THE CAS AND NEPSY AS MEASURES OF COGNITIVE PROCESSES:

EXAMINING THE UNDERLYING CONSTRUCTS

A Dissertation

by

KELLY PIZZITOLA JARRATT

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2005

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ABSTRACT

The CAS and NEPSY as Measures of Cognitive Processes:

Examining the Underlying Constructs. (August 2005)

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Although there appears to be increasing popularity in neuropsychology across disciplines of study, only modest work has been conducted with preschool and school-age children. Changes in the structure of cognitive processes during early childhood and the extent of frontal lobe maturation are important to consider when conducting assessments with young children. Many neuropsychological theories, however, are based primarily on adult research (e.g., Luria's theory) and respective assessment measures are often the extension or slight modification of items from adult assessments. Because adults and children differ on a number of neuropsychological measures, especially at younger ages, the same underlying constructs and interpretive strategies may not be appropriate for use with young children. The CAS and NEPSY are two assessment measures based on Luria's theory; however, each posits a different conclusion regarding the number of factors that explain neuropsychological functioning in young children. Luria asserted that neuropsychological functioning is comprised of three functional units, while Naglieri and Das (e.g., CAS) suggested a four factor model, and the authors of the NEPSY declared a five factor model of functioning. Due to the emerging development of a child’s frontal lobes, and the inconsistency regarding the number of factors related to neuropsychological functioning in young children, this study examined the CAS and NEPSY using factor analyses and model fit indices to determine the underlying structural model(s). The study also examined the usefulness of combining specific subscales from the CAS, NEPSY, and Peabody Picture Vocabulary Test-III (PPVT-III; Dunn & Dunn, 1997) to create a cross-battery approach to assessing neuropsychological functioning in young children. In addition to the CAS, NEPSY, and PPVT-III, data was obtained from the Behavioral Assessment System for Children (BASC; Reynolds & Kamphaus, 1992), and the Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000) to gather background information and to assess parent and teacher ratings of behavioral and neuropsychological functioning.

DEDICATION

For all of my family, in-laws, and friends who supported, encouraged, and loved me through my many years of schooling. With special thanks to my mother for talking me through the tough times and always standing behind my decisions. To my professors, especially Cyndi and Mike, for always providing me with strong supervision, the ongoing encouragement to believe in my abilities, and for the famous saying, “You know more than you think you know”. To my sweet Bella-girl who always greeted me with a loving wag of her nub after a long day at school, even when I forgot her walk. And most importantly, thank you to my wonderful husband. Without your never ending love and amazing understanding, I would not have survived the past five years. Your sacrifice and ongoing support shines through your every gesture.

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CHAPTER I

INTRODUCTION

Although neuropsychological assessment with children and adolescents has become increasingly popular over the past few decades, the utility of neuropsychology in schools continues to be debated. One of the most common views concerning neuropsychological testing in schools is the appropriateness and usefulness of neuropsychological tests in contributing additional information beyond that of traditional psychoeducational testing (Riccio, Hynd, & Cohen, 1993). Other debated issues regarding neuropsychological testing include validity and reliability of the measures, information gained, and the relevancy in creating intervention plans (Riccio et al., 1993). Hynd and Hooper (1992) asserted that from a biological and psychological perspective “better characterization of a disease or disorder will lead to a better understanding of etiology and the most effective means of differential treatment” (p. 3); therefore, the most thorough assessment of a child’s functioning would be the most beneficial.

The purpose of this study was to address the importance of examining neuropsychological functioning in young children and the appropriateness of the current assessment measures being utilized. Neuropsychological profiles can aid in identifying a child’s strengths and weaknesses and help to create the most beneficial intervention

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This dissertation follows the style and format of *Psychological Assessment.*

strategies needed for educational planning; however, many of the current assessment measures being used for young children are based on theories derived from the study of adults. This study sought to examine the appropriateness of using such assessment measures in evaluating a child’s cognitive and neuropsychological functioning.

In this chapter, an introduction of the current study is presented. A general overview of the study will be specified, including the statement of the problem, a short summation of the theoretical perspectives underlying the problem, and the rationale for the study. In addition, the current research questions are outlined and discussed. In Chapter II, an extensive review of the literature surrounding the research questions is delineated, including the issue of studying neuropsychology in children and the importance of recognizing frontal and prefrontal lobe maturation in young children. In addition, a brief overview of intelligence and neuropsychological assessment instruments are discussed, as well as the most prominent theory underlying neuropsychological assessment, Luria’s theory. Following Chapter II, a detailed account of the methodology used in the study will be described in Chapter III. This chapter includes a description of the research participants and the assessment instruments utilized in the study, as well as respective psychometric data. Results of the study are presented in Chapter IV in text and graphic format. Finally, Chapter V provides an interpretation and summation of the results presented in Chapter IV. In addition, Chapter V will discuss the limitations of the study, as well as provide direction and suggestions for future research in the area.

Statement of the Problem

Many authors have supported the need for neuropsychological testing in schools due to its usefulness in identifying individual strengths and weaknesses that lead to better intervention options (Korkman, 1999; Reynolds, 1986) and the creation of a more holistic view of a students’ functioning (Rothlisberg & D’Amato, 1988). Korkman (1999) stated that conclusions concerning a child’s primary and secondary deficits may not always be possible and that a descriptive interpretation of a child’s strengths and weaknesses, through neuropsychological assessment, may be more useful when designing interventions and planning for special education. Hartlage and Williams (1990) further emphasized the importance and relevance of creating interventions based on neuropsychological assessment due to the critical changes in the central nervous system and frontal lobes during childhood. The early identification of neurological dysfunction might allow professionals the ability to provide early intervention that can be long-standing in the child’s development.

Historically, the assessment and identification of children for achievement related special education services in schools has consisted of cognitive ability and achievement tests as the primary assessment tools. Neuropsychological testing, including tests of executive functioning in children, has become a popular topic in the research literature when studying disabilities that affect children. Examples of executive functions include the ability to monitor and control attention, to “hold” information in working memory, to make plans and set goals, to formulate mental models, and to modify these models based on experience (Dennis, 1991; Pennington, 1994).

In fact, many studies have suggested that deficits in executive functioning have been identified in children with Attention-Deficit Hyperactivity Disorder (ADHD; Chelune, Ferguson, Koon, & Dickey, 1986; Heilman, Voeller, & Nadeau, 1991; Mattes, 1980), as well as children identified with learning disabilities (Kelly, Best, & Kirk, 1989). In a literature review by Hughes (2002a), children with ADHD were found to demonstrate impaired executive control in the areas of distractibility, impulsivity, and preservative errors, as well as deficits in inhibitory control and planning at different ages. Studies reviewed by Hughes also suggested executive dysfunction in children with autism, noting specific difficulties in the areas of imitation, motor planning, reporting intentions, mental flexibility, and differentiating self and others. Barkley (2000) also stressed the importance of studying executive functioning in children, asserting that these particular functions allow children to internalize external controls and cues as mental representations and, thus, the ability to control one's behavior. There is some evidence that deficits in executive function may correlate with other difficulties, such as substance abuse and risky sexual behavior (Giancola, Martin, Tarter, Pelham, & Moss, 1996; Miller et al., 2000).

Thus, research is needed to focus on the identification of underlying characteristics or deficits that may provide information on prevention and intervention programs rather than a sole focus on diagnostic categories and comorbidity (Weinberg & Glantz, 1999). Identifying and reviewing relevant neuropsychological measures is one way to contribute to this body of literature. In reviewing such measures, it is essential to verify conformity to the standards set by the joint committee of the American

Psychological Association (APA), National Commission on Measurement in Education (NCME), and the American Educational Research Association (AERA).

Rationale for the Study

Although little research has been conducted concerning specific neuropsychological assessment measures with preschool and school age children, advances in neuropsychological research with children have evidenced a need for such study. Hynd (1988) stated that, due to the minimal research in this area, there is a lack of adequate neuropsychological norms for childhood neuropsychological measures. Because neuropsychological functioning in adults and children differ significantly, it is essential that appropriate neuropsychological assessments and interpretive strategies are developed and used for children of differing ages. Furthermore, there is an evident need to focus on a child’s individual profile of strengths and weaknesses to provide information regarding intervention strategies. Identifying and reviewing relevant neuropsychological measures is one way to contribute to this body of literature.

With the current cognitive and neuropsychological research, there has been a movement away from lengthy neuropsychological assessments toward a more process-oriented and eclectic approach that directly examines a specific referral question (Cody & Hynd, 1999). New neuropsychological assessment measures for children have been developed within the last decade including the Cognitive Assessment System (CAS; Naglieri & Das, 1997a) and the NEPSY (Korkman, Kirk, & Kemp, 1998a). The authors of both the CAS and NEPSY claim that the assessment measures are based on Luria’s (1973) neuropsychological theory, a theory based on the study of adults. Therefore, if both measures are based on the same theory, then it may be reasonable to assume that the CAS and NEPSY are measuring similar constructs. At the same time, neurodevelopmental issues, such as incomplete development of the frontal and prefrontal areas of the brain, suggest that differentiation of Luria's units in young children may not be feasible through neuropsychological assessment. The current study examined the constructs of both the CAS and NEPSY using factor analyses and model fit indices to determine the most accurate model of the underlying constructs.

Because studies have demonstrated the significance of the NEPSY in examining language (Korkman & Häkkinen-Rihu, 1994; Stinnett, Oehler-Stinnett, Fuqua, & Palmer, 2002), the Peabody Picture Vocabulary Test – 3rd Edition (PPVT-III; Dunn & Dunn, 1997a), a verbal measure that is often highly correlated with intelligence tests (Dunn & Dunn, 1997b), also was administered to the participants. To obtain a more holistic view of a child's functioning and interaction with the environment, it was deemed appropriate to collect emotional and behavioral information from a variety of sources and settings; specifically, with the use of the Behavioral Assessment System for Children (BASC-SDH, PRS, & TRS; Reynolds & Kamphaus, 1992). Also, due to the emphasis regarding neuropsychological theory and cognitive processes in the current study, it was decided that the parent and teacher form of the Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000) would be used to collect information concerning executive processes in children. Respective scales on these additional measures were evaluated, as well as compared to various scales on the CAS and NEPSY. Overall, the analyses were used to assess whether the constructs hypothesized for each test are appropriate for measuring skills in young children, ages 5-7. The analyses also were used to determine the potential for separating planning, attention, simultaneous, and successive processing in young children.

Research Questions

It has been posited by many researchers in the field that a complete neuropsychological assessment provides a more holistic view of a child's functioning and contributes vital information needed to create prevention and intervention programs. It is further argued that a neuropsychological assessment must be developmentally appropriate. The current study sought to provide further knowledge regarding the assessment of children's neuropsychological development and the measures' respective factor structures, as well as early differentiation between executive functions such as attention and planning.

Question 1

What is the strength and direction of the association between the CAS, NEPSY, PPVT-III, BRIEF, and the BASC? It was hypothesized that moderate to high correlations would result between the following scales: a) CAS Full Scale and PPVT-III; b) NEPSY Language and PPVT-III; c) CAS Attention and NEPSY Attention/Executive Function (EF); d) CAS Planning and NEPSY Attention/EF; e) CAS Simultaneous Processing and NEPSY Memory; f) CAS Successive Processing and NEPSY Memory; g) CAS Attention and all BRIEF scales except Emotional Control; h) CAS Planning and BRIEF Plan/Organize; i) NEPSY Attention/EF and all BRIEF scales except Emotional Control; j) CAS Planning and BASC Hyperactivity; k) CAS Planning and BASC

Attention Problems; l) CAS Simultaneous Processing and BASC Attention Problems; m) CAS Attention and BASC Hyperactivity; n) CAS Attention and BASC Attention Problems; o) CAS Attention and BASC Depression; p) CAS Successive Processing and BASC Attention Problems; q) NEPSY Attention/EF and BASC Hyperactivity; r) NEPSY Attention/EF and BASC Attention Problems; s) NEPSY Attention/EF and BASC Depression; t) NEPSY Attention/EF and BASC Anxiety; u) NEPSY Memory and BASC Attention Problems.

Question 2

What is the best model fit, or factor structure, for the CAS for children ages 5 to 7 years? It was hypothesized that a 3-factor Developmental model would best represent the current data using confirmatory factor analyses and model fit indices. This model consists of a Planning/Attention factor, Simultaneous Processing factor, and Successive Processing factor.

Question 3

What is the best model fit, or factor structure, for the NEPSY for children ages 5 to 7 years? Due to the past literature (Stinnett, Oehler-Stinnett, Fuqua, & Palmer, 2002) and knowledge that adequate language skills are the primary building blocks for learning and development, it was hypothesized that the 1-factor Language model would best represent the current data using confirmatory analyses and the model fit indices.

CHAPTER II

REVIEW OF THE LITERATURE

Following the overview of the current study in Chapter I, a thorough review of the literature is essential in understanding the importance of studying neuropsychology in children and the appropriateness of current and future assessment measures. This chapter will provide a general description of neuropsychology and neuropsychological assessment, as well as describe the frontal and prefrontal lobe maturation in young children, and the importance of studying brain development with regard to assessment measures. The current chapter also examines a variety of child neuropsychological assessment measures and traditional intelligence tests presently being utilized in assessment of young children. Luria's theory, one of the most popular theories studied with regard to neuropsychology, and two specific cognitive and neuropsychological measures examined in this study, the CAS and NEPSY, also are reviewed in detail in this chapter. Information regarding the tests' underlying theory and structure, as well as research surrounding the measures is thoroughly delineated.

Neuropsychology and Children

What is neuropsychology and neuropsychological assessment? In simplistic terms, neuropsychology is the study of brain-behavior relationships that utilizes both neuropsychological and psychological theories and methodologies. Neuropsychological assessment focuses on the study of various behavioral domains related to neurological structures or “functional systems” in the brain and the relationship between these behaviors and the integrity of the central nervous system (CNS; Hynd & Hooper, 1992; Riccio et al., 1993; Riccio & Reynolds, 1999). Behavioral domains often included in neuropsychological assessment focus on cognitive ability, sensory-motor ability, memory, attention, achievement, emotional functioning, and executive functioning. Executive function, as described by Hughes (2002b), “refers to a complex cognitive construct that encompasses the set of processes that underlie flexible goal-directed behaviour” (p. 69). Many higher order cognitive skills, or executive functioning skills, include the ability to control and maintain attention, organize and plan, “hold” information in working memory, and formulate and manipulate mental models. This area of functioning has been of particular interest for many researchers.

Neuropsychological assessment also has gained increasing respect in the medical community by institutions such as the American Academy of Neurology and the National Institutes of Health, and it is accepted as a standard portion of the evaluations for various disorders, including dementia, epilepsy, and ADHD (Williamson & Chelune, 1999). Medicare formally defined neuropsychological assessment in the CPT code 96117 as “testing that is intended to diagnose and characterize the neurocognitive effects of medical disorders that impinge directly or indirectly on the brain” (American Medical Association, 1996, p. 8). The code goes on to state that neuropsychological testing differs from that of psychological testing in that the neuropsychological testing battery “consists primarily of individually administered ability tests that are known to be sensitive to the functional integrity of the brain (e.g., abstraction, memory and learning, attention, language, problem solving, sensorimotor functions, constructional praxis)" (American Medical Association, 1996, p. 8). This definition supports the utility for supplemental neuropsychological testing to standard psychoeducational testing in schools to provide a more targeted and holistic view of a child's functioning.

Although there appears to be increasing popularity in neuropsychology across disciplines of study, surprisingly, little work has been conducted with preschool and school age children and age-related differences concerning these issues. Korkman (2001) noted the great developmental impact of formal instruction, environmental factors, and the interaction with the nervous system during early childhood. She added that changes in the structure of cognitive processes and performance occur over time during childhood; as such it is important to continue research in these areas. Korkman emphasized the need for specific research in areas concerning the development and emergence of stimulation and instruction with young children, as well as changes in their attention. Hughes (2002b) also noted the importance of researching executive functioning in children due to the recent belief that impairments in executive functions are thought to play a key role in a range of developmental disorders (e.g., ADHD and autism). She added that studies of children with these disabilities will aid in teasing apart distinct components of executive function.

Scant research in this area may be due to many reasons. One contributing factor may be the difficulty in making hypotheses regarding children and brain-behavior relationships due to the influence of development and the constant interaction between children and their environment (Cody & Hynd, 1999). Another contributing factor relating to limited research in this area may be the variation and subtle deviations in neurological development and their impact on developing functional systems in children, such as cognition and emotionality (Hynd & Hooper, 1992). One thing that is known about these functional systems is that, although differentiated by function, they are interconnected and do not operate independently; in fact, they jointly contribute to behavior (Hynd & Hooper, 1992). These complex interactions make it more difficult to delineate and assess specific regions of functioning.

Frontal and Prefrontal Lobe Maturation in Children

Although there is some knowledge concerning the normal development of frontal and prefrontal lobes in children, recent studies have begun to research different aspects regarding developmental changes and possible behavioral implications. The prefrontal lobes are known as the association cortex of the frontal lobe, or the prefrontal cortex (Fuster, 2002). The prefrontal cortex is primarily recognized for its functions regarding response inhibition, emotional regulation, and planning (Kanemura, Aihara, Aoki, Araki, & Nakazawa, 2003), as well as working memory, attention, and "goal-directed actions in the domains of behavior, cognition, and language" (Fuster, 2002, p. 373).

Since many neuropsychological assessment measures evaluate higher order cognitive skills, or executive functions, it is important to recognize the developmental progress of the brain regions responsible for these skills. According to Fuster (2002), the prefrontal cortex is among the last cortical regions to reach full structural development. She proposed that the earlier developing areas of this region are involved in the expression and control of emotional and instinctual behavior, while later maturing areas involve higher executive functions, such as goal-directed behavior. Studies employing magnetic resonance imaging (MRI) techniques have supported the theory of the late maturing frontal and prefrontal lobes of humans with regard to volume (Kanemura et al., 2003) and increasing cortical gray matter (Giedd et al., 1999). MRI studies conducted by Kanemura et al. (2003) have shown that both frontal and prefrontal lobe volumes continually increase during childhood and adolescence, with frontal lobe volumes steadily increasing until 10 years of age and slowly thereafter. In the same study, prefrontal lobe volumes evidenced a slow increase until 8 years of age, with rapid growth between 8 and 14 years. Another study examining gray matter in the frontal lobes illustrated a gradual increase during pre-adolescence, with maximum size occurring some time between 11 and 12 years of age (Giedd et al., 1999).

One study by Luciana and Nelson (1998) examined the performance of children, ages 4 to 8 years, on several tasks from the Cambridge Neuropsychological Test Automated Battery (CANTAB). Age-related progression was evidenced in the ability to perform tasks involving frontal lobe functioning such as Spatial Memory Span, Spatial Working Memory, the Tower of London planning task, Visual Pattern and Spatial Recognition tasks, and a Set-Shifting task. These authors noted that 4-year-olds performed significantly worse than 5- to 7-year-olds on all measures, and 8-year-olds performed better than the younger children. Another author noted that frontal lesions would often correlate with later developmental problems such as learning disabilities, ADHD, emotional problems, and possibly criminal behavior (Fuster, 2001).

Another study by Anderson (2002) also provided support pertaining to brain development and acquisition of executive functioning skills. He reported that neurophysiological changes such as synaptogenesis and myelination in the prefrontal cortex are likely aligned with the development of executive domains. Five periods of rapid growth in the frontal lobes were acknowledged through EEG data, indicating maturation of frontal lobe connections over time. Anderson (2002) reported that the first growth spurt occurred from birth to 5 years of age and demonstrated significant gains in processes involving attentional control. He further reported that information processing, cognitive flexibility, and goal setting exhibited rapid growth between the ages of 7 and 9 years; however, all four executive functions did not approach maturity or “executive control” until 11 to 13 years of age. These studies support the idea that higher-order cognitive functioning of the frontal lobes may not be well differentiated in young children.

Child Neuropsychological Assessment Measures

Consistent with what we know about development, it has been argued for years that children are not just small adults and therefore, should not be assessed in the same manner and with the same assessment measures as adults. Hynd and Hooper (1992) stated that it “is not a simple matter of generalizing adult-based research to children”, rather one must examine hypotheses based on theory, while acknowledging the “nonlinear and qualitative aspects of development” (p. 5). Hartlage and Williams (1990) recognized that many traditional childhood neuropsychological assessments have involved the extension or slight modification of items from adult assessments. These authors emphasized the great complexity in neuropsychological assessment in children, as compared to adults, and the need for particular age-specific assessments. They argued that adults and children differ on a number of neuropsychological measures, especially at younger ages, and the same interpretive strategies may not be appropriate due, in part, to the limited extent of frontal lobe maturation.

Hynd (1988) also mentioned several factors contributing to the differences between neuropsychological assessments in children as compared to adults. He noted that it is difficult to assess the effects of brain damage with regard to child development and that children tend to show more generalized effects of brain damage. Hynd (1988) stated that, in general, there is minimal research on children with neuropsychological instruments and therefore, a lack of adequate neuropsychological norms for childhood measures. Korkman (1999) also noted reasons concerning the difficulty in determining primary deficits in children as opposed to adults. She stated that children frequently have comorbid deficits (e.g., learning and attentional disorders often tend to overlap) and that there is a lack of accepted classification and description of syndromes in the child neuropsychological literature. Because neuropsychological functioning in adults and children differ significantly, it is essential that appropriate neuropsychological assessments and interpretive strategies are developed and used for children of differing ages.

Hartlage and Williams (1990) highlighted the complexity of early childhood assessment for neuropsychologists noting that knowledge of age-appropriate developmental milestones, as well as a range of clinical skills are needed. Advances in neuropsychological research with children also have contributed to the importance of the creation and use of specific, child-related neuropsychological assessments. Cody and Hynd (1999) examined a number of studies emphasizing new research implicating the differences in neurological substrates in many disorders. Areas of specific interest and importance included developmental disorders (e.g., ADHD, dyslexia, autism), neurological disorders (e.g., Tourette's Syndrome, neurofibromatosis), psychiatric disorders (e.g., depression, schizophrenia, obsessive-compulsive disorder), and other neurological insults (e.g., brain damage, low birth weight, exposure to toxins).

Traditional neuropsychological batteries for children include the Halstead Neuropsychological Test Battery for Children (HRNB; Reitan & Davison, 1974a), Reitan-Indiana Neuropsychological Battery (RINB; Reitan & Davison, 1974b), and the Luria-Nebraska Neuropsychological Battery – Children's Revised (LNNB-CR; Golden, 1984). However, in the past decade, there has been a movement away from these lengthy assessments toward a more process-oriented and eclectic approach that directly examines a specific referral question (Cody & Hynd, 1999). New neuropsychological assessment measures for children have been developed within the last decade including the Cognitive Assessment System (CAS; Naglieri & Das, 1997a) and the NEPSY (Korkman, Kirk, & Kemp, 1998a).

Traditional Intelligence Tests

Intelligence carries many different meanings and has been measured by traditional intelligence tests such as the Stanford-Binet and Wechsler Scales since their origin in the early 20th century. The foundation of intelligence testing was based on the profound work of Alfred Binet and Binet and Simon's first intelligence scale in 1905 (Naglieri, 1999a). The Army mental testing program (Yoakum & Yerkes, 1920) also relied heavily on the work of Binet. David Wechsler later combined the testing procedures of the Army mental testing and the work of Binet to create an individually administered test for adults to be used clinically in 1939 (Naglieri, 1999a). Wechsler also later designed one of the most widely used intelligence scales for children, the most current version being the Wechsler Intelligence Scale for Children-Fourth Edition (WISC-IV; Wechsler, 2003). Traditional cognitive functioning tests, such as the Stanford-Binet and versions of the WISC, continue to be used in schools due to their significant correlation with achievement in academic and non-academic settings (Naglieri, 1999a; Naglieri & Kaufman, 2001).

Binet and Simon developed the first Stanford-Binet scale in 1905 and Wechsler developed his first assessment measure in 1939. Naglieri and Kaufman (2001) stated that although many revisions have been made to these assessments since their origin, the changes included only "minor cosmetic modifications" and improved standardization samples. These authors added that the basic constructs have not been changed during the century to reflect new research.

Naglieri and Kaufman (2001) asserted that traditional intelligence tests have two main weaknesses: (a) the age of the tests, not allowing for integration of current knowledge of intelligence with relevance to neuropsychology and cognitive psychology, and (b) these tests are based on a weak theoretical foundation of general ability, with vaguely defined, achievement laden constructs. Naglieri (1999) argued that these tests reflect old “technology” and do not take into account new research. He stated that there has been a “considerable evolution in researchers’ and practitioners’ understanding of intelligence, especially as it relates to specific cognitive abilities” (p. 5). He also argued that although traditional intelligence tests have shown to be effective measures of general intelligence, they fail when more information than a general IQ score is needed. Naglieri (1999a) added that these tests do not provide sensitivity to those specific cognitive problems that underlie difficulties with learning and attention, and often affect children’s success with achievement in school. He stated that an intelligence test that reflects the “basic building blocks of intelligence” conceived in cognitive theory is needed (p. 7).

With the onset of the “cognitive revolution” in the 1960s, a number of cognitive theorists began studying neuropsychology, neuroscience, and higher mental processes and the way intelligence is conceptualized as it relates to specific cognitive abilities (Naglieri, 1999a; Naglieri & Kaufman, 2001). This “cognitive revolution” set the stage for the redefinition of intelligence, as accepted by many current researchers, as a set of interrelated cognitive processes. Many new intelligence tests were designed to encompass this conceptualization of the theory-based, multidimensional view with constructs built on research of cognitive abilities, including the Kaufman Assessment Battery for Children (K-ABC-2; Kaufman & Kaufman, 2004), Kaufman Adolescent and Adult Intelligence Test (KAIT; Kaufman & Kaufman, 1993), Differential Ability Scales (DAS; Elliott, 1990), Woodcock-Johnson III: Tests of Cognitive Ability (WJ-III;

Woodcock, McGrew, & Mather, 1997), and Cognitive Assessment System (CAS; Naglieri & Das, 1997a).

Luria's Theory

A. R. Luria's theory is one of the more frequently referenced neuropsychological theories used in testing and one on which most modern neuropsychological theories are based. Luria (1973) described human mental activity as "a complex functional system effected through a combination of concertedly working brain structures, each of which makes its own contribution to the functional system as a whole" (p. 38). He continued by adding that in this system each area of the brain "introduces its own particular factor essential to its performance, and removal of this factor makes the normal performance of this functional system impossible" (p. 39). In essence, the basic concept of Luria's theory is that higher mental activity, or cognitive processes, should be viewed as independently functioning units with specific purposes, but carried out by interconnected subprocesses.

Although Luria's neuropsychological theory is adult-based, Luria (1973) asserted that the dynamic participation of the three principal functional units of the brain system must occur for all human mental processes to take place, conscious activity in particular. Each unit is described as being hierarchical in structure and having its own specific function: "a unit for *regulating tone or waking*, a unit for *obtaining, processing and storing information* arriving from the outside world and a unit for *programming, regulating and verifying mental activity*" (p. 43). Each of the three functional units in Luria's brain functioning model is considered a basic building block of intelligence.

Each unit, in turn, is associated with basic cognitive processes related to different areas of the brain that provide the “ability” to perform certain acts (Naglieri & Kaufman, 2001). However, Luria cautioned researchers against applying a strict brain localization viewpoint to his theory and instead suggested that each differentiated unit is responsible for different aspects of a unified whole (Luria, 1973). This unit is primarily responsible in regulating tone and waking, associated with arousal, as well as selective attention (Languis & Miller, 1992).

Unit Two, in Luria’s model, is the sensory input and integration unit, primarily responsible for receiving, analyzing, and storing information (Languis & Miller, 1992). According to Luria (1966), two primary mental coding methods (e.g., simultaneous and successive processing) are used in this unit to cognitively process aspects from the outside world. Simultaneous brain activity immediately integrates various elements of experience, while successive processing involves the sequential integration of stimuli into an organized temporal or serial order. Luria (1966) further suggested that both simultaneous and successive coding processes are needed and used in both brain hemispheres, as well as in all cognitive tasks. He added that both processes contribute significantly to language comprehension in that successive coding is evident in understanding the syntax of a sentence, while simultaneous coding is essential in comprehending the meaning construction and spatial comprehension.

Unit Three is the primary unit for programming, regulation, and verification of activity, known as executive planning and organization (Languis & Miller, 1992). It is often referred to as the “executor of the brain” and is associated with frontal lobe functioning and prefrontal regions of the brain, anterior to the sensory-motor strip (Languis & Miller, 1992; Naglieri & Kaufman, 2001). This unit also is involved in such activities as impulse control, regulation of voluntary actions, and spontaneous speech (Languis & Miller, 1992). From a developmental perspective, the frontal lobes are the last of the functional systems to develop; therefore, it is reasonable to assume that a young child may not have the skills to perform as many activities in Unit Three. Due to this late maturation, one also may assume that the cognitive skills needed for Unit Two and Unit Three may not be completely differentiated at young ages.

Languis and Miller (1992) asserted that Luria’s theory of brain functioning offers several potential contributions to educational psychology. They stated that Luria’s theory bridges the gap between educational psychology and cognitive psychophysiology by associating student performance on cognitive tasks with specific brain processing patterns, and by providing an empirically testable model. Because individual differences most likely exist between students with more and less efficient constructive processes, it is reasonable to want to study the brain processing patterns of high and low performers on complex construction tasks using a theory such as Luria’s (Languis & Miller, 1992).

Languis and Miller (1992), through many case studies, suggested that topographic brain mapping of individual students provided evidence of different strengths and weaknesses in learners. Many of the differences between the high and low performers on specific tasks resulted in differing brain patterns in respective areas suggested by Luria. Understanding the differences between students and their learning strategies or deficits provides implications for academic interventions. Languis and

Miller (1992) stated that educational interventions take two forms: (a) changes made by the teacher in curriculum or instruction due to a students' cognitive processing and learning style, and (b) changes made by the student in self-management and cognitive skills.

Cognitive Assessment System

Two specific measures of cognitive processes that are based on the principles of Luria's theory are the Cognitive Assessment System (CAS) and the NEPSY. The CAS is an individually administered instrument designed to measure cognitive functioning of children and adolescents ages 5 to 17 years. The CAS includes a variety of tasks measuring functioning related to planning, attention, successive processing (performing tasks in sequence), and simultaneous processing (perceiving and integrating parts as a whole). A child's performance on these various measures are summarized with a composite score (e.g., Full Scale score) providing a general estimate of ability, cluster scores (e.g., Planning, Attention, Simultaneous Processing, Successive Processing), and individual subtest scores representing a range of abilities. Naglieri and Kaufman (2001) stated that the CAS was designed to integrate a theoretical view of human abilities based on neuropsychology and cognitive psychology, positing multiple dimensions rather than a single, general ability concept. They added that it also was designed to be highly related to achievement, relevant to differential diagnosis, and useful for instructional design and intervention for children.

The CAS is based on the theoretical foundations of Luria and the PASS theory. The PASS theory is conceptualized as a cognitive processing approach to children's abilities that includes four cognitive processes (e.g., planning, attention, successive processing, and simultaneous processing) that are interrelated and interact with an individual’s base of knowledge (Naglieri, 1999a). These four processes are considered the “basic building blocks of intelligence” and are based on Luria’s three functional units; attention, simultaneous and successive processing, and planning. The PASS theory was developed as an alternative conceptualization of intelligence as compared to a general mental ability. Naglieri (1997b) defined the four PASS processes as follows: “**planning** is a mental process by which the individual determines, selects, applies, and evaluates solutions to problems” (p. 2), “**attention** is a mental process by which the individual selectively focuses on particular stimuli while inhibiting responses to competing stimuli presented over time” (p. 3), “**simultaneous** processing is a mental process by which the individual integrates separate stimuli into a single whole or group” (p. 4), and “**successive** processing is a mental process by which the individual integrates stimuli into a specific serial order that forms a chain-like progression” (p. 5). Naglieri, Das, Stevens, and Ledbetter (1991) stated that simultaneous and successive processes may take place during direct perception, retention of information, and at higher cognitive levels. They also stated that these “processes can be applied to tasks of various modalities (auditory, visual, kinesthetic) involving different types of stimuli (verbal and nonverbal)” (p. 2).

There has been significant research and controversy amongst researchers regarding the CAS measure and the appropriate theoretical model fit (Carroll, 1995; Kranzler & Keith, 1999; Naglieri, Braden, & Gottling, 1993; Naglieri et al., 1991;

Naglieri, 1999b). Some researchers have evaluated the CAS assessment measure and agreed that the PASS model is the best model fit regarding underlying constructs. In one study by Naglieri et al. (1991), a confirmatory analysis was used to test the congruence between experimental tasks (e.g., Planning = Visual Search, Planned Connections, Matching Numbers; Attention = Selective Attention-Receptive, Selective Attention-Expressive; Simultaneous = Matrices, Figure Memory, Design Construction; Successive = Successive Word Recall, Sentence Repetition and Questions) and the PASS model, as well as competing theoretical models. Two grade groups (e.g., K-2nd and 5th-12th) were formed and each individual was administered the experimental tasks. Results from the confirmatory analysis concluded that the PASS model provided the best model fit for the K-2nd grade group with a non-significant chi-square value of 27.64, p = .19. The PASS model also was concluded as having the best model fit for the 5th-12th grade group with a non-significant chi-square value of 34.84, p = .21; however, the verbal-spatial-speed model also was found to have an acceptable model fit (X^2 = 40.81, p = .09).

Another study, conducted by Naglieri et al. (1993), also supported the PASS model as the best fit regarding data from a kindergarten sample on the CAS. When examining a single-factor g model, an orthogonal four-factor model, a hierarchical four-factor model, a correlated three-factor model, in which Planning and Attention formed a single factor, and the conceptual correlated four-factor PASS model, the PASS model was the only model that exhibited a non-significant chi-square value (X^2 = 64.70, p > .05). However, specific goodness of fit indices indicated acceptably high values (e.g.,

>.90) for the correlated three-factor model and hierarchical model, as well as the correlated four-factor PASS model.

Although some authors purported that research on the CAS supports a PASS theoretical model, other authors have disagreed (Carroll, 1995; Kranzler & Keith, 1999). Kranzler and Keith (1999) analyzed the standardization data of the CAS with confirmatory factor analysis techniques to address construct validity. In their study, they found that the CAS measured the same constructs across the 5 to 7 and 8 to 17 years of age span; however, different tests are administered to the two age groups and it was not possible to determine whether the CAS measured the same constructs across the 12-year age span.

Kranzler and Keith (1999) also examined the adequacy of the fit of the PASS model to the data, as well as the fit of the PASS model with alternative models to examine rival hypotheses of the CAS structure. These authors found that, of the non-hierarchical models, the correlated PASS model, reflecting the implied theoretical structure, was the best fit to the data; however, the fit was marginal. Kranzler and Keith (1999) suggested that the best fit to the data was a third-order hierarchical model that included one general factor (psychometric *g*), an intermediate combined Planning/Attention factor, and the four first-order factors reflecting the PASS processes (e.g., Planning, Attention, Simultaneous Processing, Successive Processing). Although these authors stated that both models provided a similar fit to the data, they stated that the latter was more parsimonious, having one more degree of freedom; therefore, superior to the correlated PASS model.

Kranzler and Keith (1999) also stated that the Planning and Attention scales correlated more than .90 across age groups suggesting that these two constructs overlap significantly and are almost undistinguishable. This may reflect a lack of differentiation of functions associated with developmental status of the frontal lobes. In addition, only the Successive Scale had enough unique variance to be interpreted separately. As an alternative hypothesis, Kranzler and Keith (1999) purported that the best fit to the data is Carroll's three-stratum theory of human cognitive abilities; processing speed, memory span, and a mixture of fluid intelligence and broad visualization.

Naglieri (1999b) offered a response to Kranzler and Keith's (1999) article regarding the CAS factor structure and stated that the article, in many ways, supported the PASS theory and the proposed structure. Naglieri (1999b) noted that "they found that a) the test measures the same constructs for children aged 5 to 7 and 8 to 17 years of age; b) the correlated PASS model resulted in the best fit to the standardization data for children 5 to 7 and 8 to 17 years of age rather than the uncorrelated PASS model; c) the PASS model resulted in a better fit rather than the (PA)SS model proposed by Kranzler and Weng (1995); and d) one factor and (PA)(SS) models resulted in worse fits rather than the PASS model" (p. 151). He added that the main disagreement pertained to Kranzler and Keith recognizing that a third-order hierarchical model was a better fit to the data due to one degree of freedom and the notion of parsimony, although both models resulted in similar fits to the standardization data.

Because Kranzler and Keith (1999) did not specify what procedures were used in computing specificity of the PASS scales, Naglieri (1999b) challenged their computation of adequate specificity when they stated that only the Successive Scale had enough unique variance to be interpreted separately. Naglieri argued that, when using the method described by Kaufman (1979), the results suggested that “the PASS scales have enough specificity to be used with confidence to determine, for example, PASS strengths and weaknesses” (p. 148).

Other authors (Carroll, 1995; Kranzler & Keith, 1999) also have criticized the Planning scale of the CAS proposing that the scale is a measure of speed rather than of pure planning abilities. In response to this criticism, Haddad (2004) conducted a study with 156 participants, ages 7 to 11 years, where the Planned Codes subtest of the CAS was administered using two different sets of directions. One set of directions followed the outlined directions in the CAS manual, specifying that the children were able to complete the task in any manner, as quickly as they could. The second set of directions instructed the children to complete the items as quickly as they could from left to right, top to bottom, and one after the other without skipping any; therefore, eliminating the cognitive strategy in the timed task. Results indicated that the mean score pertaining to the CAS manual directions was significantly higher than that of the mean score for the speeded directions when using a paired *t* test (t (155) = 11.50, $p < .0001$). Haddad (2004) also reported that the correlation coefficient between the scores was small for the two sets of directions ($r = .23$, $p < .01$), supporting the view that the CAS directions and the speeded directions do not involve the same process. None of the studies conducted or discussions addressed potential developmental confounds with young children.

NEPSY: A Developmental Neuropsychological Assessment

The NEPSY is another individually administered assessment measure based on the principles of Luria's neuropsychological theory. This instrument was designed to measure neuropsychological development in children ages 3 to 12 years. The NEPSY includes five sections termed "functional domains", including Attention/Executive Functions, Language, Visuospatial, Sensorimotor, and Memory and Learning (Kemp, Kirk, & Korkman, 2001). Kemp, Kirk, and Korkman (2001) stated that the NEPSY was developed with four interrelated purposes in mind: (a) to create a reliable and valid instrument to detect subtle deficiencies across and within the domains that can interfere with children's learning, (b) to contribute to understanding the effects of brain damage, (c) to use in long-term follow-up of children, and (d) to study neuropsychological development in children. The NEPSY is assumed to assess performance of skills that are interrelated based on Luria's functional-system model, wherein performance deficits in one area can impact the performance in other areas.

There is scant research in the literature pertaining to the validity and reliability of the NEPSY and the authors of the instrument have conducted much of the research. However, a study performed by Stinnett et al. (2002) examined the structure and psychometric properties of the NEPSY. In their study using the 5- to 12-year old data from the standardization sample, results indicated that the NEPSY was best conceptualized as a single-factor instrument, as opposed to the five-domain interpretive model suggested in the manual. The authors stated that "the primary and robust factor appears to reflect aspects of linguistic-verbal ability" (Stinnett et al., 2002, p. 78) and all but two of the core domain subtests (e.g., Finger Tapping and Memory for Faces) loaded on this factor. In support of this finding, Stinnett et al. (2002) examined a two-, three-, and four-factor model, and found that many of the subtests cross-loaded. Due to the significant loading on the language factor, the authors stated that interpretation of separate neuropsychological functions is not warranted using the NEPSY and that "subtle deficiencies" in neurocognitive functioning cannot be accurately obtained using the measure. However, Stinnett et al. (2002) stated that certain subtests may prove to be useful in a cross-battery approach to examining cognitive abilities and neuropsychological functioning in children.

One study by Korkman, Kemp, and Kirk (2001) examined the effects of age on the NEPSY using a sample of 800 children from the United States, ages 5 to 12 years. Using a one-way ANOVA with the subtest raw scores, results indicated that effects of age were significant on all subtests, providing evidence of the developmental sensitivity of the NEPSY. The authors also noted that the mean performance seemed to increase more in the younger age groups (e.g., 5- to 8-year range) as compared to the more moderate increase in older age groups (e.g., 9- to 12-year range). In line with other data pertaining to brain development (Kanemura et al., 2003; Luciana & Nelson, 1998), these results seemed to provide evidence that neurocognitive development is more rapid up to 9 years of age and less rapid in later years (Korkman et al., 2001). Other studies also have demonstrated similar rapid developmental trajectories on neurocognitive tasks in younger children (Korkman, Barron-Linnankoski, & Lahti-Nuuttila, 1999; Levin et al., 1991; McKay, Halperin, Schwartz, & Sharma, 1994; Rebok et al., 1997). In application of Luria’s model, the conflicting findings of Korkman et al. (2001) and Stinnett et al. (2002) may be explained in part by developmental aspects in young children.

Mulenga, Ahonen, and Aro (2001) studied the NEPSY using literate Zambian children and the United States standardization sample of children. Overall, the authors found that the Zambian children performed better on visuospatial tasks but poorer on some measures of attention/executive function and language. They also concluded that the NEPSY was relatively unaffected by language and cultural factors.

Schmitt and Wodrich (2004) examined the validity of the NEPSY using archival data from patient charts at a large, urban children’s hospital, as well as standardization data obtained from The Psychological Corporation. Groups of children with known neurological conditions (*n*=30), scholastic concerns (*n*=35), and controls (*n*=39) were evaluated in the study. Overall the authors determined that the data seemed to support the distinction between the three groups on some tasks, even when IQ differences were statistically controlled, and that the NEPSY could be of use as part of a battery that includes cognitive functioning tests. When examining the domain and subtest levels, authors reported that differences were not universally found; when IQ was covaried, only the Language and Sensorimotor domain scores varied among groups. In addition, when group contrasts were examined and IQ was controlled for, there was little support for the NEPSY’s use regarding the executive function and attention domain, memory and learning domain, or the visuospatial domain. In contrast, considerable variance was explained when the scholastic and neurological groups were compared on the Language domain, regardless of whether IQ was covaried. Similar findings supported the use of the

Sensorimotor domain, with differences between both clinical groups and controls when IQ was covaried.

Summary

It is evident that due to the complex nature of neuropsychological development in children, with regard specifically to frontal and prefrontal lobe maturation, that children should not be assessed in the same manner and with the same assessment measures as adults. Many studies have provided evidence that later maturing areas of the brain involving higher cognitive and executive functions, such as planning and goal-directed behavior, occur later in development. It is important to recognize the developmental progress of the brain regions responsible for these skills and their impact on developing functional systems in children. These concerns have prompted research in the area of neuropsychological assessment for young children, including the present study.

Although Luria's theory provides a well-researched basis for neuropsychological functioning, it is solely based on adults. The CAS and NEPSY are two childhood assessment measures based on this popular theory; however, much controversy exists as to whether these instruments can effectively assess a child's functioning and whether the underlying structure and constructs hold true for young children. This study sought to examine the construct validity of the CAS and NEPSY using factor analyses, as well as study whether specific executive functions, such as attention and planning, could be differentiated by these tests in young children.

This chapter provided a thorough review of the literature surrounding neuropsychological assessment with young children and the importance of considering a developmental perspective. Many of the current assessment measures were described, as well as specific studies regarding their usefulness in assessing young children. The following chapter, Chapter III, will provide a detailed account of the methodology used in the study, including a description of the research participants and assessment instruments, respective psychometric data, procedure, and data analyses.

CHAPTER III

METHOD

The current chapter will address the methodology used in the study, including a description of the research participants and assessment instruments, respective psychometric data, procedure, and data analyses. Chapter IV details the results of the study, and Chapter V provides an interpretation and summation of the results, as well as the limitations of the study and direction for future research in the area.

Participants

Participants in the current study consisted of 48 children, with ages ranging from 5 years, 0 months to 7 years, 11 months (*M* = 5.88; *SD* = .89; 22 5-year olds; 10 6-year-olds; 16 7-year-olds). Initially, data were collected for 52 children; however, 4 cases were removed from the final sample due to incomplete data. Twenty-six children were males and 22 were females. These children ranged in age from preschool to second grade (*M* = 1.27; *SD* = .92; 11 preschool; 17 kindergarten; 16 first grade; 4 second grade). The participants were predominantly Caucasian (91.7%), with the remainder of the participants being African American (2.1%) and Hispanic (6.3%). All but one child were right handed; parental education ranged from high school to advanced degrees (e.g., Master’s and Ph.D.) With regard to diagnostic status of the sample, 2 (4.0%) participants met *Diagnostic and Statistical Manual of Mental Disorders-Fourth Edition* (DSM-IV; American Psychiatric Association, 1994) criteria for Attention-

Deficit/Hyperactivity Disorder, Combined Type (ADHD/CT), 1 (2.0%) met criteria for Depressive Disorder, Not Otherwise Specified, and 3 (6.0%) were given a provisional diagnosis of ADHD. Overall the characteristics of the sample resemble a normal selection of children. Table 1 provides detailed information regarding sample demographics.

The children were recruited through the use of posted notices at a variety of facilities in the Brazos Valley area including two locations of the Texas A&M University (TAMU) Counseling and Assessment Clinic, the Brazos Valley Community Action Agency–Head Start, local preschools and businesses in the surrounding area, and by word of mouth. The posted notice indicated that parents/guardians interested in their child's development should contact the principal investigator for participation in the study. Interested parents/guardians were screened via telephone interview prior to scheduling of the evaluation appointments in order to ensure that the participants met the desired criteria for inclusion (e.g., English as a primary language, no documented hearing loss, and no history of seizure disorder or traumatic brain injury). Participation was voluntary and no monetary compensation was provided; however, parents were provided with a report of the evaluation results and the children were given small toys as rewards at the end of each session. Parental informed consent was obtained for all participants and written child assent was obtained from all 7-year-old children.

Attempts were made to ensure that males and females were equally represented. Although it was desirable for the sample to match the ethnic composition of the Brazos

Table 1

Total Sample Demographic Information

	N (%)
Mean Age	5.88 (0.89)
Sex	
Male	26 (54.20)
Female	22 (45.80)
Ethnicity	
African American	1 (2.10)
Caucasian	44 (91.70)
Hispanic	3 (6.30)
Grade	
Preschool	11 (22.90)
Kindergarten	17 (35.40)
First Grade	16 (33.30)
Second Grade	4 (8.30)
Diagnosis	
ADHD/CT	2 (0.04)
Depressive Disorder, NOS	1 (0.02)
ADHD, provisional	3 (0.06)

Note. ADHD/CT = Attention-Deficit/Hyperactivity Disorder, Combined Type; NOS = Not Otherwise Specified.

Valley area, due to the linguistic loading of some of the measures to be used, and the lack of suitable measures in languages other than English, it was necessary to limit participation to those who demonstrated English as a primary language. Attempts were made to ensure the participants included white (non-Hispanic), and Hispanic English speakers, as well as African Americans in the study.

Procedure

All individuals participated in an evaluation of developmental status including assessment of cognition, language, memory, attention, executive function, sensorimotor functions, and behavior using standardized measures that are routinely used in clinical evaluations of children (e.g., CAS, NEPSY, PPVT-III, BASC, and BRIEF). The principal investigator, a TAMU doctoral student in school psychology sufficiently trained in administering such measures, collected the majority of the data and administered all measures consistent with standardization. Four other administrators were similarly trained and assisted in the data collection. A licensed psychologist supervised all administrators. The order of presentation of the assessment measures were counter-balanced to control for order effects. Every effort was made to gather additional information regarding each child’s developmental and family history, as well as behavioral and emotional status, through parent and teacher questionnaires (e.g., BASC - Structured Developmental History; BASC - Parent and Teacher Rating Scales; BRIEF - Parent and Teacher Rating Scales).

Individual evaluations took approximately four hours and were conducted at the Counseling and Assessment Clinic (CAC) in Harrington Tower at Texas A&M

University, College Station, Texas or in the child’s home. When evaluations were conducted in a child’s home, every effort was made to secure a well-lit, well-ventilated, quiet room with appropriate sized furniture and minimal distractions. Due to the age and attention span of young children, the evaluations were conducted across two to three sessions; appointments were scheduled at the participants’ convenience.

Each parent/guardian was explained the process and procedures of the assessment and a signed informed consent form was obtained. Also, each child was explained the assessment process at a developmentally appropriate level; children seven years of age were asked to sign an assent form as a contract of participation. Each parent/guardian and seven-year-old child received a copy of the consent/assent form. During the initial meeting, each parent/guardian was given the necessary paperwork and questionnaires to complete and the instructions for completion were explained. The parent/guardian also was asked to provide a primary teacher with similar questionnaires to complete based on their knowledge of the child in a school environment. A self-addressed stamped envelope for easy return of the questionnaires accompanied each teacher form.

Following completion of the evaluation, parents/guardians were contacted for a feedback session regarding the results of the assessment, and each received a comprehensive report. When deemed appropriate, recommendations were made and explained to the parents/guardian. Results of the evaluations were confidential and not released to individuals or agencies unless written release was provided by a child’s parent/guardian. A case number was assigned to each child and the data were entered into a database with no identifying information. Results of the study are presented in group-aggregated form to ensure that no single participant can be identified.

Assessment Measures

Cognitive Assessment System (CAS)

The Cognitive Assessment System (CAS) is an individually administered instrument designed to measure cognitive functioning of children and adolescents ages 5 to 17 years. The CAS includes a variety of tasks measuring functioning related to planning, attention, successive processing (performing tasks in sequence), and simultaneous processing (perceiving and integrating parts as a whole). A child's performance on these various measures are summarized with a composite score (e.g., Full Scale score) providing a general estimate of ability, cluster scores (e.g., Planning, Attention, Simultaneous Processing, Successive Processing), and individual subtest scores representing a range of abilities. The Full Scale standard score is based on the equally weighted composite of scores on the Planning, Attention, Successive, and Simultaneous subtests (e.g., PASS scales). The PASS scaled scores are derived from the sum of the subtests included in each scale and are specifically used in identification of a child's specific strengths and weaknesses in cognitive functioning (Naglieri, 1999a). The Full Scale and PASS scales each have a normative mean of 100 and standard deviation of 15, as well as respective confidence intervals and percentile ranks.

The CAS subtests can be used in two combinations to form the PASS scales and Full Scale scores: the Basic Battery and Standard Battery. The Basic Battery includes eight subtests and the Standard Battery includes all twelve subtests (Naglieri, 1999a).

For the purposes of this study, the Standard Battery was administered because it allows for a more comprehensive examination of a child's abilities. Each subtest scaled score is set at a mean of 10 and standard deviation of 3.

According to the CAS manual, evidence based on internal structure and temporal reliability coefficients was used to assess the reliability of the CAS Full Scale, PASS scales, and individual subtests of the measure (Naglieri & Das, 1997b). Reliability coefficients were calculated for all the Simultaneous and Successive subtests, except Speech Rate, using the split-half method with the entire standardization sample. The temporal reliability was used to estimate reliability for the Planning and Attention subtests as well as Speech Rate because the tests involved time. The reliability of linear combinations (Nunnally & Bernstein, 1994) was used to assess the reliability for the Standard and Basic PASS and Full Scale. Naglieri and Das (1997b) reported that the average reliability coefficients were computed using Fisher's *z* transformation. The Full Scale reliability coefficients ranged from .95 to .97 and the average reliabilities for the Standard Battery PASS Scales were .88 for Planning, .88 for Attention, .93 for Simultaneous, and .93 for Successive. When considering the stability of the CAS, Naglieri and Das (1997b) reported examining standard scores for a sample of 215 children from the standardization sample who were administered the CAS twice, over an interval that ranged from 9 to 73 days. It was reported that the mean corrected stability coefficients across all ages was .73 for the CAS subtests and .82 for the Basic and Standard Battery PASS scales.

The reliability of the underlying structure of the CAS was evaluated with the data from the current sample. All subscales were statistically significantly correlated ($p < .01$) with their respective scale (see Table 2); however, many subscales significantly loaded on multiple scales. This suggests that many subscales are not unique to one scale. For example, as hypothesized, all Planning subscales significantly loaded ($p < .001$) on the Attention scale, as well as Attention subscales ($p < .001$) on the Planning scale. Also, at least 2 out of 3 subscales for each of the Planning, Attention, and Successive Processing scales significantly loaded ($p < .01$) on the Simultaneous scale. Not surprisingly, due to the nature of the tasks, all Attention subscales significantly loaded ($p < .01$) on the Successive scale, as well as all subscales on the Full Scale (all subscales $p < .001$ except Figure Memory, $p < .01$).

Many measures of validity were utilized in assessing the CAS. With regard to evidence based on test content, the subtests and items were developed using a "combination of task analysis and experimental examination so they would efficiently reflect the processes described in the PASS theory" (Naglieri & Das, 1997b, p. 50). In examining differential item functioning, it was found that scores increased or decreased with age as expected across all subtests. Naglieri and Das (1997b) also provided inter-correlations of the PASS subtests and correlations between each subtest and scale for the standardization sample. In general, the subtests from each of the PASS Scales correlated the highest with the scales on which they were assigned and lowest on the scales in which they were not included. Confirmatory and exploratory factor analyses also were

Table 2

Correlations Between Scales and Subscales for the CAS

Subscales	1	2	3	4	5
CAS Planning	—	.46**	.80**	.38*	.84**
Matching Numbers	.89**	.37*	.72**	.27	.72**
Planned Codes	.69**	.51**	.53**	.54**	.72**
Planned Connections	.77**	.22	.62**	.12	.55**
CAS Simultaneous	.46**	—	.51**	.44*	.75**
Nonverbal Matrices	.49**	.83**	.59**	.44*	.74**
Verbal-Spatial Relat	.43*	.83**	.38*	.47**	.65**
Figure Memory	.17	.77**	.26	.15	.42*
CAS Attention	.80**	.51**	—	.43*	.88**
Expressive Attention	.69**	.57**	.83**	.38*	.78**
Number Detection	.68**	.31	.85**	.35*	.70**
Receptive Attention	.72**	.43*	.92**	.38*	.79**
CAS Successive	.38*	.44*	.43*	—	.70**
Word Series	.29	.26	.32	.86**	.54**
Sentence Repetition	.23	.45**	.32	.86**	.57**
Speech Rate	.42*	.37*	.41*	.66**	.58**

Note. CAS = Cognitive Assessment System; 1 = CAS Planning; 2 = CAS Simultaneous; 3 = CAS Attention; 4 = CAS Successive; 5 = CAS Full Scale; Relat = Relations.

**p* < .01. ***p* < .001.

conducted and are outlined in the *Cognitive Assessment System Interpretive Handbook* (Naglieri & Das, 1997b).

Test-criterion relationships as well as convergent evidence were assessed by examining the relationship between the CAS and an individually administered achievement measure (e.g., Woodcock-Johnson III: Tests of Achievement; WJ-III; Woodcock, McGrew, & Mather, 1997) and a measure of cognitive ability (e.g., Wechsler Intelligence Scale for Children – Third Edition; WISC-III; Wechsler, 1991). The reported correlation between the CAS Full Scale standard score and the WJ-R Skills cluster score (e.g., Letter-Word Identification, Applied Problems, and Dictation) was .73 for the Standard Battery and .74 for the Basic Battery. The PASS scales correlated from .50 to .67 (Standard Battery) and .44 to .64 (Basic Battery) with the WJ-R Skills Cluster. Naglieri and Das (1997b) noted that these scores suggest that the PASS cognitive processes are related to achievement as measured by the WJ-R tests of achievement.

With regard to comparisons of regular education children administered the CAS and WISC-III, the CAS Full Scale (mean = 106.1) and the WISC-III Full Scale (mean = 105.1) standard scores were comparable; consistency also was reported in the PASS scale scores. It was noted that the CAS Simultaneous and Successive scores were most related to the WISC-III. All WISC-III IQ scores and indices significantly correlated with the CAS Full Scale score at the $p < .01$ level for regular education students, as well as children with learning disabilities and mental retardation (Naglieri & Das, 1997b). When examining the CAS and a variety of neuropsychological tests (e.g., Trail Making Test, Tower of London, Token Test, Underlining Test, Embedded Figures, Stroop Color and

Word Test, and Sentence Repetition Test), results provided a perspective on the processes involved in selected neuropsychological tests (Naglieri & Das, 1997b).

NEPSY: A Developmental Neuropsychological Assessment

The NEPSY is an individually administered, comprehensive measure designed to assess neuropsychological development in preschool and school-age children ages 3 to 12. It includes a variety of tasks designed to provide information concerning attention/executive functions, language, sensorimotor functions (e.g., sensation and motor coordination), visuospatial processing (e.g., synthesize elements into a whole, represent objects mentally, judge orientation of lines, copy a model), and memory and learning areas. The NEPSY includes five sections termed “functional domains”, surrounding the above mentioned areas of functioning, and each domain includes Core and Expanded subtests from which clinicians can select additional subtests to address specific referral questions (Kemp et al., 2001). For the purposes of this study, the fourteen subtests that comprise the Core Domain Scores were administered.

Scaled scores on the NEPSY are derived from each subtest’s raw score. The five Core Domain Scores are derived from the sum of the subtests scaled scores within each domain. A Core Domain Score is yielded for the Attention/Executive Functions (EF), Language, Visuospatial, Sensorimotor, and Memory and Learning domains. Each domain score has a normative mean of 100 and standard deviation of 15. Confidence intervals and percentile ranks also are provided for each domain. The NEPSY does not yield an overall score.

According to the NEPSY manual, multiple procedures were used to assess the reliability of the NEPSY including split-half reliabilities, temporal reliability, and validity generalization (Korkman, Kirk, & Kemp, 1998b). Internal consistency reliability coefficients were calculated by partitioning the subtest into two halves of equal length and approximate quality. Pearson correlations were computed and then corrected for length of the test using the Spearman-Brown formula. Temporal reliability or validity generalizations were used for subtests with structural limitations. Specifically, temporal reliability procedures were used on subtests where a child could receive full or partial credit due to allowed latency time (e.g., Auditory Attention and Response Set) or the use of speed of performance as a scoring criterion (e.g., Fingertip Tapping) (Korkman et al., 1998b). Validity generalization procedures were used for three specific subtests (e.g., Visual Attention, Speeded Naming, and Visuomotor Precision) to account for multiple sources of error due to speed and accuracy components.

Results from the reliability studies indicated that most of the NEPSY subtests demonstrated moderate to high reliability based on internal structure (Korkman et al., 1998b). The Core Domain reliability scores were in the moderately high range, which is expected due to the wider range of behavior sampled. The authors noted that the somewhat lower reliability coefficient for the Attention/EF Core Domain Score (e.g., .70 average) for ages 3-4 is expected due to the inherent developmental variability for very young children. The remaining reliability scores for the Core Domain Scores ranged from .88 to .91 for 3- to 4-year-olds, and from .79 to .87 for 5- to 12-year-olds.

To assess for temporal reliability on the NEPSY, the Full NEPSY was administered to a sample of 168 children on two occasions, ranging from 2 to 10 weeks apart (Korkman et al., 1998b). Pearson coefficients were derived using the scores obtained from both testing sessions and coefficients for the Core Domain Scores ranged from .68 (e.g., Attention/EF) to .90 (e.g., Memory and Learning). Due to the interpretive scoring on some NEPSY subtests, inter-rater agreement also was assessed for three subtests (e.g., Design Copying, Visuomotor Precision, and Repetition of Nonsense Words). A sample of 50 test cases was selected at random from the standardization sample and scored by two trained raters. The interrater agreement coefficient was .99 for Design Copying, .99 for Visuomotor Precision, and .97 for Repetition of Nonsense Words (Korkman et al., 1998b).

With regard to evidence based on test content of the NEPSY, Korkman et al. (1998b) reported that the present version contains many of Luria's original elements, as well as content revisions based on the authors' clinical and research experience and other research studies addressing all relevant areas of the assessment measure. It is reported that experts including pediatric neuropsychologists and school psychologists from around the United States have reviewed the NEPSY twice for appropriateness of content, breadth of coverage, and bias; modifications were made accordingly.

The internal structure of the NEPSY also was evaluated; moderate positive correlations were found among the Core Domain Scores for the 3-4 year age group, while low to moderate correlations were found for children ages 5-12. In the younger age group, the highest correlations occurred between Language and Memory and

Learning, as well as Sensorimotor Functions and Visuospatial Processing. In the older age group, the highest correlations occurred between Language and Memory and Learning, and between Language and Attention/EF. Korkman et al. (1998b) noted that measures of language functioning are consistently highly correlated and that inter-correlated subtests within other domains are also present, but to a lesser degree.

The reliability of the underlying structure of the NEPSY was evaluated with the data from the current sample. All subscales were statistically significantly correlated ($p < .01$) with their respective scale (see Table 3); however, many subscales significantly loaded on multiple scales. This suggests that many subscales are not unique to one scale (e.g., Auditory Attention and Response Set, Visual Attention, Phonological Processing, Speeded Naming, Fingertip Tapping, Arrows, Memory for Faces); therefore, the proposed underlying 5-factor structure may not be the most accurate representation.

Estimates of validity also were assessed by comparing the NEPSY to other measures of cognitive, academic, and neuropsychological ability. With regard to cognitive ability, the NEPSY and the WISC-III were administered to a group of 127 non-clinical children (Korkman et al., 1998b). Results indicated moderate positive correlations between the NEPSY Core Domain and the WISC-III IQ scores, with the highest correlations between NEPSY Language Domain and the Verbal IQ ($r = .62$) and Verbal Comprehension Index ($r = .58$). The Memory and Learning Domain Score showed a similar relationship with verbal measures ($r = .43$ for both), while the Visuospatial Processing Domain Score correlated mostly with the Performance IQ ($r = .43$) and Perceptual Organization Index ($r = .45$). The remaining NEPSY domains

Table 3

Correlations Between Scales and Subscales for the NEPSY

Subscales	1	2	3	4	5
NEPSY Attention/EF	__	.56**	.53**	.55**	.45*
Tower	.66**	.26	.39*	.23	.15
Aud Atten/Resp Set	.69**	.41*	.42*	.42*	.33
Visual Attention	.65**	.45**	.29	.43*	.38*
NEPSY Language	.56**	__	.41*	.46**	.52**
Phonological Proc	.41*	.79**	.27	.29	.35*
Speeded Naming	.59**	.77**	.49**	.49**	.44*
Comp of Instruct	.27	.77**	.16	.27	.52**
NEPSY Sensorimotor	.53**	.41*	__	.28	.21
Fingertip Tapping	.46**	.41*	.81**	.24	.18
Imitating Hand Pos	.32	.40*	.66**	.21	.14
Visuomotor Precision	.34	.10	.67**	.16	.12
NEPSY Visuospatial	.55**	.46**	.28	__	.39*
Design Copying	.49**	.33	.35*	.89**	.30
Arrows	.47**	.49**	.14	.82**	.39*
NEPSY Memory	.45*	.52**	.21	.39*	__
Memory for Faces	.36*	.33	.24	.37*	.72**
Memory for Names	.31	.54**	.08	.24	.73**
Narrative Memory	.29	.27	.12	.23	.68**

Note. NEPSY = A Developmental Neuropsychological Assessment; EF = Executive Function; 1 = NEPSY Attention/EF; 2 = NEPSY Language; 3 = NEPSY Sensorimotor; 4 = NEPSY Visuospatial; 5 = NEPSY Memory; Aud Atten/Resp Set = Auditory Attention and Response Set; Proc = Processing; Comp of Instruct = Comprehension of Instructions; Pos = Positions.

**p* < .01. ***p* < .001.

(e.g., Attention/EF and Sensorimotor Functions) resulted in low moderate correlations across all IQ scores. Similar results were found when comparing the NEPSY to other cognitive ability tests (e.g., Wechsler Preschool and Primary Scale of Intelligence – Revised and Bayley Scales of Infant Development – Second Edition).

With regard to academic achievement, in a study using 445 children (Korkman et al., 1998b), the NEPSY measure resulted in low positive correlations with classroom grades; however, the Language Core Domain Score was the most predictive of academic performance. When compared to the Wechsler Individual Achievement Test (WIAT), the Language Core Domain Score had a moderate relationship with each of the WIAT domains. Also, there was a moderate relationship between Visuospatial Processing and math skills (r = .44) and Attention/EF and Language (r = .57). When examining the NEPSY with regard to other relevant neuropsychological tests (e.g., Benton Neuropsychological Tests) and measures of memory and attention, moderate correlations were found in areas of attention, executive functioning, language, visuospatial processing, and memory (Korkman et al., 1998b).

Peabody Picture Vocabulary Test – III (PPVT-III)

The Peabody Picture Vocabulary Test – III (PPVT-III; Dunn & Dunn, 1997a) is an individually administered, norm-referenced test designed to be used as a measure of receptive vocabulary or as a screening test of verbal ability and intellectual functioning (Dunn & Dunn, 1997b). There are two forms of the test (e.g., Form A and Form B) and each item consists of four black and white pictures presented on a picture plate. The examinee is asked to select the picture that best represents the meaning of a stimulus word presented orally by the examiner. For the purposes of this study, Form A was used. A raw score is calculated by subtracting the number of incorrect responses from the highest item number administered. The raw score is transferred into a standard score with a mean of 100 and a standard deviation of 15. Percentile ranks, normal curve equivalents, stanines, and age equivalent scores also are calculated.

According to the PPVT-III manual, alpha reliability coefficients and split half reliability coefficients were obtained for the PPVT-III as estimates of evidence based on internal structure (Dunn & Dunn, 1997b). The median alpha reliability coefficient for both Form A and Form B was .95, and scores ranged from .92 to .98. Unadministered items were included in the computation; therefore, the authors noted that caution should be used when interpreting these results because spuriously higher coefficients may have resulted. Split half reliability coefficients also were computed by taking the items actually administered to each participant and dividing them into comparable halved, with the odd-numbered items in one half and the even-numbered in the other half. A W-ability scale score was estimated for each part and then the scores were correlated and the full-test length coefficient was estimated using the Spearman-Brown formula. The median reliability score for each form was .94, with scores ranging from .86 to .97 (Dunn & Dunn, 1997b).

Alternate-forms reliability coefficients also were computed by administering both forms A and B of the PPVT-III to all participants from the standardization sample within the same session or a few days apart. The coefficient of equivalence was computed and the median coefficient was .94, with scores ranging from .88 to .96. As a measure of temporal stability, both forms were administered to 226 participants during the initial session and approximately one month later; all reliability coefficients were in the .90s (Dunn & Dunn, 1997b).

A variety of procedures were used to assess the validity of the PPVT-III. With regard to evidence based on test content, the authors noted that the stimulus words were selected and retained on the basis of rational, logical reasoning and selection of the pictures were selected and retained using statistical procedures such as item analysis (Dunn & Dunn, 1997b). Possible stimulus words, whose meanings could be clearly depicted with black and white line drawings, were chosen from the 1953 edition of *Webster's New Collegiate Dictionary*. An original pool of 300 items was used on the original PPVT. An expanded item pool was selected for the second edition of the PPVT (PPVT-R) from the 1967 edition of *Webster's New Collegiate Dictionary* and other published studies. Of the final pool of 350 items retained for initial consideration of the PPVT-R, only 144 were of the original 300 words. The item pool for the PPVT-III was further expanded, and the authors used information from a variety of sources including the 1981 edition of *Webster's New Collegiate Dictionary*, *Roget's International Thesaurus*, *The American Heritage Word Frequency Book*, and picture dictionary books (Dunn & Dunn, 1997b).

With regard to the 480 picture plates selected for field testing, an original pool of 1,920 illustrations was used, with some art being retained from the two previous editions of the PPVT (Dunn & Dunn, 1997b). The authors noted that highly qualified commercial illustrators drew the original illustrations, while computer graphics specialists edited, refined, and balanced the art (Dunn &Dunn, 1997b). Field testing and final item selection was based on a national tryout of a 480-item pool, with a sample of 908 participants. To identify poorly discriminating items, both classical and Rasch item analyses were conducted. The tryout pool was reduced to a final 408 items that were later divided into two parallel test forms (e.g., Form A and Form B), each consisting of 204 items.

When considering differential item functioning, Dunn and Dunn (1997b) reported a logical rationale based on evidence from previous measures (e.g., Binet-Simon Intelligence Scale, Revised Stanford-Binet Tests of Intelligence, WISC-R, WISC-III, and DAS) that purported that vocabulary tests and tests of verbal ability significantly correlate with overall intelligence. Test-criterion relationships were assessed by examining correlations between the PPVT-III and a variety of measures including the WISC-III, the KAIT, the Kaufman Brief Intelligence Test (K-BIT; Kaufman & Kaufman, 1990), and the Oral and Written Language Scales (OWLS; Carrow-Woolfolk, 1995). The following are the reported corrected correlations for the PPVT-III and the above respective tests: WISC-III ranged from .82 to .92, KAIT ranged from .76 to .91, K-BIT ranged from .62 to .82, and OWLS ranged from .63 to .83. As expected, the PPVT-III standard scores correlated slightly higher with vocabulary and verbal scores from the respective tests, as well as with the Crystallized IQ scores from the KAIT as opposed to the Fluid IQ or Composite IQ scores (Dunn & Dunn, 1997b).

Behavioral Assessment System for Children (BASC)

Obtaining a thorough history is particularly important when assessing preschool and school-age children. Hartlage and Williams (1990) recommended that information in the following areas is essential to obtain when assessing the neurological functioning of children: prenatal and perinatal (e.g., significant illness or trauma endured by mother during pregnancy, duration and conditions of labor, periods of separation of child and mother), neonatal (e.g., insults to the central nervous system,, medical disorders of non-neurological origin), development (e.g., developmental milestones in such areas as language and motor abilities, comparison with siblings on milestones), and family history (e.g., late development of verbal or motor skills, other developmental disorders, attentional problems). Due to the importance of a thorough history in providing a holistic presentation of a child's functioning, the current study included the Behavioral Assessment System for Children – Structured Developmental History (BASC-SDH; Reynolds & Kamphaus, 1992) as a measure to gather the respective information.

To obtain a more holistic view of a child's functioning and interaction with the environment, it was deemed appropriate to collect emotional and behavioral information from a variety of sources and settings using the Behavior Assessment System for Children parent and teacher rating scales (BASC-PRS & TRS). These measures are described as providing a multidimensional approach to evaluating dimensions of behavior and personality in children, both positive and negative (Reynolds & Kamphaus, 2002). These questionnaires require a parent/guardian or teacher to rate a number of observable behaviors according to frequency evidenced during the past six months. With regard to preschool and younger, school-age children, the BASC-PRS has nine clinical scales including Hyperactivity, Aggression, Conduct Problems, Anxiety, Depression, Somatization, Atypicality, Withdrawal, and Attention Problems, and three adaptive scales including Adaptability, Social Skills, and Leadership.

This emotional/behavioral measure also yields four composite scores including Externalizing Problems, Internalizing Problems, Behavioral Symptoms Index, and Adaptive Skills. The BASC-TRS includes the above mentioned nine scales and also adds the Learning Problems clinical scale, as well as the Study Skills adaptive scale and a School Problems composite score (Reynolds & Kamphaus, 2002). Each scale yields a mean *T* score of 50 and a standard deviation of 10. Confidence intervals and percentile ranks also are reported for each scale. With regard to the clinical scales, a *T* score of 70 or above is considered clinically significant, whereas a *T* score ranging from 60-69 is considered in the at-risk range. When considering the adaptive scales, a *T* score of 30 or below is considered clinically significant, whereas a *T* score ranging from 31-40 is considered in the at-risk range. Adequate reliability and validity has been shown for this measure (Reynolds & Kamphaus, 2002). For this study, forty-five parent BASC forms were returned and analyzed, as well as twelve teacher forms.

Behavior Rating Inventory of Executive Function (BRIEF)

Due to the emphasis regarding neuropsychological theory and cognitive processes in the current study, it was decided that the Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000) would be used to collect information concerning executive processes in children. The BRIEF is a specific measure used to assess executive functioning behaviors in preschool and school-age children, such as the ability to control and maintain attention, organize and plan, “hold” information in working memory, and formulate and manipulate mental models. There are eight clinical scales including Inhibit, Shift, Emotional Control, Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor that are used to measure executive functioning. There also are two broad indexes (e.g., Metacognition and Behavioral Regulation), and an overall score (e.g., Global Executive Composite). Each scale yields a mean *T* score of 50 and a standard deviation of 10. Confidence intervals and percentile ranks also are reported for each scale. A *T* score of 70 or above is considered clinically significant, whereas a *T* score of 60-69 is considered in the at-risk range. The BRIEF scales were introduced following initial collection of data; therefore, BRIEF scales are not available for every child. For this study, thirty-two parent BRIEF forms were returned and analyzed, as well as twelve teacher forms.

Descriptive statistics and results by research question are presented in Chapter IV. Interpretation and summation of the results, as well as implications for future research are provided in Chapter V.

CHAPTER IV

RESULTS

Chapter I provided a general overview of the current study, identifying the purpose and outlining the three primary research questions. Chapter II presented an extensive review of the literature surrounding the research questions, while Chapter III described the methodology used in the study. The current chapter details the results of the study. The results are provided in narrative, tabular, and graphic format. Chapter V will include an interpretation and summation of the results in relation to the respective research questions.

Data Analyses

Descriptive Statistics

Descriptive statistics including mean scores and standard deviations, as well as skewness and kurtosis were computed for all measures in the study and are presented in Table 4. Upon review, this sample appears to be appropriately heterogeneous with ability levels ranging from below average to above average (e.g., PPVT-III standard score range = 88-146; CAS Full Scale standard score range = 77-145; NEPSY standard score range = 75 [Sensorimotor]-150 [Language and Visuospatial]). Data pertaining to social and emotional behavior, as evaluated with the BASC parent and teacher report scales, also resulted in a range of scores (e.g., BASC parent *T*-score range = 30

Table 4

Total Sample Descriptive Statistics

	N	Mean	*SD*	Skewness	Kurtosis
PPVT-III	48	111.6	12.5	.17	.08
CAS					
Planning	48	110.0	13.7	-.27	-.65
Simultaneous	48	114.2	13.3	-.27	.76
Attention	48	110.2	14.9	-.28	.00
Successive	48	101.9	12.1	.35	.83
Full Scale	48	111.5	14.1	-.10	.79
NEPSY					
Attention/EF	48	116.7	12.2	-.38	.81
Language	48	109.4	15.2	.75	.75
Sensorimotor	48	98.2	13.1	.36	-.41
Visuospatial	48	113.1	13.9	.25	-.12
Memory	48	111.2	14.8	-.05	-.27
BASC Parent					
Hyperactivity	45	45.0	9.5	1.6	4.6
Aggression	45	48.0	7.7	.02	-1.1
Anxiety	45	47.9	10.4	1.2	2.2
Depression	45	43.7	8.6	1.1	1.5

Table 4. Continued

	N	Mean	*SD*	Skewness	Kurtosis
BASC Parent					
Somatization	45	44.4	9.3	.49	-.70
Atypicality	45	44.2	8.6	2.1	5.2
Withdrawal	45	45.1	7.4	.52	-.05
Attention Probs	45	47.3	10.6	.98	1.3
Adaptability	45	53.6	9.9	-.03	-.64
Social Skills	45	55.3	9.4	-.42	-.19
Externalizing Probs	45	46.3	8.0	.80	1.7
Internalizing Probs	45	43.9	9.5	1.5	3.4
Behavioral Symp	45	44.4	8.3	.97	1.6
Adaptive Skills	45	55.2	9.5	-.05	-.42
BASC Teacher					
Hyperactivity	12	50.0	12.8	.88	-.77
Aggression	12	52.6	12.4	.69	-.84
Anxiety	12	54.8	10.1	.01	-.76
Depression	12	48.0	8.9	.90	-.30
Somatization	12	49.8	11.3	1.4	1.9
Attention Probs	12	48.9	13.4	.73	-.54
Atypicality	12	49.0	9.7	1.7	2.3

Table 4. Continued

	N	Mean	*SD*	Skewness	Kurtosis
BASC Teacher					
Withdrawal	12	48.2	8.7	1.1	.82
Adaptability	12	51.1	8.5	.11	-.58
Social Skills	12	50.5	8.8	.48	-.33
Externalizing Probs	12	51.3	11.4	.81	-.82
Internalizing Probs	12	51.5	9.5	.19	-.76
Behavioral Symp	12	51.4	9.7	.19	-1.1
Adaptive Skills	12	50.9	6.4	1.1	2.7
BRIEF Parent					
Inhibit	32	50.0	9.1	.78	.58
Shift	32	47.5	10.1	.99	-.13
Emotional Control	32	49.8	11.8	.58	.15
Initiate	32	51.4	9.5	.46	-.19
Working Memory	32	51.4	11.9	.29	-1.3
Plan/Organize	32	52.1	7.9	.33	-.24
Org of Materials	32	51.2	11.0	.28	-.62
Monitor	32	50.5	12.4	.22	-1.2
BRI	32	48.9	9.7	.69	.43
MI	32	51.3	10.4	.26	-1.1
GEC	32	50.6	10.0	.39	-.46

Table 4. Continued

	N	Mean	*SD*	Skewness	Kurtosis
BRIEF Teacher					
Inhibit	12	54.0	9.0	.27	-1.3
Shift	12	53.6	11.0	.54	-1.2
Emotional Control	12	55.4	13.1	1.4	1.9
Initiate	12	53.1	9.8	.93	1.5
Working Memory	12	54.8	13.8	.98	.68
Plan/Organize	12	52.5	10.5	.41	-1.0
Org of Materials	12	55.2	12.1	.98	.13
Monitor	12	54.8	10.6	-.07	-1.7
BRI	12	54.7	9.1	.10	-1.2
MI	12	54.6	11.6	.63	-.17
GEC	12	54.8	10.3	.21	-1.1

Note. SD = Standard Deviation; PPVT-III = Peabody Picture Vocabulary Test-III; CAS = Cognitive Assessment System; NEPSY = A Developmental Neuropsychological Assessment; EF = Executive Function; BASC = Behavioral Assessment System for Children; Probs = Problems; Symp = Symptoms; BRIEF = Behavior Rating Inventory of Executive Function; Org of Materials = Organization of Materials; BRI = Behavioral Regulation Index; MI = Metacognition Index; GEC = Global Executive Composite.

[Internalizing Problems and Behavioral Symptoms]-83 [Hyperactivity]; BASC teacher *T*-score range = 37 [Hyperactivity and Depression]-77 [Somatization]). Results from parent and teacher BRIEF forms evaluating executive functioning ranged in scores as well (e.g., BRIEF parent *T*-score range = 32 [Monitor]-82 [Emotional Control]; BRIEF teacher *T*-score range = 38 [Working Memory]-87 [Emotional Control]). Skewness and kurtosis were within normal ranges for all measures.

Correlations

The first research question addressed the interrelations between the CAS, NEPSY, PPVT-III, BASC, and BRIEF. Results pertaining to the BASC and BRIEF will be presented later in this chapter. In order to determine the level of association between the CAS, NEPSY, and PPVT-III, Pearson Product Moment correlations were computed and are displayed in a correlation matrix in Table 5. Due to the number of correlations, it was necessary to control for Type 1 error, and thus, statistical significance was set at $p < .01$. Because of the similar nature of their proposed underlying constructs (e.g., language and attention), it was hypothesized, and confirmed by the data from the current study, that moderate to high correlations would result between the following scales: a) CAS Full Scale and PPVT-III ($r = .51$, $p < .001$); b) NEPSY Language and PPVT-III ($r = .48$, $p < .001$); c) CAS Attention and NEPSY Attention/EF ($r = .60$, $p < .001$); d) CAS Planning and NEPSY Attention/EF ($r = .52$, $p < .001$). The CAS Simultaneous Processing and NEPSY Memory ($r = .46$, $p < .001$) also significantly correlated; however, there was little association between the CAS Successive Processing scale and NEPSY Memory scale ($r = .32$, $p < .05$), with regard to this sample.

Table 5

Correlations Between Scales for the CAS, NEPSY, and PPVT-III

Scales	1	2	3	4	5	6	7	8	9	10	11
CAS Planning	—	.46**	.80**	.38*	.84**	.52**	.53**	.24	.32	.31	.45**
CAS Simultaneous		—	.51**	.44*	.75**	.43*	.57**	.15	.32	.46**	.39*
CAS Attention			—	.43*	.88**	.60**	.47**	.42*	.31	.40*	.47**
CAS Successive				—	.70**	.23	.33	.43*	-.06	.32	.30
CAS Full Scale					—	.58**	.60**	.40*	.28	.47**	.51**
NEPSY Attention/EF						—	.56**	.53**	.55**	.45*	.42*
NEPSY Language							—	.41*	.46**	.52**	.48**
NEPSY Sensorimotor								—	.28	.21	.24
NEPSY Visuospatial									—	.39*	.23
NEPSY Memory										—	.38**
PPVT-III											—

Note. CAS = Cognitive Assessment System; NEPSY = A Developmental Neuropsychological Assessment; PPVT-III = Peabody Picture Vocabulary Test-III; EF = Executive Function; 1 = CAS Planning; 2 = CAS Simultaneous; 3 = CAS Attention; 4 = CAS Successive; 5 = CAS Full Scale; 6 = NEPSY Attention/EF; 7 = NEPSY Language; 8 = NEPSY Sensorimotor; 9 = NEPSY Visuospatial; 10 = Memory; 11 = PPVT-III.

**p* < .01. ***p* < .001.

Data analyses also resulted in moderate positive correlations between three of the CAS scales and the NEPSY Language scale (Planning, $r = .53$, $p < .001$; Simultaneous, $r = .57$, $p < .001$; Full Scale, $r = .60$, $p < .001$). The CAS Full Scale score moderately correlated with NEPSY Attention ($r = .58$, $p < .001$). Other scales significantly correlated at the $p < .001$ level, including the following: CAS Planning and PPVT-III ($r = .45$); CAS Attention and NEPSY Language ($r = .47$); CAS Attention and PPVT-III ($r = .47$); CAS Full Scale and NEPSY Memory ($r = .47$).

The first research question also addressed the association between the BASC and BRIEF with respect to the CAS, NEPSY, and PPVT-III. Pearson Product Moment correlations were computed independently for the BASC and BRIEF; separate correlation matrices are located in Tables 6 and 7. As noted previously, BASC parent forms were available for forty-five children, while teacher forms were only available for twelve. BRIEF parent forms were available for thirty-three children and teacher forms were available for twelve. Caution should be used when interpreting scores for the teacher scales for both measures because of the low return rate. Due to the number of correlations and to greater control for Type 1 error, statistical significance was set at $p < .01$ for both BASC and BRIEF results.

With regard to the BASC, the following variables were removed prior to data analysis due to inconsistencies in the preschool and school-age forms: Conduct Problems (parent and teacher form), Leadership Skills (parent and teacher form), Learning Problems (teacher form), Study Skills (teacher form), and School Problems (teacher form). It was hypothesized that moderate correlations would result between the following scales: a) CAS Planning and BASC Hyperactivity; b) CAS Planning and BASC Attention Problems; c) CAS Simultaneous Processing and BASC Attention Problems; d) CAS Attention and BASC Hyperactivity; e) CAS Attention and BASC Attention Problems; f) CAS Attention and BASC Depression; g) CAS Successive Processing and BASC Attention Problems; h) NEPSY Attention/EF and BASC Hyperactivity; i) NEPSY Attention/EF and BASC Attention Problems; j) NEPSY Attention/EF and BASC Depression; k) NEPSY Attention/EF and BASC Anxiety; l) NEPSY Memory and BASC Attention Problems.

Results suggested few statistically significant associations between the BASC and the CAS and NEPSY; none of which were originally hypothesized. There were no significant correlations with respect to the BASC subscales and PPVT-III. With regard to the BASC parent form, the following low to moderate correlations resulted between scales at the $p < .01$ level: a) NEPSY Attention/EF and BASC Atypicality ($r = -.39$); b) CAS Full Scale and BASC Attention Problems ($r = -.40$); c) CAS Planning and BASC Adaptability ($r = .39$); d) CAS Attention and BASC Adaptability ($r = .35$); e) CAS Simultaneous and BASC Social Skills ($r = .44$); f) CAS Full Scale and BASC Social Skills ($r = .38$); g) CAS Planning and BASC Adaptive Skills ($r = .36$); h) CAS Simultaneous and BASC Adaptive Skills ($r = .46$); i) CAS Full Scale and BASC Adaptive Skills ($r = .41$). With regard to the BASC teacher form, the following moderate correlations resulted between scales at the $p < .01$ level: a) CAS Simultaneous and BASC Atypicality ($r = -.66$); b) CAS Full Scale and BASC Atypicality ($r = -.68$); c) CAS Successive Processing and BASC Adaptive Skills ($r = .69$).

Table 6

Correlations Between Subscales for the BASC Parent and Teacher Rating Scales with the CAS, NEPSY, and PPVT-III

Subscales	1	2	3	4	5	6	7	8	9	10	11
BASC-P Hyperactivity	.02	-.11	-.06	-.15	-.10	-.09	-.04	-.06	.07	.07	.05
BASC-P Aggression	-.11	.10	-.01	-.10	-.04	.04	.09	.20	.30	.13	-.00
BASC-P Anxiety	.11	.08	.02	.16	.12	-.16	-.05	.10	.03	-.07	-.11
BASC-P Depression	.05	.18	.12	.25	.18	.12	.07	.26	.17	.13	-.05
BASC-P Somatization	.08	.10	.21	.24	.20	.26	-.00	.19	.18	.00	.10
BASC-P Atypicality	-.14	-.12	-.14	-.10	-.18	-.19	-.39*	-.18	.06	-.11	-.11
BASC-P Withdrawal	-.17	-.19	-.13	.16	-.10	-.12	-.11	.18	.07	-.03	-.31
BASC-P Attention Probs	-.32	-.31	-.34	-.30	-.40*	-.18	-.25	-.13	-.09	.06	-.11
BASC-P Adaptability	.39*	-.31	.35*	.02	.34	.19	.08	-.21	.04	.13	.29
BASC-P Social Skills	.24	.44*	.25	.28	.38*	.03	.01	-.07	.07	.17	.32
BASC-P Externalizing	-.08	-.07	-.05	-.17	-.12	-.05	-.02	.07	.18	.10	.02
BASC-P Internalizing	.10	.15	.14	.28	.20	.08	.00	.23	.15	.02	-.03

Table 6. Continued

Subscales	1	2	3	4	5	6	7	8	9	10	11
BASC-P Behave Symp	-.11	-.07	-.12	-.07	-.13	-.13	-.17	.03	.12	.05	-.09
BASC-P Adaptive Skills	.36*	.46*	-.33	.16	.41*	.13	.10	-.19	.09	.18	.36
BASC-T Hyperactivity	-.20	-.25	-.22	-.51	-.39	-.14	-.09	-.50	-.34	.01	.51
BASC-T Aggression	-.04	-.19	.16	-.34	-.12	.01	.02	-.15	-.22	.07	.52
BASC-T Anxiety	.27	-.36	.07	-.36	-.15	-.53	-.32	-.07	-.29	-.60	-.31
BASC-T Depression	-.11	-.21	.12	-.10	-.11	-.28	-.35	.16	-.51	-.38	.05
BASC-T Somatization	-.41	-.37	-.12	-.25	-.42	.16	-.44	.35	.14	-.21	-.32
BASC-T Attention Prob	-.21	-.34	-.39	-.59	-.54	-.57	-.40	-.59	-.57	-.31	.18
BASC-T Atypicality	-.45	-.66*	-.45	-.32	-.68*	-.18	-.21	-.13	-.41	-.52	.26
BASC-T Withdrawal	-.36	-.47	-.01	-.14	-.10	.14	.37	.17	.14	-.54	-.18
BASC-T Adaptability	-.03	.27	-.16	.61	.20	.08	.09	.04	.18	.03	-.44
BASC-T Social Skills	-.09	.39	.25	.24	.29	.39	.05	.33	.28	.27	.10
BASC-T Externalizing	-.04	-.21	.07	-.45	-.19	-.03	.02	-.28	-.23	.08	.56

Table 6. Continued

Subscales	1	2	3	4	5	6	7	8	9	10	11
BASC-T Internalizing	-.06	-.42	.08	-.33	-.28	-.29	-.49	.20	-.23	-.54	-.30
BASC-T Behave Symp	-.11	-.48	-.11	-.61	-.46	-.47	-.37	-.38	-.51	-.42	.28
BASC-T Adaptive Skills	.08	.44	.13	.69*	.45	.30	.35	.28	.20	.23	.03

Note. CAS = Cognitive Assessment System; NEPSY = A Developmental Neuropsychological Assessment; PPVT-III = Peabody Picture Vocabulary Test-III; BASC = Behavioral Assessment System for Children; BASC-P = BASC Parent Rating Scale; BASC-T = BASC Teacher Rating Scale; Behave Symp = Behavioral Symptoms; 1 = CAS Planning; 2 = CAS Simultaneous; 3 = CAS Attention; 4 = CAS Successive; 5 = CAS Full Scale; 6 = NEPSY Attention/EF; 7 = NEPSY Language; 8 = NEPSY Sensorimotor; 9 = NEPSY Visuospatial; 10 = Memory; 11 = PPVT-III.

*$p < .01$.

The BRIEF also was correlated with the CAS, NEPSY, and PPVT-III to determine the strength and direction of associations (see Table 7). Assuming that the BRIEF scales are a measure of executive functioning, and that attention and planning are examples of executive functions, it was hypothesized that moderate correlations would result between the following scales: a) CAS Attention and all BRIEF scales except Emotional Control; b) CAS Planning and BRIEF Plan/Organize; c) NEPSY Attention/EF and all BRIEF scales except Emotional Control.

Results suggested few statistically significant associations with the BRIEF and the CAS and NEPSY. There were no significant correlations with respect to the BRIEF subscales and PPVT-III. Only two of the original hypotheses resulted in statistically significant associations; a) CAS Attention and Parent BRIEF Shift (r = -.51, p < .01); b) NEPSY Attention/EF and Teacher BRIEF Organization of Materials (r = -.67, p < .01). The following low to moderate correlations also resulted with regard to BRIEF parent scales at the p < .01 level: a) CAS Simultaneous and BRIEF Shift (r = -.43); b) CAS Full Scale and BRIEF Shift (r = -.48); c) CAS Planning and BRIEF Working Memory (r = -.45). With respect to the BRIEF teacher form, the following moderate correlations resulted between scales at the p < .01 level: a) NEPSY Visuospatial and BRIEF Plan/Organize (r = -.70); b) NEPSY Visuospatial and BRIEF BRI (r = -.66); c) NEPSY Visuospatial and BRIEF GEC (r = -.69).

Table 7

Correlations Between Subscales for the BRIEF Parent and Teacher Rating Scales with the CAS, NEPSY, and PPVT-III

Subscales	1	2	3	4	5	6	7	8	9	10	11
BRIEF-P Inhibit	-.15	-.16	-.14	-.19	-.22	-.30	.05	-.09	.07	-.01	-.03
BRIEF-P Shift	-.29	-.43*	-.51*	-.16	-.48*	-.32	.11	.14	-.02	-.27	-.21
BRIEF-P Emot Control	-.07	-.08	-.07	.07	-.06	.05	.29	.35	.14	.12	-.13
BRIEF-P Initiate	-.29	-.35	-.27	-.10	-.34	-.13	-.14	.18	.09	-.02	-.29
BRIEF-P Work Memory	-.45*	-.18	-.35	-.24	-.41	-.32	-.24	-.07	-.18	-.04	-.20
BRIEF-P Plan/Organize	-.24	-.17	-.32	-.00	-.25	-.30	-.01	-.09	.00	.06	-.16
BRIEF-P Org of Materials	-.18	-.34	-.21	-.26	-.34	-.18	.00	.01	.10	-.04	-.04
BRIEF-P Monitor	-.33	-.23	-.35	-.12	-.36	-.17	.07	.03	.08	.21	-.06
BRIEF-P BRI	-.19	-.23	-.24	-.09	-.26	-.18	.20	.20	.10	-.02	-.14
BRIEF-P MI	-.35	-.28	-.34	-.17	-.39	-.26	-.07	.00	.00	.04	-.17
BRIEF-P GEC	-.32	-.28	-.34	-.16	-.38	-.24	.04	.08	.06	.03	-.18

Table 7. Continued

Subscales	1	2	3	4	5	6	7	8	9	10	11
BRIEF-T Inhibit	-.37	-.16	-.05	-.28	-.28	-.16	-.34	-.23	-.54	-.11	.57
BRIEF-T Shift	-.48	-.43	-.16	-.36	-.51	-.14	-.63	.22	-.28	-.41	-.15
BRIEF-T Emot Control	-.11	-.26	-.00	.18	-.10	-.36	-.11	.21	-.56	-.15	.25
BRIEF-T Initiate	-.37	-.17	-.49	-.46	-.51	-.48	-.55	-.39	-.40	-.21	-.11
BRIEF-T Work Memory	-.36	-.25	-.45	-.50	-.54	-.65	-.61	-.53	-.59	-.37	.02
BRIEF-T Plan/Organize	-.29	-.21	-.29	-.46	-.43	-.60	-.53	-.48	-.70*	-.29	.27
BRIEF-T Org of Materials	-.05	-.27	-.28	-.41	-.35	-.67*	-.35	-.45	-.51	-.22	.16
BRIEF-T Monitor	-.51	-.22	-.34	-.39	-.50	-.35	-.52	-.37	-.65	-.17	.38
BRIEF-T BRI	-.41	-.36	-.06	-.15	-.36	-.32	-.47	.10	-.66*	-.28	.35
BRIEF-T MI	-.36	-.25	-.42	-.49	-.52	-.61	-.57	-.52	-.64	-.28	.17
BRIEF-T GEC	-.40	-.31	-.33	-.44	-.52	-.55	-.59	-.35	-.69*	-.32	.22

Note. CAS = Cognitive Assessment System; NEPSY = A Developmental Neuropsychological Assessment; PPVT-III = Peabody Picture Vocabulary Test-III; BRIEF = Behavior Rating Inventory of Executive Function; BRIEF-P = BRIEF Parent Rating Scale; BRIEF-T = BRIEF Teacher Rating Scale; Emot Control = Emotional Control; Org of Materials = Organization of Materials; BRI = Behavioral Regulation Index; MI = Metacognition Index; GEC = Global Executive Composite; 1 = CAS Planning; 2 = CAS Simultaneous; 3 = CAS Attention; 4 = CAS Successive; 5 = CAS Full Scale; 6 = NEPSY Attention/EF; 7 = NEPSY Language; 8 = NEPSY Sensorimotor; 9 = NEPSY Visuospatial; 10 = Memory; 11 = PPVT-III.

*$p < .01$.

Confirmatory Factor Analyses

Confirmatory factor analyses were used to determine the number of hypothetical constructs (or factors) that could be explained by the relations among the observed variables. The analyses were conducted using AMOS 4.01 version (Arbuckle, 1999), and maximum-likelihood estimation of standard scores was used for all analyses. Maximum-likelihood extraction allows computation of several goodness-of-fit indices, as well as the testing of the significance of loadings and correlations between factors, with the assumption of multivariate normality. Several goodness-of-fit indices were chosen to evaluate these hypothesized models. Although the chi-square statistic (X^2) is the most common fit index, it assumes a large sample to obtain precise parameters, and may be statistically significant even though differences between observed and model-implied covariances are minimal (Kline, 1998). One fit statistic that was created to address this problem was the X^2/degrees of freedom ratio (X^2/df; Byrne, 2001), which was used in this study. Although no clear guideline has been set regarding a minimally acceptable value, it is suggested that the ratio be less than 3 (Kline, 1998).

Additional goodness-of-fit indices were used to evaluate all hypothesized models, including the Goodness-of-Fit Index (GFI), Adjusted Goodness-of-Fit Index (AGFI; Jöreskog & Sörbom, 1993), Normed Fit Index (NFI; Bentler & Bonett, 1980), Comparative Fit Index (CFI; Bentler, 1990), Incremental Fit Index (IFI; Bollen, 1989), Root-Mean-Square error of approximation (RMSEA; Browne & Cudeck, 1993; Hu & Bentler, 1999), Bayes Information Criterion (BIC; Raftery, 1993), and Expected Cross-Validation Index (ECVI). Some fit indices were selected based on past literature (e.g., GFI, NFI, RMSEA); however, the remaining indices were chosen so that sample size, degrees of freedom, and parsimony could be taken into account (e.g., AGFI, CFI, IFI). With regard to analysis of covariance structures, statistical significance is driven by the degrees of freedom involving the parameters and the number of elements in the sample covariance matrix (Byrne, 2001).

The GFI statistic “indicates the proportion of the observed covariances explained by the model-implied covariances” (Kline, 1998, p. 128), whereas the AGFI further adjusts for degrees of freedom in the hypothesized model and addresses the issue of parsimony (Byrne, 2001). For both statistics, values close to 1.00 are indicative of a good fit. Although the NFI is considered the classic incremental or comparative index, it has been shown to underestimate fit in small sample sizes; whereas, the CFI (revised NFI statistic) takes sample size into account (Bentler, 1990; Byrne, 2001). Another revised NFI statistic, the IFI, also addresses sample size as well as degrees of freedom and parsimony. With regard to these statistics, values greater than .90 are considered a good fit, while values close to .95 are indicative of a superior fit (Byrne, 2001).

The RMSEA (Steiger & Lind, 1980) takes into account error of approximation in the population and is sensitive to the complexity of the model (e.g., number of estimated parameters); however, when sample size is small, it tends to over-reject true population models (Byrne, 2001). Values less than .05 are considered a good fit, whereas values near .08 are reasonable and .08 to 1.0 are considered mediocre (Byrne, 2001). The Bayes Information Criterion (BIC; Raftery, 1993) and Expected Cross-Validation Index (ECVI) are commonly used for model comparison. The BIC reflects the extent to which the sample parameter estimates will cross-validate in future samples, whereas the ECVI determines the likelihood that the model will cross-validate in similar-sized samples from the same population (Browne & Cudeck, 1989). Although no specified range of values is indicated, both fit statistics for the hypothesized model should be smaller than that of the independence or saturated model to signify the best fit to the data (Byrne, 2001). When two models are compared, a BIC difference of 5 points provides strong evidence of a better fit for the model with the lower value (Raftery, 1993).

CAS Analyses

In order to address the second research question and determine which conceptual model best summarizes the CAS data in this sample, CFA was used to test four theoretical models: a 1-factor Language model, a 3-factor Developmental model, a 3-factor model based on Luria's theory, and the 4-factor PASS model. Figure 1 illustrates the 1-factor Language model used for the first set of analyses. The left side of the model, as for all the CAS models, displays the subtests from the CAS, while the right side illustrates the hypothesized construct(s). Each set of analyses for the hypothesized models was attempted with and without correlation of the error scores to determine which was a better fit to the data. Goodness-of-fit statistics for all models are shown in Table 8.

The first set of analyses examined the first-order, 1-factor Language model (see Figure 1) and demonstrated a poor to moderate fit to the data when examining most fit indices (X^2/df = 1.96, good; GFI = .69, poor; AGFI = .56, poor; NFI = .64, poor; CFI = .77, moderate; IFI = .78, moderate; RMSEA = .14, poor; BIC = 258.38; ECVI = 3.27).

Table 8

Goodness-of-Fit Statistics for Confirmatory Factor Analyses with the CAS

	X^2/df	GFI	AGFI	NFI	CFI	IFI	RMSEA	BIC	ECVI
CAS									
1-Factor Language Model	1.96	.69	.56	.64	.77	.79	.14	258.38	2.68
Uncorrelated Error Scores									
1-Factor Language Model	1.28	.85	.73	.82	.95	.95	.08	282.56	2.68
Correlated Error Scores									
3-Factor Developmental Model	1.33	.82	.72	.77	.93	.93	.08	239.66	2.60
3-Factor Luria's Model	1.59	.78	.67	.73	.87	.88	.11	252.72	2.88
4-Factor PASS Model	1.41	.82	.71	.77	.92	.92	.09	258.11	2.71

Note. CAS = Cognitive Assessment System; X^2/df = Chi-square/degrees of freedom ratio; GFI = Goodness-of-Fit Index; AGFI = Adjusted Goodness-of-Fit Index; NFI = Normed Fit Index; CFI = Comparative Fit Index; IFI = Incremental Fit Index; RMSEA = Root-Mean-Square error of approximation; ECVI = Expected Cross-Validation Index; PASS Model = Planning, Attention, Successive Processing, and Simultaneous Processing Model.

Table 9

Goodness-of-Fit Statistics for Confirmatory Factor Analyses with the NEPSY

	X^2/df	GFI	AGFI	NFI	CFI	IFI	RMSEA	BIC	ECVI
NEPSY									
1-Factor Language Model	1.25	.79	.71	.56	.85	.86	.07	204.91	3.25
Uncorrelated Error Scores									
1-Factor Language Model	1.11	.83	.73	.68	.94	.95	.05	229.92	3.26
Correlated Error Scores									
3-Factor Developmental Model*	—	—	—	—	—	—	—	—	—
3-Factor Developmental Model	1.11	.84	.76	.66	.94	.95	.05	255.81	2.71
Without Visual Precision									
3-Factor Luria's Model*	—	—	—	—	—	—	—	—	—
3-Factor Luria's Model	1.20	.82	.74	.63	.90	.91	.07	261.23	2.82
Without Visual Precision									
5-Factor NEPSY Model	1.11	.84	.74	.66	.95	.95	.05	321.46	3.19

Note. NEPSY = A Developmental Neuropsychological Assessment; X^2/df = Chi-square/degrees of freedom ratio; GFI = Goodness-of-Fit Index; AGFI = Adjusted Goodness-of-Fit Index; NFI = Normed Fit Index; CFI = Comparative Fit Index; IFI = Incremental Fit Index; RMSEA = Root-Mean-Square error of approximation; ECVI = Expected Cross-Validation Index; * = model unidentified.

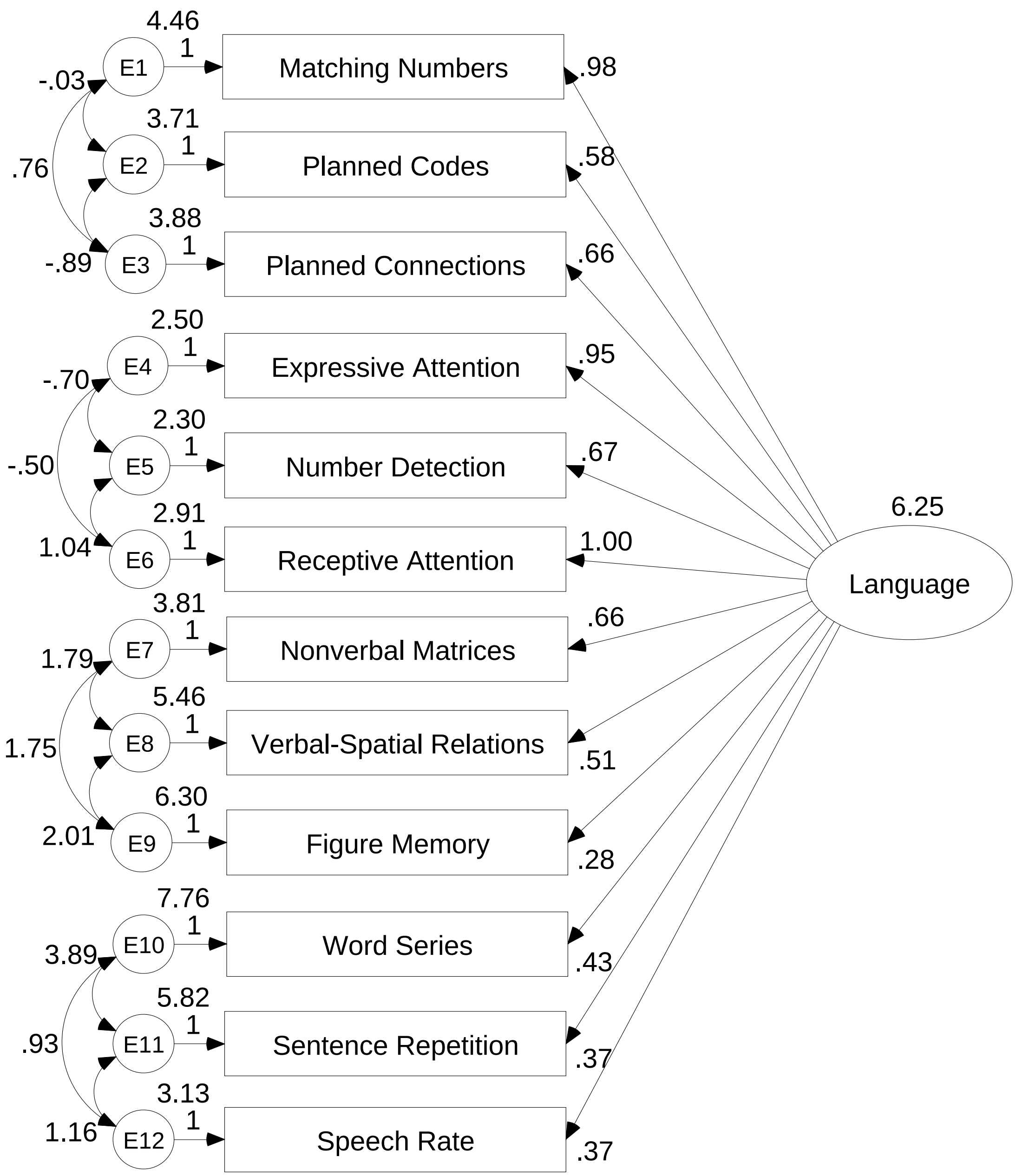

Figure 1. Hypothesized 1-Factor Language Model for the CAS with Correlated Error Scores.

This model attempted to load all subscales onto one factor. When error scores were correlated for each of the CAS scales, the fit indices reflected a somewhat better fit to the data (X^2/df = 1.28, good; GFI = .85, good; AGFI = .73, moderate; NFI = .82, moderate; CFI = .95, superior; IFI = .95, superior; RMSEA = .08, reasonable; BIC = 282.56; ECVI = 2.68); however, fit indices ranged from moderate to superior fit with inconsistent findings. Correlations with respect to individual subscales ranged from .28 to 1.00. This model is not the best representation of the underlying constructs of the CAS.

The second set of analyses examined the correlated first-order, 3-factor Developmental model, consisting of a Planning/Attention factor, Simultaneous Processing factor, and Successive Processing factor using the respective published subscales for each scale. This model (see Figure 2) was initially hypothesized as the best fit for the CAS data due to the notion that attention and planning may not be well differentiated in young children. When the factors were allowed to correlate freely, fit indices suggested a moderate to superior fit to the data (X^2/df = 1.33, good; GFI = .82, good; AGFI = .72, moderate; NFI = .77, moderate; CFI = .93, good/superior; IFI = .93, good/superior; RMSEA = .08, reasonable; BIC = 239.66; ECVI = 2.60). The BIC fit index was approximately 40 points lower than that of the 1-factor Language model (correlated error scores) suggesting the 3-factor Developmental model to be a better fit to the data. When error scores were correlated between subscales for each original CAS scale, the model was unidentified; therefore, fit indices could not be calculated.

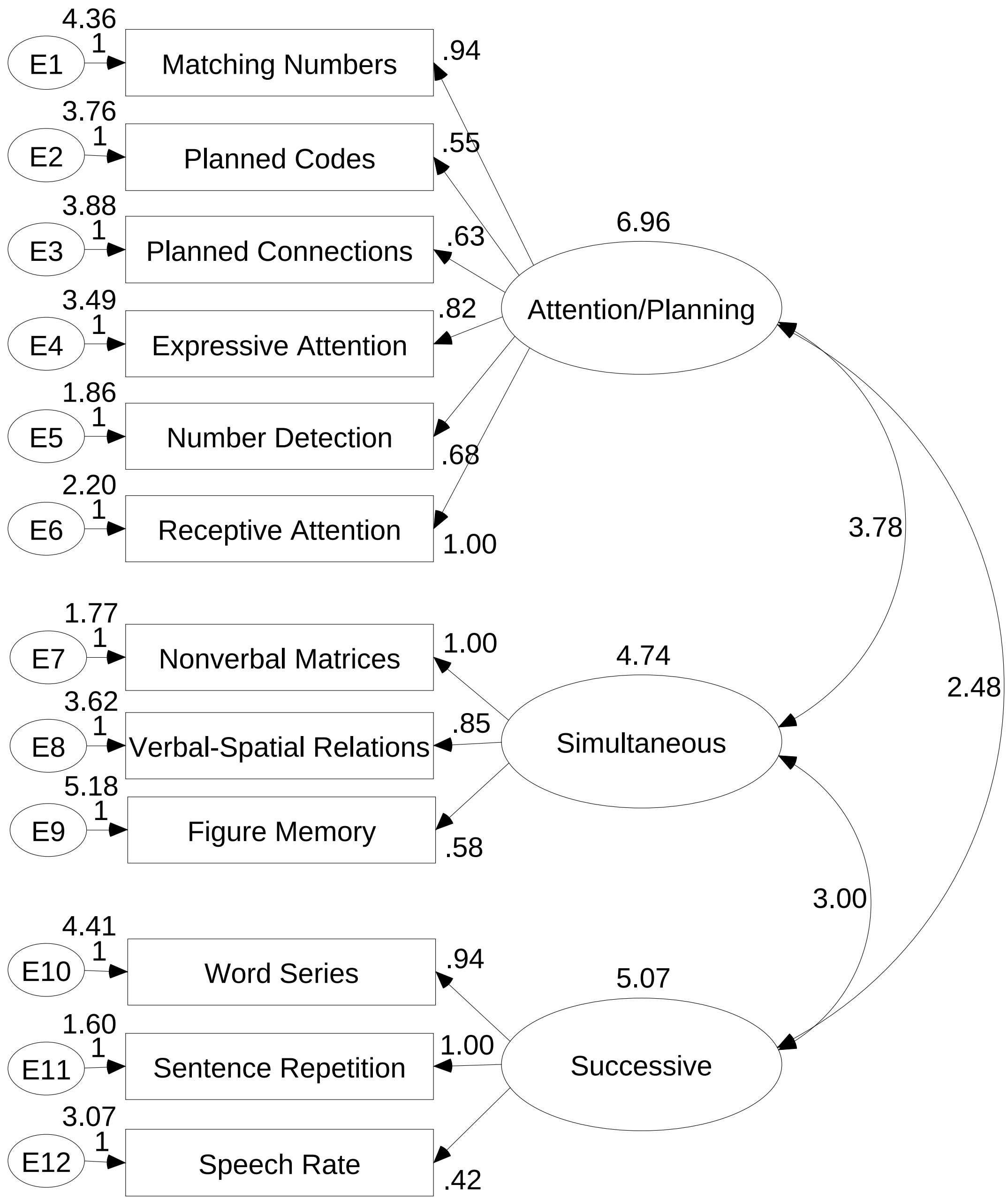

Figure 2. Hypothesized 3-Factor Developmental Model for the CAS.

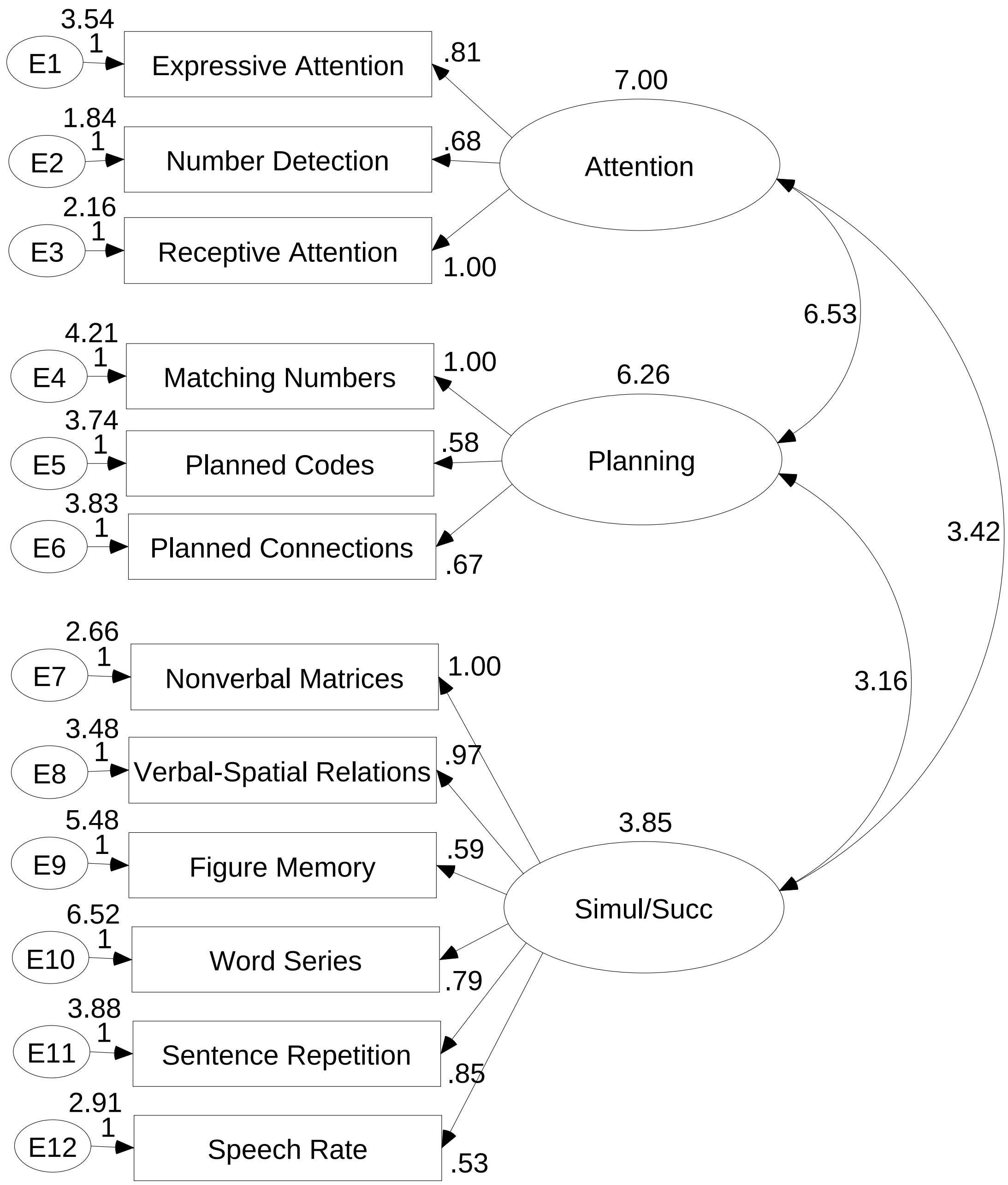

Figure 3. Hypothesized 3-Factor Luria's Model for the CAS.

The third set of analyses evaluated the correlated first-order, 3-factor Luria's model with regard to the data in this study. This model (see Figure 3) consisted of a Planning factor, Attention factor, and combined Simultaneous and Successive factor as described by Luria. Again, when factors were allowed to correlate freely, fit indices suggested a moderate fit to the data (X^2/df = 1.59, good; GFI = .78, moderate; AGFI = .67, moderate/poor; NFI = .73, moderate; CFI = .87, moderate; IFI = .88, moderate; RMSEA = .11, mediocre/poor; BIC = 252.72; ECVI = 2.88). Although the BIC fit index was approximately 30 points lower than that of the 1-factor Language model (correlated error scores) suggesting a better fit, the 3-factor Luria's model did not provide a better fit to the data than the 3-factor Developmental model. When error scores were correlated between subscales for the 3-factor Luria's model, this model also was unidentified; therefore, fit indices could not be calculated.

The last set of analyses examined with respect to the CAS data was the correlated first-order, 4-factor PASS model as hypothesized by the test developers. Fit indices calculated for this model (see Figure 4) suggested a moderate to good fit for the data (X^2/df = 1.41, good; GFI = .82, good; AGFI = .71, moderate/poor; NFI = .77, moderate; CFI = .92, good; IFI = .92, good; RMSEA = .09, mediocre; BIC = 258.11; ECVI = 2.71). Although the PASS model and the 3-factor Developmental model appeared to be similar fits for the current data, the BIC index for the Developmental Model was approximately 19 points lower than that of the PASS model suggesting a slightly better model fit.

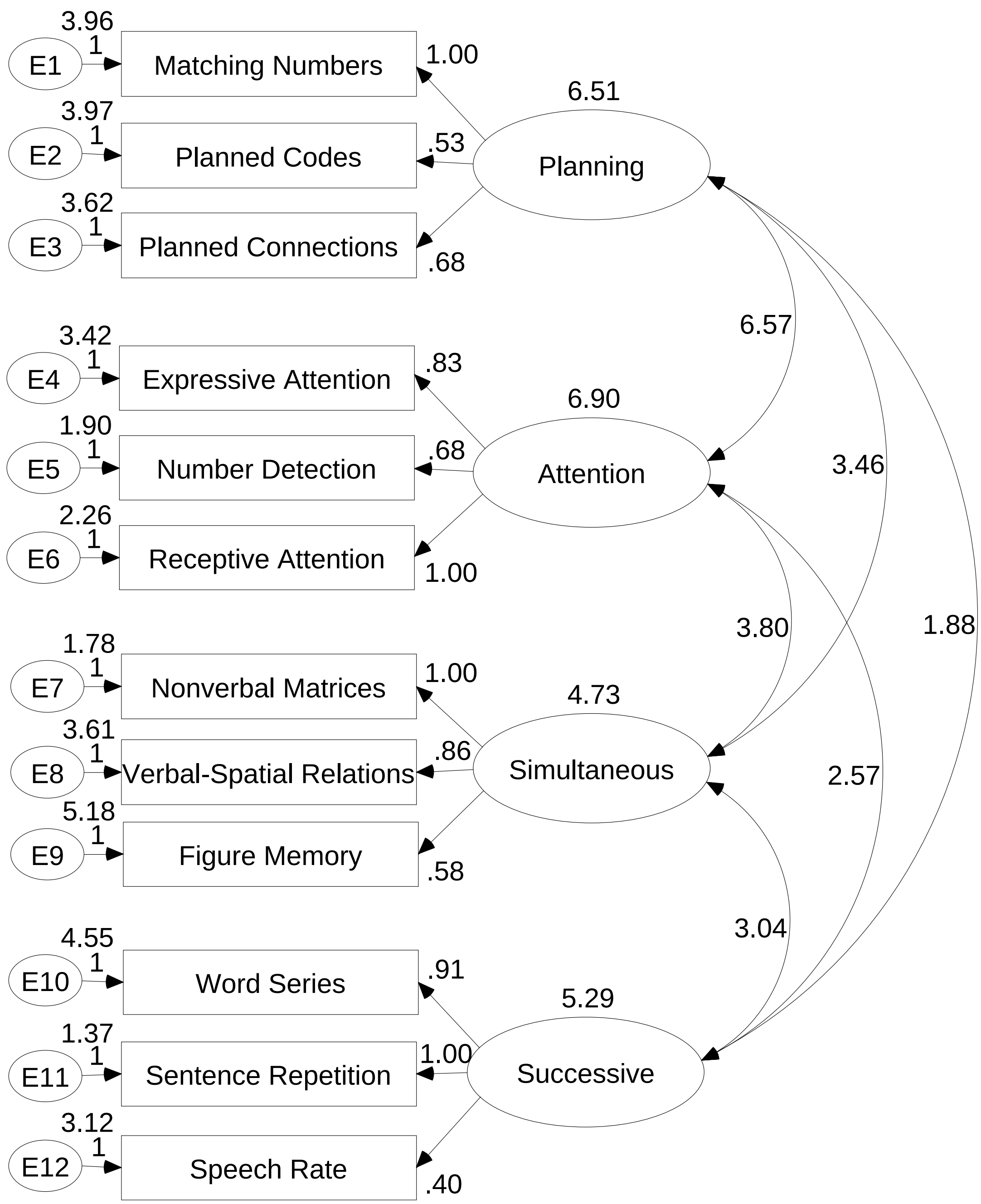

Figure 4. The PASS Model for the CAS as Hypothesized by the Test Developers.

NEPSY Analyses

The third research question addressed which hypothesized model would best summarize the NEPSY data in this sample. Although it was proposed by one study that the NEPSY yielded a 1-factor model, this study evaluated four hypothesized models using CFA analyses to determine the most accurate underlying structure: a 1-factor Language model, a 3-factor Developmental model (e.g., Language, Sensory, Visual-Spatial), a 3-factor model based on Luria's theory (e.g., Attention/Memory, Executive Function, Sensory/Visual-Spatial), and a 5-factor NEPSY model. The 4-factor PASS model was not evaluated with respect to the NEPSY data because it was not theoretically justified when considering the subscales.

The first set of analyses examined the first-order, 1-factor Language model and attempted to load all NEPSY subscales onto one factor. This model (see Figure 5) demonstrated a poor to moderate fit to the data when examining most fit indices (X^2/df = 1.25, good; GFI = .78, moderate; AGFI = .71, moderate/poor; NFI = .56, poor; CFI = .85, moderate; IFI = .86, moderate; RMSEA = .07, reasonable; BIC = 204.91; ECVI = 3.24). When error scores were correlated for the subscales with respect to individual NEPSY scales, the fit indices reflected a somewhat better fit to the data (X^2/df = 1.11, good; GFI = .83, good; AGFI = .73, moderate; NFI = .68, moderate/poor; CFI = .94, superior; IFI = .95, superior; RMSEA = .04, good; BIC = 229.92; ECVI = 2.26); however, the BIC fit index for the uncorrelated model was approximately 25 points lower than the correlated model. Correlations with respect to individual subscales ranged from .41 to 1.00.

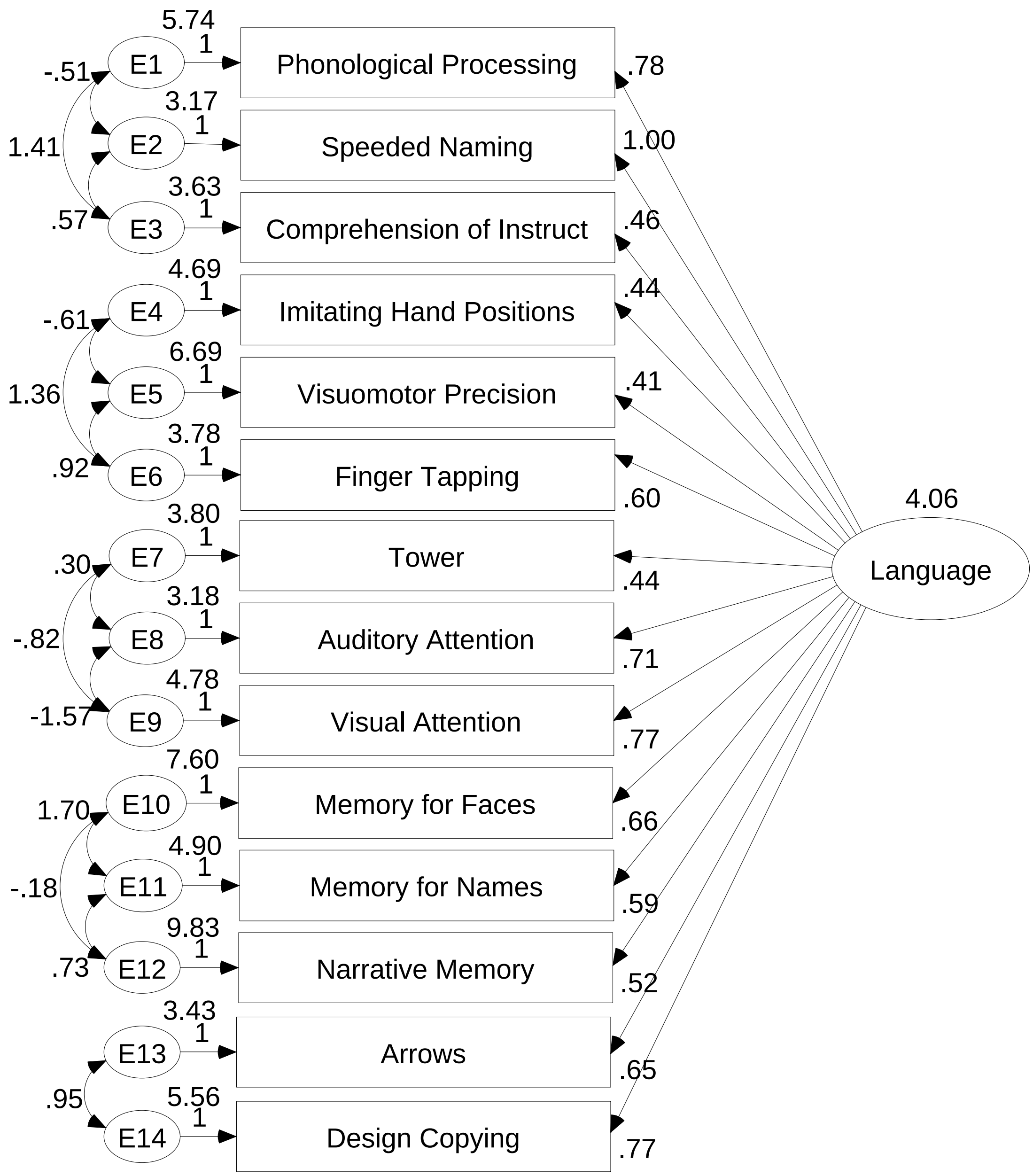

Figure 5. Hypothesized 1-Factor Language Model for the NEPSY with Correlated Error Scores.

With regard to the NEPSY, three other models were hypothesized to fit the data. The second set of analyses examined a correlated first-order, 3-factor Developmental model, consisting of a Language factor (e.g., Phonological Processing, Speeded Naming, Comprehension of Instructions, Auditory Attention, Memory for Names, Narrative Memory), Sensory factor (e.g., Imitating Hand Positions, Visuomotor Precision, Finger Tapping, Tower), and Visual-Spatial factor (e.g., Visual Attention, Memory for Faces, Arrows, Design Copying). When the 3-factor Developmental model subscales were allowed to correlate freely, the model was unidentified using the AMOS 4.01 program. After examining the results and determining that the Visuomotor Precision subscale was the problem subscale, it was removed from the analyses. The second evaluation of this model (see Figure 6) resulted in a good to superior fit to the data (X^2/df = 1.11, good; GFI = .84, good; AGFI = .76, moderate; NFI = .66, moderate/poor; CFI = .94, superior; IFI = .95, superior; RMSEA = .05, good; BIC = 255.81; ECVI = 2.71). This revised 3-factor Developmental model and the 1-factor Language model (correlated error scores) appeared to demonstrate similar fits to the data; however, the Language model resulted in a BIC fit index of approximately 26 points lower suggesting a better fit.

A correlated first-order, 3-factor Luria's model, consisting of an Attention/Memory factor (e.g., Memory for Faces, Memory for Names, Narrative Memory), Executive Function factor (e.g., Tower, Auditory Attention, Visual Attention, Arrows, Design Copying), and a combination of Sensory/Visual-Spatial factor (e.g., Phonological Processing, Speeded Naming, Comprehension of Instructions, Imitating Hand Positions, Visuomotor Precision, Finger Tapping), also was tested. When factors

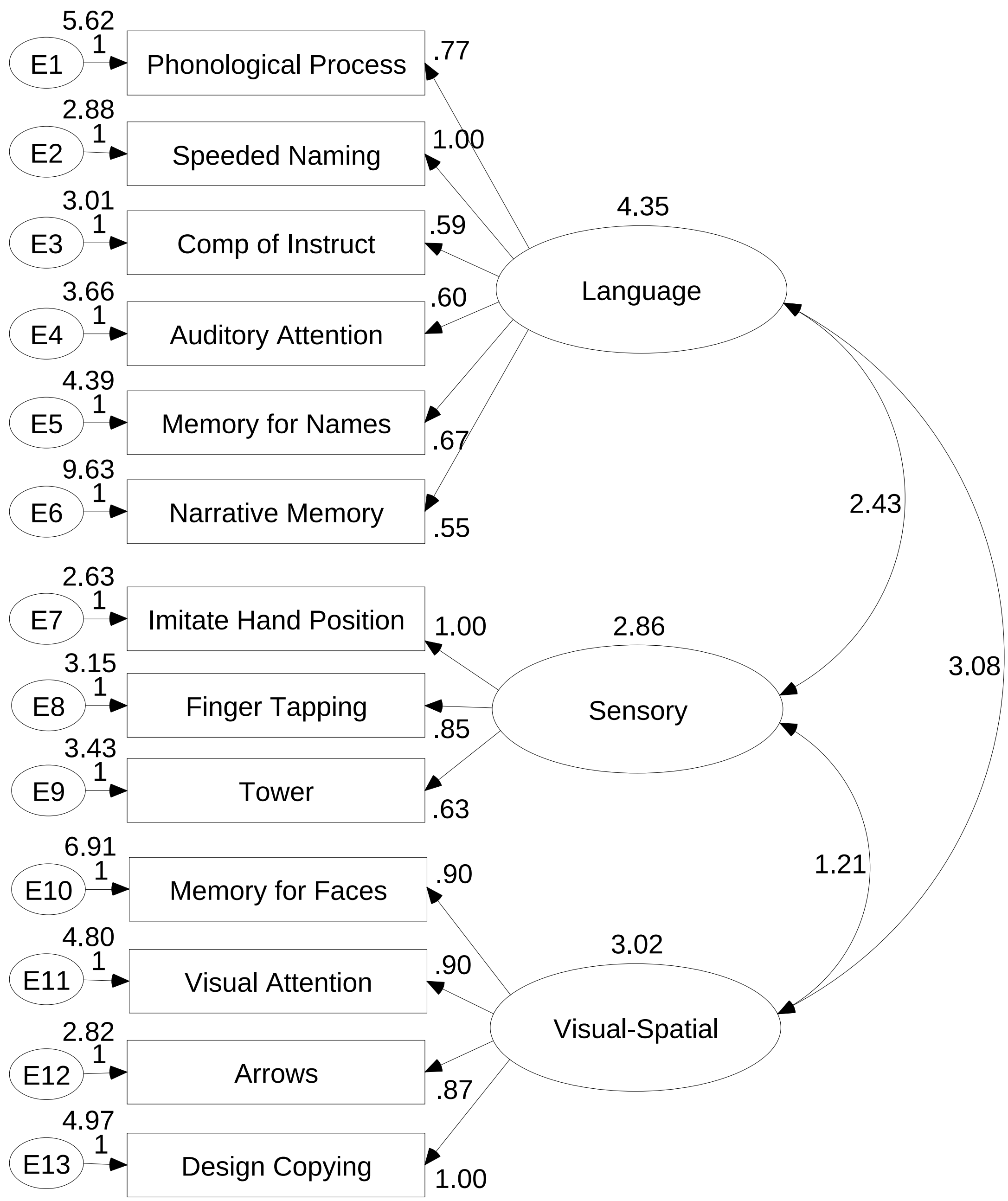

Figure 6. Hypothesized 3-Factor Developmental Model for the NEPSY without the Visuomotor Precision Subscale.

were allowed to correlate freely, the model was unidentified. Similar to the Developmental model, the Visuomotor Precision subscale appeared to be the reason for the unidentified model. The subscale was removed from the analyses and the resulting model (see Figure 7) was evaluated as a good fit (X^2/df = 1.20, good; GFI = .82, good; AGFI = .74, moderate; NFI = .63, moderate/poor; CFI = .90, good; IFI = .91, good; RMSEA = .07, reasonable; BIC = 261.23; ECVI = 2.82); however, this revised 3-factor Luria's model appeared to be slightly less superior model as compared to the Language model and Developmental model.

The last model tested with regard to the NEPSY data was the correlated first-order, 5-factor NEPSY model as hypothesized by the developers, consisting of a Language factor, Sensorimotor factor, Attention/Executive Function factor, Memory factor, and a Visuospatial factor. Fit indices for this model (see Figure 8) resulted in a good fit (X^2/df = 1.11, good; GFI = .84, good; AGFI = .74, moderate; NFI = .66, moderate/poor; CFI = .95, superior; IFI = .95, superior; RMSEA = .05, good; BIC = 321.46; ECVI = 3.19). The 5-factor NEPSY model and the Developmental model appeared to demonstrate similar fit to the data; however, the BIC index for the Developmental model was approximately 65 points lower than that of the 5-factor model suggesting a better fit. Although many of these models provided a good fit to the data, the 1-factor Language model continues to be the best representation of the underlying factor structure.

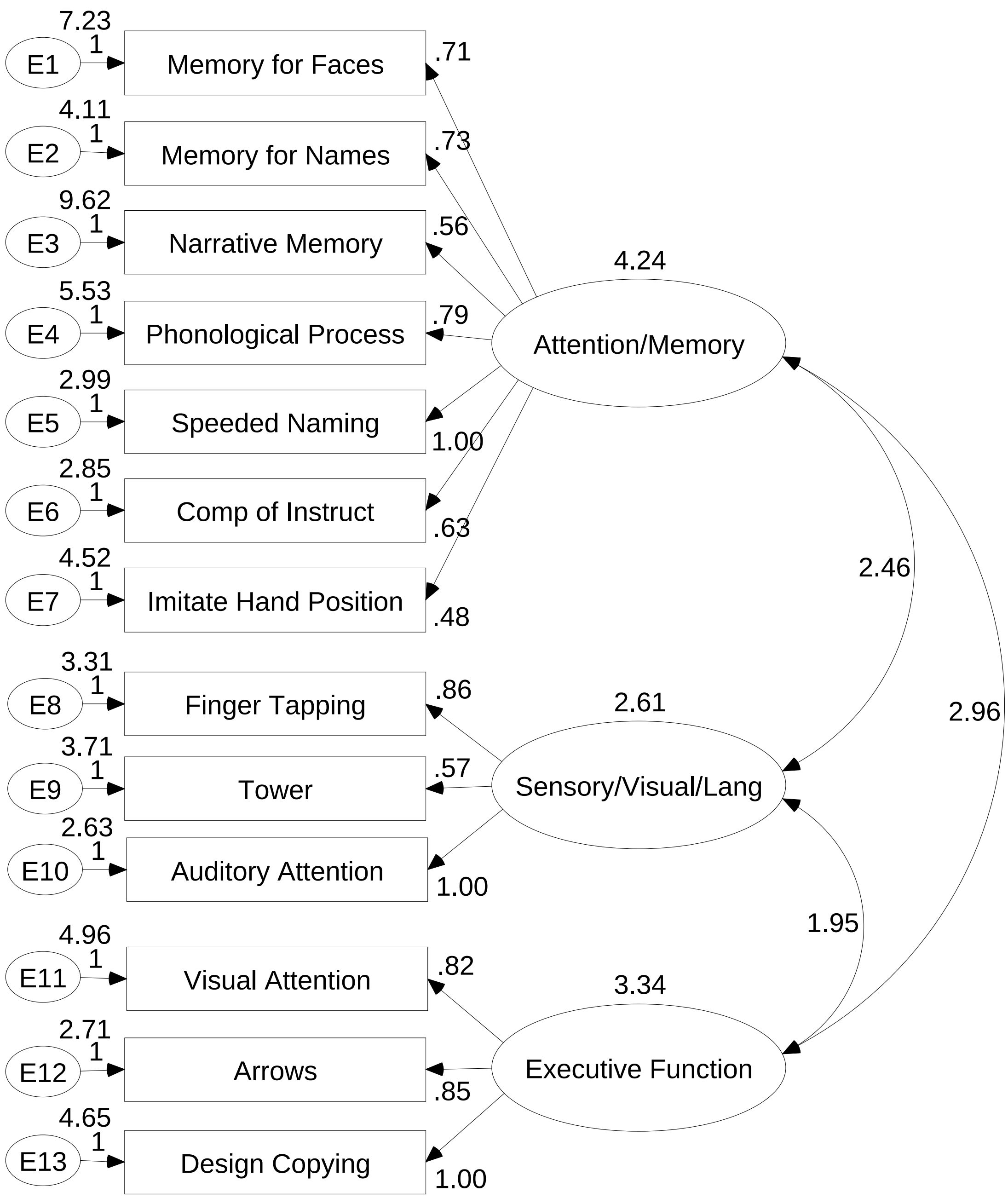

Figure 7. Hypothesized 3-Factor Luria's Model for the NEPSY without the Visuomotor Precision Subscale.

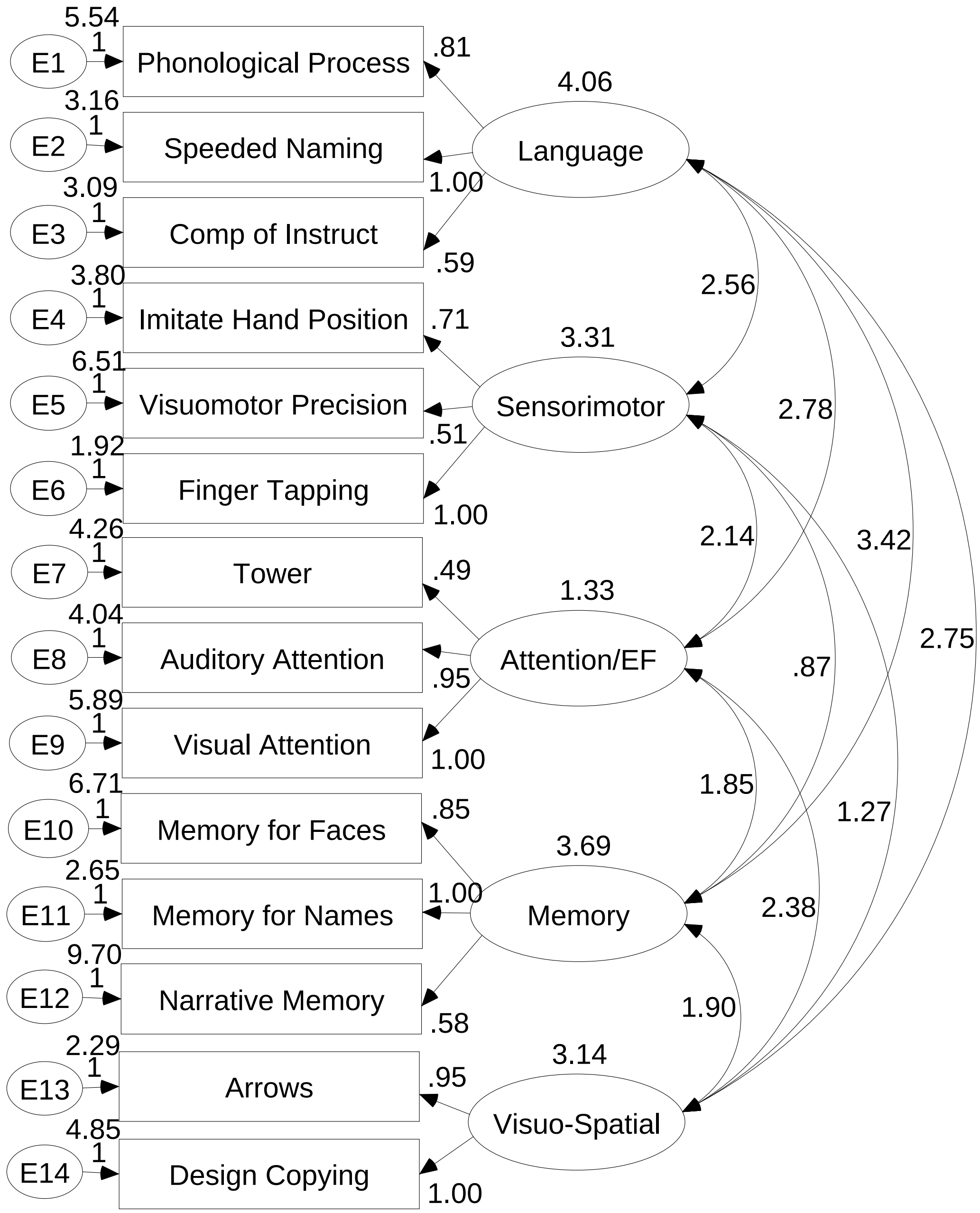

Figure 8. The 5-Factor NEPSY Model as Hypothesized by the Test Developers.

CHAPTER V

SUMMARY AND CONCLUSIONS

Chapter I provided an overview of the current study, identified the purpose and rationale, and presented the pertinent research questions and corresponding hypotheses. Chapter II reviewed the relevant literature as it pertains to studying neuropsychology in children and discussed the importance of recognizing frontal and prefrontal lobe maturation in young children. A brief overview of intelligence and neuropsychological assessment instruments also was included, as well as a discussion on Luria's theory. Chapter III provided a detailed account of the methodology used in the study, as well as the demographics of the sample and a description of the assessment instruments utilized. Results of the study were presented in Chapter IV in text and graphic format.

The current chapter will include an extensive interpretation and discussion of the results from the data analyses and their relation to the respective research questions and hypotheses. Also, a discussion regarding the limitations of the study, as well as future research directions will be provided.

Research Questions

For ease of discussion, the proposed research questions and corresponding hypotheses are listed in this chapter. The results from the data analyses are discussed regarding each question.

Question 1: Correlational Analyses

What is the strength and direction of the association between the CAS, NEPSY, PPVT-III, BRIEF, and the BASC? It was hypothesized that moderate to high correlations would result between many scales, primarily those proposed to measure similar constructs such as attention, planning, executive functioning, and overall intelligence. Other scales expected to correlate were those related to emotional functioning and measures of attention.

Correlations between the CAS, NEPSY, and PPVT-III. With regard to the interrelations between the CAS, NEPSY, and PPVT-III, results confirmed the hypotheses that moderate to high positive correlations would result between selected scales purported to measure similar constructs. These included the global scores on the CAS and PPVT-III, as well as similar scales across measures examining language, attention, planning and attention, and simultaneous processing and memory. Due to the positive relationships between the PPVT-III and other measures of cognitive ability, as reviewed in the literature, it was expected that the CAS Full Scale score would significantly correlate with the overall standard score for the PPVT-III. It is unclear, however, if this positive correlation is due to similar underlying measures of cognitive ability or basic language skills in these young children. In the same respect, the NEPSY Language standard score significantly positively correlated with the overall standard score for the PPVT-III, a primary measure of receptive language skills. These correlations provided support for the importance of successful language development in young children.

As expected, similar scales pertaining to attention on the CAS and NEPSY were significantly correlated, as well as the standard scores for the CAS Planning scale and measures of Attention/EF on the NEPSY. These positive correlations are most likely due to the similarities of skills measured by both the CAS Attention and Planning scales, as evidenced by their statistically significant interrelationship ($r = .80$, $p < .001$) previously calculated in this study. These results are consistent regarding the view that children's frontal lobes are not fully developed at this young age and therefore, exhibit non-differentiation of basic attention and higher executive functioning skills.

Although both the CAS Simultaneous and Successive Processing scales, on examination, appear to require short-term and working memory skills, only the Simultaneous scale significantly correlated with the NEPSY Memory scale. These results may be a function of specific tasks used to evaluate memory on the NEPSY. For example, Memory for Faces is a function of visual immediate and delayed memory where a child is required to examine each face as a whole and decide whether subsequent faces are a match. This task does not require sequencing skills, or successive processing, as described by Luria. In the same respect, Memory for Names taxes a child's visual and associative memory by requiring a child to associate a picture with a name, but not in any specific order. The third memory task within the Memory scale of the NEPSY, Narrative Memory, is a function of auditory and short-term memory where a child is asked to listen to a story and then re-tell the story word-for-word if possible. Although re-telling the story in a logical order could be deciphered as requiring sequencing abilities, this task most likely relies on short-term auditory memory, as well as integration of individual facts into a whole to establish a reasonable story; skills required for simultaneous processing, as described by Luria.

Unexpected, yet plausible, results were found regarding the NEPSY Language scale and statistically significant positive correlations with the CAS Attention, Planning, Simultaneous, and Full Scale scores. Standard scores on the CAS Planning and PPVT-III also demonstrated a positive correlation. Again, it is difficult to conclude whether these results are due to true individual differences between scales, or if assessment tools used to examine young children's intelligence are primarily assessing language abilities. In addition, the CAS Full Scale score moderately correlated with NEPSY Attention/EF and NEPSY Memory standard scores, while CAS Attention and PPVT-III significantly correlated as well. These statistical relationships signify the importance in the ability to attend and successfully utilize short-term and working memory in order to perform well on cognitive tasks.

Overall, it appeared that similar scales across tests are measuring similar constructs; however, many scales also suggested a significant relationship with language skills. Again, it is important to understand the significant role that basic language skills play in young children. Although scales specifically examining "attention" tended to correlate across assessment measures, it should be noted that the term "attention" may not adequately portray the range of activities that truly define the variable. Also, the statistically significant correlations among attention, planning, and executive functioning scales should be recognized as supporting the research regarding developmental maturation of frontal lobes and differentiation of higher order cognitive skills.

Correlations between the CAS, NEPSY, and PPVT-III with the BASC. The first research question also addressed the association between the BASC and the CAS, NEPSY, and PPVT-III. It was hypothesized that moderate correlations would result between respective scales across measures due to the assumption that executive functioning (e.g., attention, planning, mental processing) tasks across individual tests should measure similar constructs, that attention and hyperactivity often are associated with one another, that decreased attention can be a symptom of negative emotional functioning, and that sufficient attention is required for memory tasks.

Results suggested few statistically significant associations with the BASC forms, none of which were originally hypothesized and some of which seemed spurious in nature. With regard to the parent form, the NEPSY Attention/EF and BASC Atypicality standard scores resulted in a negative correlation. This correlation suggested a relationship between children rated as exhibiting many atypical behaviors and children with difficulties attending to tasks and successfully performing mental operations. This appears to be a reasonable explanation for the data. The CAS Full Scale and BASC Attention Problems (parent form) standard scores also resulted in a statistically significant correlation acknowledging a relationship between sufficient attentional abilities and the successful completion of a range of cognitive tasks, as defined by the CAS. Similar findings occurred with regard to the CAS Full Scale and NEPSY Attention/EF, further supporting this relationship.

Low to moderate correlations ($p < .01$) also occurred with regard to the BASC parent forms between the following scales: CAS Planning and BASC Adaptability, CAS

Attention and BASC Adaptability, and CAS Planning and BASC Adaptive Skills. Although not originally hypothesized, these findings suggested a positive relationship between children who demonstrate sufficient attentional and executive functioning skills, and the tendency to exhibit greater adaptive skills, as well as social and cognitive flexibility. Similar findings occurred with regard to the CAS Full Scale standard score and its significant relationship with the BASC Social Skills and Adaptive Skills standard scores. Results suggested a positive relationship regarding social and adaptive skills and overall ability to complete a range of cognitive tasks.

Results pertaining to CAS Simultaneous Processing and parent BASC Social and Adaptive Skills scales appeared to be spurious in nature with little plausible direct explanation. Although there is not a clear explanation, these results may suggest a relationship between successful mental processing in general and the ability to adapt to changes, relate to others, and possess social and cognitive flexibility.

With regard to the BASC teacher form, moderate correlations resulted between the following scales at the $p < .01$ level: CAS Simultaneous and BASC Atypicality, CAS Full Scale and BASC Atypicality, and CAS Successive Processing and BASC Adaptive Skills. The BASC Atypicality and CAS correlations suggested a relationship between children rated as exhibiting many atypical behaviors, and experiencing difficulties successfully performing a range of mental operations. The correlation involving the CAS Successive Processing and BASC Adaptive Skills standard scores is somewhat spurious in nature; however, as noted above with the BASC parent forms, may suggest a relationship between successful mental processing skills and behaviors rated as being adaptive (e.g., ability to adapt to change, relating to others, social and cognitive flexibility).

Interestingly, many scales proposed to measure attention, planning, and processing abilities on objective measures did not significantly correlate with parent and teacher report measures of attention, hyperactivity, memory, or emotional functioning (e.g., anxiety and depression) as defined by the BASC. These findings are possibly due to the differences in parent and teacher perceptions of children as compared to actual performance in these areas on objective measures. Results also may suggest an innate difference in the structure of objective and report measures; therefore, creating the need for caution when interpreting and integrating such results within a comprehensive psychological battery. It should be noted that scales purporting to measure “attention” may not be completely representing an adequate range of activities; therefore, scores across measures may differ.

Correlations between the CAS, NEPSY, and PPVT-III with the BRIEF. The BRIEF also was correlated with the CAS, NEPSY, and PPVT-III to determine the strength and direction of associations. It was originally hypothesized that moderate correlations would result between the following scales: CAS Attention and NEPSY Attention/EF with all BRIEF scales except Emotional Control, as well as CAS Planning and BRIEF Plan/Organize. These relationships were suggested due to the assumption that the BRIEF scales are measures of executive functioning and that attention and planning are examples of executive functions; therefore, similar subscales across tests should measure the same constructs.

Results suggested few significant associations with the BRIEF parent and teacher forms. Only two of the original hypotheses resulted in statistically significant associations, CAS Attention and Parent BRIEF Shift, as well as NEPSY Attention and Teacher BRIEF Organization of Materials. These results suggested a statistically significant relationship between a child's ability to selectively attend and maintain attention, and possess the skills necessary to mentally shift task sets and maintain organizational skills. For example, the greater a child's attentional abilities, the more successful they will be in mentally shifting tasks and organizing materials. This appeared to be a plausible explanation for the data. Although, it was initially hypothesized that the CAS Planning and BRIEF Plan/Organize standard scores would significantly correlate, the scales do not appear to be measuring a similar construct.

Low to moderate correlations also resulted with regard to BRIEF parent scales at the $p < .01$ level: CAS Simultaneous Processing and BRIEF Shift, CAS Full Scale and BRIEF Shift, and CAS Planning and BRIEF Working Memory. With regard to the relationship between the BRIEF Shift standard scores and the CAS Simultaneous and Full Scale scores, it is suggested that there is a positive relationship between a child's ability to perform mental operations, such as holistically examining and performing a task (e.g., taking individual pieces and forming a whole), and the ability to mentally shift task sets (e.g., cognitive flexibility). Statistical significant correlations also were evidenced with regard to the CAS Planning and the BRIEF Working Memory standard scores, insinuating that a positive association exists between working memory and a child's ability to successfully execute a mapped out plan. When considering these tasks, it is reasonable to assume that a child's ability to plan ahead, mentally shift tasks, and manipulate information within short-term memory would significantly impact the performance of mental operations.

Although it was assumed that scales from the BRIEF, a proposed measure of executive functioning, would significantly correlate with the NEPSY, an objective neuropsychological measure, few significant associations were found. In fact, there were only three statistically significant correlations, which all resulted from the BRIEF teacher form. Moderate correlations resulted between the following scales at the $p < .01$ level: NEPSY Visuospatial and BRIEF Plan/Organize, NEPSY Visuospatial and BRIEF BRI, and NEPSY Visuospatial and BRIEF GEC. The NEPSY Visuospatial and BRIEF Plan/Organize association is the only one that can be reasonable explained. Design Copying (e.g., directly copying visually presented figures), one of the two tasks that comprise the Visuospatial scale, appears to have a planning and mental organizational component; while the Arrows subtest (e.g., visually determine which two arrows, from an array of arrows, point to the center of a target without tracing a finger) seems to require mental organization as well. There did not appear to be a logical explanation for the correlation between the NEPSY Visuospatial scale and the BRIEF BRI and GEC scales. Again, it is recommended that caution be taken when interpreting results regarding teacher forms due to the low response rate.

Another interesting finding, with regard to the BRIEF, is that the parent form correlated with various scales from the CAS but not with the NEPSY, while the teacher form correlated with scales from the NEPSY and not with the CAS. This may be due to the difference in items presented on the two forms, as well as the difference in environments in which the behaviors are observed.

Question 2: CAS Model Fit

What is the best model fit, or factor structure, for the CAS for children ages 5 to 7 years? It was hypothesized that a 3-factor Developmental model would best represent the current data using confirmatory factor analyses and model fit indices.

In order to address the second research question and determine which conceptual model best summarizes the CAS data in this sample, CFA was used to test four theoretical models: a 1-factor Language model, a 3-factor Developmental model, a 3-factor model based on Luria's theory, and the 4-factor PASS model. Although all models resulted in a fit for the CAS data, the 1-factor Language model (correlated error scores) was the least likely to be the best representation of the underlying constructs.

The correlated first-order, 3-factor Developmental model (uncorrelated error scores), consisting of a Planning/Attention factor, Simultaneous Processing factor, and Successive Processing factor, was initially hypothesized as the best fit for the CAS data. When the factors were allowed to correlate freely, fit indices suggested a moderate to superior fit to the data. The BIC fit index was approximately 40 points lower than that of the 1-factor Language model (correlated error scores) suggesting the Developmental model to be a better fit to the data. These fit indices support the belief that attention and planning may not be well differentiated in young children; therefore, separately measuring these constructs may not be possible.

A correlated first-order, 3-factor Luria's model (uncorrelated error scores) consisting of a Planning factor, Attention factor, and combined Simultaneous and Successive factor also was tested and suggested a moderate fit to the data. Although this model provided a better fit than the 1-factor Language model (correlated error scores), the Developmental model continued to be the best explanation of the underlying factors of the CAS (e.g., BIC fit index 13 points lower than Luria's model).

When examining the correlated first-order, 4-factor PASS model as hypothesized by the test developers, fit indices calculated for this model suggested a moderate to good fit for the data. Although the PASS model and the Developmental model appeared to be similar fits for the current data, the BIC index for the Developmental Model was approximately 19 points lower than that of the PASS model possibly suggesting a slightly better model fit. Previous research on the CAS standardization data, as well as other data, have yielded various factor structures; only the CAS authors have found the PASS model to be the best model fit. The current results would further support the hypothesis that the Attention and Planning scales on the CAS are almost undistinguishable and may reflect a lack of differentiation of functions associated with developmental status of the frontal lobes.

When considering the proposed models and respective fit indices using CFA, it is clear that the Developmental model is the best representation of the underlying constructs of the CAS. These results support the idea that executive functioning skills, such as attention and planning, cannot be clearly delineated in young children and are better represented as one construct when measuring such abilities. These findings also are congruent with the literature pertaining to the development of the frontal lobes in young children, and suggest that full maturation may not be complete until beyond the age of 7 years. Therefore, if assessment measures cannot provide sufficient specificity, then evaluation of individual constructs should not be measured in young children. Perhaps when evaluating early development, a global developmental score would be a better representation of a child's abilities (e.g., CAS Full Scale). The significant correlation between the CAS Full Scale, PPVT-III, and NEPSY Language standard scores provide support for this hypothesis.

Question 3: NEPSY Model Fit

What is the best model fit, or factor structure, for the NEPSY for children ages 5 to 7 years? Due to the past literature (Stinnett et al., 2002) and knowledge that adequate language skills are the primary building blocks for learning and development, it was hypothesized that the 1-factor Language model would best represent the current data using confirmatory analyses and the model fit indices.

In order to address the third research question and determine which conceptual model best summarizes the NEPSY data in this sample, CFA was used to test four theoretical models: a 1-factor Language model, a 3-factor Developmental model (e.g., Language, Sensory, Visual-Spatial), a 3-factor model based on Luria's theory (e.g., Attention/Memory, Executive Function, Sensory/Visual-Spatial), and a 5-factor NEPSY model. Although all models resulted in a fit for the NEPSY data, the 1-factor Language model (correlated error scores) resulted in the best representation of the underlying constructs. Furthermore, the 3-factor Developmental model and the 3-factor Luria's model required the deletion of the Visuomotor Precision subscale in order to provide an identified and reasonable model fit to the data. This subscale may have been a confound due to the speeded nature of the task, as well as the variation of motor development across children.

The revised Developmental model and the Language model (correlated error scores) resulted in similar fit indices, demonstrating comparable fits to the data; however, the Language model resulted in a BIC fit index of approximately 26 points lower than the Developmental model providing further support for the 1-factor Language model. The 5-factor NEPSY model, as proposed by the authors, and the Developmental model also appeared to demonstrate similar fits to the data; however, the BIC index for the Developmental model was approximately 65 points lower than that of the 5-factor model suggesting a better fit. Therefore, when considering the proposed models and respective fit indices using CFA, it is clear that the 1-factor Language model is the best representation of the underlying constructs of the NEPSY, with the Developmental model a close second.

Prior research, as well as results provided by the current study, supports the idea that successful acquisition of language skills is essential in the early stages of development. In addition, the frontal and prefrontal cortex, which is primarily recognized for its functions regarding response inhibition, emotional regulation, and planning (Kanemura et al., 2003), as well as working memory, attention, and goal-directed actions (Fuster, 2002), may not be fully developed in young children. The current findings with the CAS and NEPSY are congruent with this literature. Although it is not clearly evident whether components of executive functioning are neuropsychologically separable from other basic cognitive processes, such as language, memory, and basic attention, the current results suggested that constructs measuring such executive functions should not be individually assessed. The possible non-differentiation of these skills in young children further supports the use of a global developmental score as a better representation of a child's abilities. A model focusing on more basic areas of functioning, such as the proposed Developmental models, also may be a viable alternative.

Strengths of the Study

This study was designed to question the appropriateness of current neuropsychological assessment measures utilized with young children. While many studies have researched the underlying factor structure of the CAS and NEPSY, none have specifically examined the relationship of the structures with regard to Luria's adult theory, which the two measures claim as their basic conceptualization. Due to the differences between brain maturation of adults and children, it is important that developmental progression is considered with regard to the development of assessment measures designed to evaluate children's abilities. This study also examined the relationship of the BASC, a measure of social/emotional functioning, and the BRIEF, a relatively recent report measure of executive functioning, with similar scales to the CAS and NEPSY. This question was explored to determine whether report measures and objective measures of similar hypothesized constructs would significantly correlate, lending promise to their use in comprehensive psychological batteries. Overall, in depth research pertaining to children and the appropriateness of neuropsychological measures is still lacking; therefore, this study hoped to contribute to the existing research base.

Limitations of the Study

It should be noted that this study is a preliminary examination of the underlying constructs of the CAS and NEPSY. Although specific models were hypothesized and tested considering past literature, a variety of other models could be created using the combination and/or deletion of subtests and also may result in reasonable fits to the data. In that regard, careful interpretation regarding the results of the current study is warranted. Although attempts were made to ensure a reasonable sample size, time limitations and referral base were restricting. A larger sample size would have provided more opportunity to detect actual differences. Also, although this sample of children was adequately heterogeneous with regard to age, sex, cognitive ability, and emotional functioning, there was a clear under-representation of minority populations. To reasonably generalize this study's results to other populations, a more representative sample must be obtained. Another limitation pertaining to the generalizability of this study concerned the low return rate of parent and teacher rating forms; therefore, results regarding rating forms should be carefully interpreted.

Future Research Directions

With the limitations of the study briefly reviewed, suggested directions for future research are evident. Adequate sample size and appropriate demographic representation of the population is possibly the most important factor that future studies should take into account, ensuring greater detection and generalization of results. Due to the lack of research concerning children and neuropsychology, it is pertinent that more studies be completed with these (e.g., CAS and NEPSY) and similar measures. Researchers should carefully examine neuropsychological measures and determine whether respective factor structures are the best representation of the hypothesized constructs at differing ages. In addition, future studies should examine the interrelationships between similar objective assessment measures to determine their individual utility in a comprehensive assessment or the possible use of a combined battery. Furthermore, exploration of factor analyses with the CAS and NEPSY with regard to other relevant theories, such as Carroll’s three-stratum theory (e.g., processing speed, memory, and fluid intelligence/broad visualization), also may be of interest to researchers.

Summary

As discussed throughout this paper, neuropsychological testing plays an important role in determining a child’s current and future abilities, and in providing a more holistic view of a students’ functioning. Neuropsychological profiles, as determined through appropriate testing, can aid in identifying a child’s strengths and weaknesses and help create the most beneficial intervention strategies for educational planning and everyday functioning. The measurement of impairment in executive functioning, which is thought to play a key role in a range of developmental disorders such as ADHD, learning disabilities, and autism (Chelune et al., 1986; Heilman et al., 1991; Hughes, 2002b; Mattes, 1980), also is of importance as part of neuropsychological testing.

Because neuropsychological functioning in adults and children differ significantly, it is essential that appropriate assessments and interpretive strategies are developed and used for children of differing ages. Many issues must be considered when creating assessment measures for young children including the variation and subtle deviations in neurological development, such as maturation of the frontal and prefrontal lobes and changes in attention. Due to minimal research in these areas, identifying and reviewing relevant neuropsychological measures is one way to contribute to this body of literature.

The current study examined the CAS and NEPSY with 5-7 year olds and used factor analyses and model fit indices to determine the most accurate model of the underlying constructs. In doing so, the current hypothesized models created by the test developers did not appear to be the best representation of the CAS and NEPSY factor structures. Models that proved to be better fits to the current data supported the early developmental literature pertaining to maturation of the frontal and prefrontal cortex and the importance of language acquisition in young children. Due to the literature and findings from this study, it is suggested that a global developmental score or a more basic model of functioning, such as the proposed Developmental models, may be the best representation of young child’s abilities.

This study also sought to examine the relationship between similar scales across objective assessment measures (e.g., CAS, NEPSY, and PPVT-III). Results indicated significant correlations among many scales, particularly those pertaining to language, attention, and memory/processing abilities. These results suggested that although the hypothesized factor structures of the CAS and NEPSY were not found to be robust, comparable scales across the two measures appear to be evaluating similar constructs. In addition, the relationship between parent and teacher rating scales and objective measures of functioning were examined to determine whether similar scales across measures would significantly correlate. Unfortunately, most scales from the report measures hypothesized to evaluate social/emotional (e.g., BASC) and executive functioning (e.g., BRIEF) did not significantly correlate with similar scales from objective measures. Again, careful interpretation of these results is warranted due to limited sample size and demographics of the study. Future studies are recommended to further research these measures and their appropriateness with young children.

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Recent Publications

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