid, G. H., Shaughnessy, M. F., & Greathouse, D. (2005). An interview with Gale Roid about the Stanford-Binet 5. *North American Journal of Psychology, 7,* 493-504.

Rummel, R. J. (1970). *Applied factor analysis*. Evanston, IL: Northwestern University Press.

Savage, R. C., & Wolcott, G. F. (1994*). Educational dimensions of acquired brain injury*. Austin, TX: Pro-Ed.

Sattler, J. M. (1992). *Assessment of children: Third edition*. San Diego: Jerome M. Sattler.

Sattler, J. M. (2001). *Assessment of children – cognitive applications*. *Fourth edition.* Jerome M. Sattler, Publisher, Inc.

Siegel, L. S. (1988). Evidence that IQ scores are irrelevant to the definition and analysis of reading disability. *Canadian Journal of Psychology/Revue canadienne de psychologie, 42,* 201-215.

Siegel, L. S. (1989a). IQ is irrelevant to the definition of learning disabilities. *Journal of Learning Disabilities, 22,* 469-478.

Siegel, L. S. (1989b). Why we do not need intelligence test scores in the definition and analyses of learning disabilities. *Journal of Learning Disabilities, 22,* 514-518.

Spearman. C. (1927). *The abilities of man*. New York: Macmillian.

Spreen, O., & Strauss, E. (1991). *A compendium of neuropsychological tests: Administration, norms, and commentary*. New York: Oxford University Press.

SPSS, Inc. (2008). *SPSS Version 17 for Windows.* Chicago: SPSS Inc.

Stanley, D. A. (1995). *A validation study of the Planning, Attention, Simultaneous, Successive cognitive processing model with academically gifted adolescents.* Published Doctor of Philosophy dissertation, University of Northern Colorado.

Stevens, J. P. (1996). *Applied multivariate statistics for the social sciences* (3rd edition). Mahwah, NJ: Erlbaum.

Stroop, J. (1935). Studies of interference in serial, verbal reactions. *Journal of Experimental Psychology, 18,* 643-661.

Stuebing, K. K., Barth, A. E., Molfese, P. J., Weiss, B. & Fletcher, J. M. (2009). IQ is not strongly related to response to reading instruction: A meta-analytic interpretation. *Exceptional Children,* 76, 31-51.

Tabachnick, B. G., and Fidel, L. S. (2007). *Using multivariate statistics, 5th edition*. New York: Pearson Education.

Terman, L. M. (1916). *The measurement of intelligence*. Boston: Houghton Mifflin.

Thompson, G. H. (1939). *The factorial analysis of human ability*. London: University of London Press.

Thurstone, L. L. (1938). *Primary mental abilities*. Chicago: Chicago University Press.

Thurstone, L. L. (1947). *Multiple-Factor Analysis*. Chicago: Chicago University Press.

Trenerry, M. R., Crosson, B., DeBoe, J., & Leber, W. R. (1990). *Visual Search and Attention Test* manual. Odessa, FL: Psychological Assessment Resources.

Vellutino, F. R., Scanlon, D. M., Sipay, E. R., Small, S. G., Pratt, A., Chen, R., & Dencklea, M.B. (1996). Cognitive profiles of difficult-to-remediate and readily remediated poor readers: Early intervention as a vehicle for distinguishing between cognitive and experiential deficits as basic causes of specific reading disability. *Journal of Educational Psychology, 88,* 601–638.

Vellutino, F. R., Scanlon, D. M., & Lyon, G. R. (2000). Differentiating between difficult-to-remediate and readily remediated poor readers: More evidence against the IQ-achievement discrepancy definition of reading disability. *Journal of Learning Disabilities, 33*, 223-238.

Vellutino, F. R., Scanlon, D. M., Small, S. G., & Fanuele, D. (2003). *Response to intervention as a vehicle for distinguishing between reading disabled and non-reading disabled children: Evidence for the role of kindergarten and first grade intervention.* Paper presented at the National Research Center on Learning Disabilities Responsiveness-to-Intervention Symposium, Kansas City, MO.

Van Luit, J. E. H., Kroesbergen, E. H., & Naglieri, J. A. (2005). Utility of the PASS Theory and Cognitive Assessment System for Dutch children with or without ADHD. *Journal of Learning Disabilities, 38,* 434-439.

Vernon, P. E. (1950). *The structure of human abilities*. New York: Wiley.

Wachs, M. C., & Harris, M. (1986). Simultaneous and successive processing in university students: Contributions to academic performance. *Journal of Psychoeducational Assessment*, *4*, 103-112.

Warrick, P.D. (1989). Investigation of the PASS model of cognitive processing and mathematics achievement (Doctoral dissertation, The Ohio State University, Columbus, Ohio, 1989). *Dissertation Abstracts International*, *51-01A*, 121.

Watkins, M. W. (2000). Cognitive profile analysis: A shared professional myth. *School Psychology Quarterly*, *15*, 465-479.

Wechsler, D. (1958). *The measurement and appraisal of adult intelligence* (4th ed.). Baltimore, MD: Williams & Wilkins.

Wechsler, D. (1997). *The Wechsler Adult Intelligence Scale – Third Edition*. San Antonio, TX: Harcourt Assessment.

Wechsler, D. (2007). *The measure of adult intelligence*. Baltimore, MD: Waverly Press Inc.

Witkin, H.A. & Goodenough, D.R. (1976). *Field dependence and interpersonal behavior*, (RB 76 - 12). Princeton, NJ: Educational Testing Service.

Woodcock, R. W., McGrew, K. S., & Mather, N. (2000). *Woodcock Johnson-III Tests of Cognitive Abilities*. Itasca, IL: Riverside Publishing.

Woodward, J. (1991). Procedural knowledge in mathematics: The role of the curriculum. *Journal of Learning Disabilities*, *24*, 242-251.

APPENDIX A

ARTICLE

Intelligence testing remains an important component in the assessment of children and adults in the field of psychology. However, recent movements in education have threatened the use of standardized tests, particularly tests measuring cognitive abilities. For example, the Response-to-Intervention (RtI) paradigm suggests a reduction in the need for cognitive testing because ability scores fail to provide interventions to remediate difficulties (Vellutino et al., 1996; Vellutino et al., 2003). As a result, large-scale non-categorical models are already underway (Canter, 1997) reducing the need for diagnostic labeling of disorders. Even with a potential paradigm shift in the field of school psychology, an understanding regarding the proper use of intelligence testing will likely remain an essential skill for practitioners.

The history of intellectual assessment is long and complex. Beginning in the 1800's, scientists drew connections between a person's mental incapacity and mental illness and began testing for individual differences (Sattler, 2001). The next 100 years produced some of the biggest names in the field of psychology, many of whom were searching for a way measure the construct of intelligence. One such concept to gain favor was the notion of a general intelligence, or "*g*" (Spearman, 1927; Vernon, 1950; Wechsler, 1958). This theory suggests that one's capacity to problem solve is based on a pinnacle of general intelligence, "*g*," and that within this hierarchy of intelligence, specific and broad factors provided the basis for general intelligence (McGrew & Flanagan, 1998). The concept of "*g*" itself lead Spearman (1927) to argue about the concept of mental energy of which differences in test scores are a result of individual differences in mental energy. Although he was not the first person to state that intellectual abilities in humans could be describe by a single factor, he was the first to employ rigorous empirical and statistical techniques to explore his notions (Cianciolo & Sternberg, 2004).

A one factor theory was quickly disputed by others suggesting that many independent faculties make up what can be considered a person's "intelligence" (Sattler, 2001). In fact, Thurstone (1938) was an influential psychologist who disputed Spearman's single-factor theory by suggesting that intelligence is composed of seven distinct, yet interrelated factors. Guliford (1956) followed with a proposal that intelligence contained no less than 120 distinct abilities. Multidimensional views such as the seven modules of intelligence (Gardner, 1983) and a triarchic theory (Sternberg, 1985) have recently become more prevalent in examining intelligence. Although there was not agreement on the number of factors comprising intelligence, researchers opposed the one factor theory of Spearman.

Three major theories drive the application of instruments today. First, the Cattell-Horn-Carroll theory and its relationship to "*g*" is found in tests such as the Stanford-Binet Intelligence Scales, Fifth Edition (SB-V; Roid, 2003). The CHC theory is a combination of Horn and Cattell's *Gf-Gc* model (Horn & Cattell, 1966; 1967) and Carroll's Three-Stratum Theory (Carroll, 1993; McGrew, 1997). The *Gf-Gc* theory also provides the basis for another particularly widely used measure, the *Woodcock-Johnson Tests of Cognitive Ability – Third Edition* (WJ-III COG; Woodcock et al., 2000).

The original Binet scales have undergone criticism (Gould, 1981). Despite nearly a century of research on human abilities, the tests today have changed little since their pioneering predecessors. Because of this limitation, a shift from an empirical to a clinical approach has been taken in testing, as evidenced by the increase in popularity of the

Wechsler scales, which focuses on profile analysis for interpretation of an individual's cognitive abilities (Kamphaus et al., 1997). Unfortunately, this specific approach has not been without criticism itself. It has been suggested that there is a lack of theoretical basis for interpreting test scores with these measures (Harrison et al., 1997). Macmann and Barnett (1994) went so far as to say that the Wechsler scales "were not designed with much theory in mind" (p. 224).

An alternative has emerged. Rather than being preoccupied with intelligence, the creators of *The Das-Naglieri: Cognitive Assessment System* (CAS; Das & Naglieri, 1997a) chose to focus on one's mental abilities as cognitive processing. Known today as the Planning, Attention, Simultaneous, and Successive (PASS) theory (Naglieri & Das, 1988), the roots of the CAS and PASS theory lie in neuropsychological studies. Stemming largely from the work of A. R. Luria (1966, 1973, 1980), the functional units of the brain are responsible for how a person solves problems. For example, controlling arousal allows a person to pay *attention*, while processing information is the catalyst for how we handle *simultaneous* information or *successive* input. Finally, the frontal cortex provides the human ability to *plan* for and modify problem-solving approaches.

Over the past 30 years, extensive research has been done examining the utility of the PASS theory and the CAS with various populations. The first, and largest area of study, has been with academics. The CAS has been shown to correlate with achievement at least as well as tests of general intelligence (Naglieri, 1999a). PASS areas have been investigated extensively with reading performance and students with disabilities. Research demonstrates that the PASS areas, and specifically the area of Successive processing, have been good predictors of reading performance (Crawford, 2002; Naglieri

& Das 1987, 1990; Naglieri & Rojahn, 2004; Powell, 1999). Next, in the area of mathematics, the Planning area has been widely examined. Using response to strategy instruction, several studies (Hald, 2000; Naglieri and Gottling, 1995; Naglieri & Johnson, 2000) have shown that students low in Planning skills have benefited from strategy instruction. Finally, students with writing difficulties have unique profiles on the CAS (Germaine, 2004; Johnson, 2001). In school settings, the CAS has been useful in identifying gifted students (Stanley, 1995) and students with learning disabilities (Brams, 1999; Pelletier, 1996).

The CAS has also been widely shown to be a discriminator among groups. Using PASS tasks, Bardos (1988) demonstrated not only do children with reading disabilities have unique profiles, but children with cognitive disabilities do as well. The CAS has been examined with both emotional disturbed children and children with brain injuries and these groups have depressed scores in some PASS areas but not in others (Naglieri & Das, 1997b). Recent commentary has suggested the use of measures of psychological processing in assessing attention disorders (Naglieri & Das, 2006). Students with ADHD have benefited from cognitive instruction to improve reading and math (Lerew, 2000; Palencia, 2003). Although Attention Deficit Hyperactivity Disorder –Inattentive type (ADHD-I) and Hyperactive-Impulsive type (ADHD-H) are two ways to categorize people with attention disorder, the underlying processes appear to be quite different. It appears that children with ADHD-H earn average scores on all PASS areas except Planning (Naglieri, Goldstein, & Iseman, 2003; Naglieri, Salter & Edwards, 2004; Paolitto, 1999). This result was replicated with Dutch students as well (Van Luit et al., 2005). As mentioned earlier, Planning is most closely associated with the third functional unit of the brain described by Luria (1973) and therefore suggests that ADHD-H is relevant to this area.

Despite the overwhelming evidence for the PASS theory and its application in a variety of areas, little literature is available on this theory with adult populations. Using an experimental battery of tasks, Maricle (1994) was able to demonstrate a four-factor solution when conducting exploratory factor analysis. Additionally, this study showed that PASS areas can be used to predict academic performance. Other studies have shown that the PASS tasks are at least as good at predicting academic performance as the Wechsler scales in adults (Macdonald, 1994). Davis (2003) used the PASS areas to demonstrate differences among gender of college students with and without a learning disability. However, no studies have sought a population outside of the university setting.

Methodology

This study recruited 121 participants – 53 males, 61 females, and 7 participants of unknown gender – in several ways. First, volunteers through the undergraduate subject pool were obtained. A total of 48 participants completed an experimental test battery of tasks. The research used this archived data and further recruited 73 additional participants from the undergraduate psychology participant pool, undergraduate classes, graduate classes, and other adult volunteers. In cases where the participants were undergraduates, course credit was given for cooperation. In cases where participants were outside the undergraduate level, no compensation was given. Ages ranged from 18 to 54, although due to the voluntary nature of the study at the university, most of the subjects came from the 18-20 group. The age break down was as follows: 18-19 (n=56, 46.3%), 20-30 age (n= 51, 42.1%), 31-40 (n=4, 3.3%), 41-49 (n=1, 0.8%), 50 and up (n=2, 1.7%). Information on age and gender for seven participants from the archived data was not obtained. No significant mean score differences for age were found.

Each of the participants joined a group setting and completed the Nelson-Denny Reading Test (NDRT; Brown et al., 1993a) which measure Vocabulary, Comprehension, Reading Rate, and a Total Score. One of the tasks used for the experimental PASS battery was the General Ability Measure for Adults (GAMA; Naglieri & Bardos, 1997). This and a task called Crack the Code were also delivered in a group setting. The remaining tasks were administered individually by the examiner. Many of the tasks are adaptations of the standardization edition of the CAS (*Das-Naglieri: Cognitive Assessment System – Standardization edition*; Das & Naglieri, 1993). Each of the tasks have been shown to load on one of the four theoretical PASS areas. Planning tasks require the examinee to plot a course of action and evaluate that decision along the way. Simultaneous tasks necessitate that an individual to see how processes are interrelated and contribute parts to a whole. The Attention tasks require focused, selective, sustained, and effortful activity from an individual. The Successive tasks require immediate verbal recall and that items sort in a strictly defined order (Naglieri & Das, 1990; Naglieri, 1999a). A brief description of the tasks follows in accordance to the PASS area the task is theoretically thought to load on.

Planning

Matching Numbers is a timed task where the examinee underlines an identical pair of numbers in a row of other numbers. There are four pages of stimuli. Planned Codes is a timed paper and pencil subtest that involves coding symbols to letters. This is similar to the Coding tasks on the Wechsler scales. In Trail Making, examinees must connect a series of alternating numbers and letters in a path. Finally, Crack the Code requires the participant to determine the correct series of shapes based on written cues.

Simultaneous

In Verbal Spatial, a series of pictures are presented and the examinee must select the correct picture based on a question written at the bottom of the page. The Design Construction task consists of a series of colored blocks that must be arranged to match a picture stimulus. In Figure Memory, a picture is reveled for five seconds, then removed. The examinee must trace the picture from memory onto a new sheet with additional distracting lines and shapes. The GAMA also has been found to load on this factor. Individuals complete as many items as possible in 25 minutes. The GAMA resembles picture matrices where several options are presented as a solution to the missing piece of a puzzle.

Attention

The Expressive Attention test presents a series of color names printed in a different color. For example, the word “yellow” may be written in green lettering. The examinee must say the color the word is written in to be correct. Visual Selective is a task with a page of numbers, some of which are written in bold font, and some that are written in open font. A series of numbers are at the top of the page in various fonts. The individual must underline the numbers on the page that match the stimuli at the top of the page within a time limit. The Auditory Selective Attention task plays a tape recording for five minutes. A man’s voice and a woman’s voice are saying the names of furniture items and animals. The examinee must tap his or her hand on the table when the predetermined combination of voice and item are presented.

Successive

Word series is simply a list of words presented by the examiner and repeated by the examinee. The number of words presented increases as the task goes on. In Sentence Repetition, nonsensical sentences are presented and the examinee repeats what they can remember. The next two tasks are similar. In Sentence Questions (Auditory), a question is presented verbally by the examiner. The examinee then answers the question. In Sentence Questions (Written), the individual reads the questions on the paper and writes their response down.

The purpose of this study was two-fold. First, it was necessary to determine if the PASS four-factor structure would emerge from a battery of experimental tasks when administered to adults. Second, the study would determine the usefulness of the PASS battery in predicting reading achievement in adults.

Results

Each of the PASS tasks were standardized to have a mean of 10 and a standard deviation of 3. Composite scores were formulated by combining the specific tasks with the corresponding PASS area (i.e., Planning). The PASS composite areas had a mean of 100 and a standard deviation of 15. The first result to note was the wide range in reliability coefficients among the experimental PASS tasks. Reliability ranged from extremely low ($\alpha = .146$) to acceptable ($r = .789$).

A variety of correlation analyses were conducted. Closer analyses did not reveal consistent patterns among the subtests. The GAMA correlated significantly with all subtests except for Word Series and Sentence Repetition. This finding is interesting because previous studies (Naglieri & Das, 1987; Naglieri, Prewett, & Bardos, 1989) suggest that a Simultaneous task would correlate most highly with Successive tasks. In general, the subtests of each of the PASS areas appeared to correlate well with other subtests of the same area. To confirm this observation a Pearson product-moment correlation was conducted on the experimental PASS tasks and the PASS areas. In general the tasks correlated highly and significantly with the PASS area to which they belong and correlated weakly and insignificantly to the other areas. With the exception of Trail Making, the other Planning tasks correlated moderately (.51 to .69) with the Planning area. The correlation between the Attention tasks and the Attention area was moderate to strong (.67 to .78). The Simultaneous tasks and the Simultaneous areas also correlated moderately to strongly (.69 to .75). The strongest group was the Successive, which tasks correlated moderate to strongly (.61 to .80) with the Successive area. Finally, supporting the findings of Naglieri and Das (1987) and Naglieri, Prewett, and Bardos (1989), the Planning tasks correlated better with the Attention scale, while the Simultaneous tasks correlated better with the Successive tasks. All four of the PASS areas correlated significantly with Nelson-Denny Comprehension. Only the Simultaneous and Successive areas correlated significantly with Vocabulary, and none of the PASS areas except for Successive correlated with Reading Rate or Total Score. These correlations are considered weak to moderate (.23 to .38).

Principal Components analysis was conducted. Five factors emerged through the Kaiser (1958) criterion of eigenvalues greater than 1. These five factors explained 63% of the variance with the first factor explaining 27% of the variance. A scree plot suggested that only two factors be retained (Cattell, 1966). Both of these solutions were analyzed although an interpretable solution could not be found.

A Maximum Likelihood analysis was conducted with a four-factor solution to ft the PASS theory. Factor 1 was defined largely by the Successive Tasks, but also included one Simultaneous Task – Verbal Spatial. The Simultaneous tasks and two Planning tasks (Matching Numbers and Crack the Code) made up the second factor. Although Crack the Code was described as a Planning task in the literature, this study used an altered version of the task which may have changed its factor loading. Factor 3 was comprised of the Attention tasks while the remaining Planning tasks (Planned Codes and Trail Making) rested on Factor 4. This suggests that although the PASS tasks appear to load on similar factors when administered to both adults and children, a "clean" loading with adults has yet to be achieved.

The relationship between the PASS tasks and areas with reading achievement were examined through multiple regression analyses ($p < .01$ unless noted). Using the stepwise method, Verbal Spatial and Sentence Questions (Written) contributed 13.4% of the variance of Vocabulary. Three tasks combined to explain 25.7% of the variance in Comprehension - Verbal Spatial, Crack the Code, and Sentence Repetition. Only 4% of the variance in Reading Rate was explained by Sentence Repetition ($p < .05$). And finally, Verbal Spatial accounted for 11.6% of the variance of the Nelson-Denny Total Score.

The same was done for the PASS composite areas and the Nelson-Denny scores. The Successive area was a clear contributor. Of the variance in Vocabulary, 8.4% was explained by the Successive area ($p < .01$). For Comprehension, 19.6% of the variance was accounted for by the Successive and Planning areas ($p < .01$). The Successive and Attention areas contributed 8.9% of the variance in Total Score ($p < .01$). The Successive area attributed 4.3% of the variance in Reading Rate ($p < .05$)

The Successive cognitive processing area has been found to be highly related to reading ability. Students with reading disabilities perform lowest on Successive processing tasks (Crawford, 2002; Kirby et al., 1996; Naglieri & Das, 1987, 1990). Because the Successive area was found in every model that significantly explained variance among the Nelson-Denny reading areas, this study supports previous findings suggesting the importance of Successive processing skills in reading performance for adults as it does for children. However, due to the interrelated nature of the PASS areas, the other composite areas (i.e., Planning, Attention, and Simultaneous) contribute some variability to reading skills. The results of this study suggest that the PASS areas provide adequate prediction of academic achievement in adults as measured by the areas of the Nelson-Denny Reading Test.

Limitations

A major limitation of this study was the representativeness. Since the sample was voluntary rather than random, generalizability of the findings need to be judged accordingly. Many of the participants were accessed from the undergraduate psychology department subject pool. Others volunteered through undergraduate classes or athletic teams. Although no differences in mean scores were found across age ranges, the large number of participants of college age weights the finds somewhat toward that population.

Because the PASS composite areas were constructed out of the recommendations in the literature rather than the resulting factor analysis, conclusions about the PASS composite area's ability to make predictions of reading achievement need to be made with this limitation in mind.

Finally, the reliabilities of the PASS experimental tasks ranged from extremely low (α = .146) to acceptable (r =.789) (Nunnally & Bernstein, 1994). Although slightly lower reliabilities might be found in an exploratory study, several tasks (such as Sentence Repetition and Sentence Questions (Auditory) were extremely low. Future studies would need to assess tasks that can provide adequate reliability coefficients for decision making. PASS experimental tasks that fail to provide adequate reliability with adult populations will need to be excluded.

Suggestions for Further Research

There are several steps to be taken with regard to the PASS theory and adults. First and foremost, a reliable battery of tasks that fit the theoretical factor structure of the PASS theory need to be normed on a large sample of participants. Once a concrete battery of tasks has been established, numerous studies will be able to utilize a PASS battery with adults, from academic achievement, to discriminating among groups of people with various disabilities, and on to prediction of job performance.

Conclusion

This study set out to determine first and foremost if a battery of experimental PASS tasks given to an adult population would maintain the same theoretical factor structure as the published version used with children. Evidence suggests that these tasks still fit best on a four-factor model, although a consistent loading of tasks has yet to be established with an adult population as it has with child participants. In addition, the PASS tasks and composite areas demonstrated some success in predicting the scores of a reading test and comprehension appears to be the reading area that is best predicted by PASS tasks and composite areas. Future research is needed to help develop a reliable battery of tasks that best fit the PASS theoretical model and contribute to the prediction of academic areas.

A battery of PASS tasks could prove very useful with an adult population. Because the PASS model goes beyond merely the assessment of cognitive processes and provides information on how to best remediate cognitive processing deficits (Das, Naglieri, & Kirby, 1994), a published battery could be utilized in both clinical and general populations for ability assessments, academic achievement, job performance, and other yet to be researched areas.

APPENDIX B

INSTITUTIONAL REVIEW BOARD APPROVAL

November 27, 2006

TO: Teresa McDevitt
School of Psychological Sciences

FROM: SPARC

RE: Exempt Review of *A Validation of the PASS Theory with Adults,* submitted by Justin Walker (Research Advisor: Achilles Bardos)

The above proposal is being submitted to you for exemption review. When approved, return the proposal to Sherry May in SPARC.

I recommend approval.

[signature] 12-11-06
Signature of Co-Chair Date

The above referenced prospectus has been reviewed for compliance with HHS guidelines for ethical principles in human subjects research. The decision of the Institutional Review Board is that the project is exempt from further review.

IT IS THE ADVISOR'S RESPONSIBILITY TO NOTIFY THE STUDENT OF THIS STATUS.

Comments: See email correspondence and attachments

UNIVERSITY of NORTHERN COLORADO

APPENDIX C

SAMPLE CONSENT FORM

Informed Consent for Participation in Research
University of Northern Colorado
Project Title: A Validation of the PASS Theory with Adults

Researcher: Justin M. Walker - Department of School Psychology
Phone Number: (970) 313-3987

This study will attempt to reveal if a theory of intelligence that has traditionally been used with children is valid with adults. In this task you will be asked to complete a series of cognitive and academic tests, both in a group format as well as individually. Along with other participants in this study, you will be placed in a classroom and asked to complete a measure of reading achievement as well as some other paper and pencil tasks. It is estimated that you will spend one hour in this group format, although all work will be completed individually. During another session, you will meet with a researcher individually to complete a series of tasks. These include matching numbers and repeating numbers or sentences. These tasks are not personal in nature. The time for these tasks is estimated to be one hour.

I foresee no risks to participants beyond those that are normally encountered with testing situations in the classroom. This study is not designed to improve your memory or understanding of cognitive ability but you may enjoy the activities. To further help maintain confidentiality, computer files of your performance will be created and your name will be replaced by numerical identifiers. The names of participants will not appear in any professional report of this research or on the test materials.

Participation is voluntary and you may discontinue participation at anytime.

Please feel free to phone me if you have any questions or concerns about this research and please retain one copy of this letter for your records.

Thank you for assisting me with my research.

Sincerely,
Justin Walker
Graduate Student – School Psychology

Participation is voluntary. You may decide not to participate in this study and if you begin participation you may still decide to stop and withdraw at any time. Your decision will be respected and will not result in loss of benefits to which you are otherwise entitled. Having read the above and having had an opportunity to ask any questions, please sign below if you would like to participate in this research. A copy of this form will be given to you to retain for future reference. If you have any concerns about your selection or treatment as a research participant, please contact the Sponsored Programs and Academic Research Center, Kepner Hall, University of Northern Colorado Greeley, CO 80639; 970-351-1907

__________________ __________________ _______________
Full Name (please print)   Signature   Birth Date (month/day/year)

____________________________________ _____________________
Researcher's Signature   Date

APPENDIX D

DEBRIEFING FORM

Debriefing Form

Cognitive Processing and Academic Performance with Adults

Thank you for participating in this study.

The purpose of this study is to determine if a previously established theory of intelligence works with adults. I modified a battery of tests and am administering them to a variety of different adults.

These tasks you completed were constructed to fit within a popular theory of intelligence. Some of them were related to planning skills, such as creating a sheet of codes. Others were focused on attention, like when you were asked to find similar numbers in a list. Some other tests were focused on simultaneous processing, or how you were able to ignore certain items to find the correct answer, like you did when you looked at the color matrices in a group setting. And finally, some tasks were successive, and asked you to answer in a correct order, like when you repeated a series of words.

In the group setting, you completed a measure of reading achievement. The scores from that portion of the testing will be compared to the rest of the testing to determine if reading achievement and these processes are related.

As was discussed in the inform consent, your answers and protocols are coded with a number so that your identity remains anonymous in the data processing. Your name will never be used in publishing and will remain only known to the researcher. These data will be analyzed and used in my doctoral dissertation.

Thank you again for your participation and if you have any questions, please contact the numbers below.

Sincerely,

Justin Walker
970-313-3987

If you have any concerns regarding how you were treated in this experiment, please contact Dr. Thom Dunn (Participant Pool Coordinator) or Dr. Mark Alcorn (Chair, Psychology) at 351-2957.