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## Profiles of executive functioning in preschoolers with autism

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PROFILES OF EXECUTIVE FUNCTIONING IN PRESCHOOLERS WITH AUTISM

A dissertation presented by

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## Abstract

The research on executive functioning in adults, adolescents, and older children with autism has demonstrated clear executive function impairments. However, little research has been conducted on preschool-aged children with autism, even though characteristics of the disorder begin to manifest as early as birth. Preschool-aged children are different from older children and adults as they are consistently developing their skills and abilities, which has historically made it difficult to assess executive functioning skills in this age group. Few researchers have attempted to identify executive functioning profiles in preschool-aged children with autism.

This study compared the performance of 29 preschool children (4-6 years of age) with Autistic Disorder ( $n = 10$ ) and Pervasive Developmental Disorder – Not Otherwise Specified ( $n = 19$ ) to 30 same aged children without autism on global and domain specific elicited measures of executive functioning and an ecologically valid executive functioning behavioral rating scale. Age and intelligence was analyzed to examine executive functioning performance over age and intellect. A comparison of executive functioning performance on the *Dimensional Card Sorting Test*, *Day-Night test*, *Tower of Hanoi-R*, *Noisy Book*, and *Self-Control* task to the *BRIEF-P* was used to examine the correlation between ecologically valid and elicited instrumentation. An age group comparison in both groups was conducted to observe differences in performance among 4, 5, and 6 year olds. Both global and domain specific weaknesses in the children diagnosed with autism were found when compared to the children without autism. Moreover, the children without autism exhibited increased age-based performance on executive functioning tests measuring working memory, self- monitoring, and planning/organization. The *BRIEF-P* was correlated strongly with elicited measures across each domain of executive functioning.

## Profiles of Executive Functioning in Preschool Children with Autism

## CHAPTER ONE

In this introductory chapter, the framework for this study of executive functioning in preschool children with autism and Autism Spectrum Disorders (ASD) is presented. First, an explanation of the background and rationale for the investigation is provided. Second, a theoretical model of executive dysfunction in individuals with autism is presented along with the definition of terms used in the study. Third, the purpose of the study and research questions and hypotheses are provided. Finally, the significance of the study is discussed.

*Background and Rationale*

The background and rationale section provides an introduction to the important role executive functioning plays in learning, the difficulties in defining and assessing executive functioning, and the importance of assessing executive functioning in young children with autism. In addition, this section offers an explanation of executive functioning vulnerability in preschool-aged children with autism. Lastly, the characteristics, the prevalence rate, and the importance of early detection in autism are reviewed.

*Introduction*

Many young children have difficulties learning. Difficulties in executive functioning often implicate these children. The term executive functioning contains multiple components of learning including the specific abilities of working memory, mental flexibility/shifting sets, self-monitoring, inhibition, and planning/organizing information. Particular concern is for children who present lower scores on measures of executive functioning compared to children without

autism because they will likely suffer from learning, developmental, and academic difficulties throughout their lifespan.

The study of executive functions is critically important in the overall neuropsychological functioning, especially in young children. Executive functioning plays a fundamental role in a child's behavioral, cognitive, social, and emotional development beginning as early as birth. Young children use executive functioning skills to observe, interpret, and interact with their external world. To gain a better comprehension of executive functions would mean to have a clearer understanding of how young children begin to learn and interact with their environment.

Preschool children with ASD such as Autistic Disorder, Asperger's Disorder and Pervasive Developmental Disorder – Not Otherwise Specified have been found to display more vulnerabilities in executive functioning in the areas of inhibition, shifting mental set, and self-monitoring of action when compared to same-aged children without autism (McEvoy, Pennington, & Rogers, 1993; Pennington & Ozonoff, 1996; Russell, 1996b, Ozonoff & Strayer, 1997; Griffith, Pennington, Wehner, & Rogers, 1999; Ozonoff & Jensen, 1999; Hughes & Graham, 2002; and Coldren & Holloran, 2003). Vulnerabilities in executive functioning are typically observed to affect many everyday behaviors in children with ASD, such as perseverative responses, rigid and repetitive actions, and decreased impulse control. If executive functions can be assessed during the early stages of school entry, executive functioning profiles may be more clearly established to use in detecting specific diagnostic criteria for young children with autism.

#### *Explanation of Executive Functioning in Preschool Children*

The term executive functioning contains multiple components of learning including the specific abilities of working memory, mental flexibility/shifting sets, self-monitoring, inhibition,

and planning/organizing information. Particular concern is for children who present relatively low scores on measures of executive functioning because they will likely suffer from learning, developmental, and academic difficulties throughout their lifespan.

Executive functioning (EF) skills can be classified into two categories: lower order and higher order processes. Lower-order executive functioning skills are considered more simplistic, basic processes such as initiation, working memory, and inhibition. Due to the simplistic nature of these skills, the skills tend to develop earlier in childhood, and are usually observable at approximately 2-4 years of age. Higher-order EF skills require multiple and more complex learning processes. Higher-order EF skills consist of planning/organization and self-monitoring. These skills are generally thought to fully develop later in childhood because the effective use of these skills requires a combination of lower-order EF skills. Higher-order EF skills are typically observable at approximately 4-7 years of age.

One of the difficulties in assessing executive functioning is understanding the term itself. Over the past 15 years, researchers have argued over the definition of executive functioning and its domain components. The mere definition of executive functions presents obstacles, which has made neuropsychological assessment challenging across all age groups. The understanding of executive functioning is difficult due to the complexity of the domain, partly because of its dynamic essence, and partly from the obvious links between the central neuropsychological processes and the associated domain-specific processes, such as language, attention, and motor functioning (Isquith, Crawford, Espy, & Gioia, 2005). However, researchers have made strides within the last decade to develop more concrete definitions of executive functioning.

In general, many researchers would agree the term executive functioning is an umbrella construct defined as the control, supervisory, or self-regulatory functions that organize and direct

all cognitive activity, emotional response, and overt behavior (Welsh & Pennington, 1988; Griffith, et al., 1999; Lezak, Howieson, & Loring, 2004; Isquith et al., 2005; and Hill, 2004). More specifically, executive functions have been described as brain-based skills that begin to develop in the first years of life. Globally, Griffith et al. (1999) defined executive functions “as a flexible, strategic plan of action to solve a problem or attain a future goal” (p. 817). As a result of this broad multidimensional construct, the term executive functioning contains multiple components of learning including the specific abilities of working memory, mental flexibility/shifting sets, self-monitoring, inhibition, and planning/organizing information.

The topic of preschool-aged children possessing the ability to exhibit executive functioning skills has been debatable. Early research on executive functioning has suggested that executive functions were non-existent in children under the age of twelve (Espy et al., 2001). More recently, Espy et al., (2001) explained the emergence of executive functioning skills began to be conceptualized in preschool-aged children, once Chelune and Baer (1986) provided evidence for age-related changes in executive functioning performance on tests like the *Wisconsin Card Sorting Test*. The age-related changes findings from Chelune and Baer (1986) suggested that young children at the age of 5 years do indeed begin to develop executive functioning skills, such as shifting set and self-monitoring. By the age of 10, children perform equally as well on the *Wisconsin Card Sorting Test* compared to adults (Chelune & Baer, 1986).

In addition, Diamond (1990) noted that the relationship of performance on executive function tasks, and the functions of the prefrontal cortex in animals and humans, suggests that executive functions begin to develop early in infancy. Espy et al. (2001) reported Diamond’s (1990) conclusions: similar to other cognitive skills such as language, executive functions, although not fully present in their higher level form, can be measured across the early lifespan, if

developmentally appropriate tasks are used that account for more limited behavioral repertoire of infants and young children. Currently, developmental psychologists are using many Piagetian tasks and the development of the prefrontal cortex to assess executive functioning skills in children as young as two and a half years old (Espy, Kaufmann, McDiarmid, & Glisky, 1999; Espy et al., 2001; Isquith, Gioia, & Espy, 2004; and Rennie, Bull, & Diamond, 2004).

*The Assessment of Executive Functions in Preschool-Age Children*

The assessment of executive functions in preschoolers has presented a more complex challenge since young children are continually learning and developing at a rapid rate. Researchers have indicated that executive functioning could reliably be measured across the early life span with developmentally appropriate tasks (Diamond, 2000; Espy et al. 2001; and Isquith et al., 2005). The difficulties with assessing executive functions in children have been in adapting developmental and construct-appropriate instrumentation.

Along with adapting developmental constructs, ecological validity is critical when designing executive functioning tasks for preschoolers. Ecological validity in the assessment context is defined as a functional and predictive relationship between the individual's behavior on a set of neuropsychological tests and the individual's behavior in a variety of real-world settings (Isquith et al., 2005). The available measurements for preschool aged children are based, predominately, on elicited, laboratory based tasks, possessing little ecological validity. To assess executive functions at any age is not only to find appropriate performance-based measures, but also to evaluate the functional, real-world impact of executive functions expressed in everyday activities (Isquith et al., 2005).

To better assist preschool children, accurate assessment of executive functions is required. Progress has been made to develop clinical assessment and observational approaches

that measure executive functions in adults and older children, but there are limited executive function measures for young children (Isquith et al., 2005). However, over the past 10-years, researchers have made positive strides on developing developmentally appropriate, ecologically valid assessment tools, such as the *Behavior Rating Inventory of Executive Function-Preschool (BRIEF-P)*, *School Shape*, and *Trails-Preschool* (Espy, 1997; Gioia, Espy, & Isquith, 2002; and Espy & Cwik, 2004). The majority of preschool-aged executive function measures have been designed from previous adult measures, such as the *BRIEF*, *Stroop Test*, *Wisconsin Card Sorting Test*, and *Trails A & B*.

#### *Explanation of Executive Functioning in Preschoolers with Autism*

Preschool children with autism have been found to display more significant executive functioning weaknesses in the areas of inhibition, shifting mental set, and self-monitoring of action when compared to same-aged children without autism (McEvoy, Pennington, & Rogers, 1993; Pennington & Ozonoff, 1996; Russell, 1996b, Ozonoff & Strayer, 1997; Griffith, Pennington, Wehner, & Rogers, 1999; Ozonoff & Jensen, 1999; Hughes & Graham, 2002; and Coldren & Holloran, 2003). In addition, children with autism are of particular concern compared with children diagnosed with other neurologic, behavioral, and cognitive disorders, such as Down syndrome, ADHD, Tourette's syndrome, and learning disabilities; they generally display more impairments in executive functioning tasks and in their daily activities compared to peers with other developmental disorders (Coldren & Halloran, 2003). Deficits in executive functioning are also typically observed to affect many everyday behaviors in children with autism, such as perseverative responses, rigid and repetitive actions, and decreased impulse control. If executive functions can be assessed during the early stages of school entry, deficit profiles will be established to detect specific diagnostic criteria for young children with autism.

In many cases of individuals diagnosed with autistic disorder there is an associated diagnosis of mental retardation ranging from mild to profound (American Psychiatric Association, 2000). This confound presents a major concern when assessing executive functioning deficits in preschool children with autism because it can be difficult to distinguish between executive and cognitive deficits. Scheuffgen, Happe, Anderson, & Frith, (2000) reviewed several studies and found a general trend suggesting that 75 percent of children and adults diagnosed with autism score in the below average range of intelligence (Intelligence Quotient below 70) on assessments that have proven to be stable over time. The profile of cognitive deficits is usually uneven, regardless of the general level of intelligence, with verbal skills typically weaker compared to nonverbal skills (American Psychiatric Association, 2000). A dual diagnosis of mental retardation can range from mild to profound (American Psychiatric Association, 2000). This diagnosis often includes abnormalities in the development of cognitive skills. The difficulty is to assess executive functioning profiles appropriately in preschool children with autism independent of their cognitive/intellectual deficits.

### *Autistic Disorder*

Autistic Spectrum Disorders (ASD) are also known as Pervasive Developmental Disorders (PDD) which affect areas of development including, but are not limited to, language, social interaction, and behavior. ASD has been a term coined within the past 5 to 10 years to describe and categorize several disorders such as: Autistic Disorder, Asperger's Disorder, Non-Verbal Learning Disability, and Pervasive Developmental Disorder – Not Otherwise Specified. The term was created and used to describe the different disorders on a continuum of symptoms. Each of the disorders of ASD displays similar symptoms yet varying degrees of symptomatology. It is commonly thought that individuals with autistic disorder are generally on the more severe

end of the spectrum while individuals with non-verbal learning disabilities (NLD) and higher functioning autism (individuals with average to above average IQ) are on the mild end of the spectrum. Common symptoms of autism are marked language and social/communication impairments, and restrictive and repetitive behaviors. The DSM-IV-TR describes the autistic disorder as “markedly abnormal or impaired development in social interaction and communication and a markedly restricted repertoire of activities and interests” (American Psychiatric Association, 2000; p. 70). The characteristics and diagnostic features of autism rely on the developmental level and chronological age of the individual. In the same vein, Asperger’s Disorder typically is defined with language impairments and repetitive and restrictive behaviors, while NLD presents primarily with visuo-spatial impairments.

Autistic Disorder can be viewed as containing three categories: (1) repetitive interests and behaviors, (2) language difficulties, and (3) relative social impairments, when compared to same aged peers (Griffith et al., 1999). Symptoms from the repetitive interests and behaviors relate most clearly to deficits of executive functions (Griffith et al., 1999). The language and social aspects of the autism disorder are less clearly related to executive functions, but researchers have suggested that impairments in executive functions may cause autism-specific deficits in other cognitive domains that are more closely tied to language and social functioning (McEvoy et al., 1993; and Griffith et al., 1999). In addition, empirical work has demonstrated executive function vulnerabilities in older children and adults diagnosed with autism (McEvoy et al., 1993; Griffith et al., 1999; Ahmad & Warriner, 2001; Coldren & Halloran, 2003; and Goldberg et al., 2005). Therefore, there can be a compelling argument can be made that young children with autism will display relatively lower scores on executive function measures compared to other children,

because autism is a neurological disorder with deficits becoming apparent between two and five years of life.

### *Prevalence of Autism*

The exact rate of autism prevalence in the United States is currently unknown due to the lack of national research on prevalence. However, several local studies have been conducted that indicate that the rate of autism has steadily increased over the past decade. A recent investigation by the Center for Disease Control (CDC) in Brick Township, New Jersey, found a prevalence rate for autism of 4.0 per 1,000 children and a rate of 6.7 per 1,000 children for the more broadly defined category of autistic spectrum disorders (Yeargin-Allsopp et al., 2003). Furthermore, in a study of prevalence of autism among 289,456 children aged 3 to 10 years in Atlanta, Georgia, conducted by Yeargin-Allsopp et al. (2003), the authors found the rate of autism was 3.4 per 1000 children studied; 987 children met Diagnostic and Statistic Manual of Mental Disorder-Fourth Edition-Text Revision (DSM-TR-IV) criteria for a pervasive developmental disorder. Yeargin-Allsopp et al. (2003) concluded that the rate of autism was higher than the previous rates of studies conducted in the United States during the 1980's and early 1990's. Newschaffer, Falb, and Gurney (2005) investigated autism prevalence rates using national special education data in the United States with birth cohorts 6 to 17 years old between the 1992 and 2001. The study's findings suggested the prevalence of autism over time has increased, as evident by higher rates in younger birth cohorts (Newschaffer et al., 2005).

Regardless of research design and sampled populations, all researchers studying the prevalence rate of autism reported a marked increase of autism within the past 10 to 15 years (Newschaffer et al., 2005; Yeargin-Allsopp et al., 2003; Prior, 2003; Fombonne, 2003; and The American Psychiatric Association, 2000). The increasing rate of autism has sparked a debate

regarding a possible epidemic of autism. According to Yeargin-Allsopp et al. (2003), there is now greater public awareness of the autism disorder and the symptoms associated with it, which may be one contributing factor to the increased rate of autism. Another reason may be the addition of autism as a condition for special education services as a result of amendments to federal laws that provide entitlement services to children with special needs (IDEA, 1991).

#### *Importance of Early Detection in Autism*

Apart from the possible reasons behind the increase in prevalence rates of autism, it is important to develop age and population appropriate measures that will provide early detection of executive functioning profiles in children at risk for being diagnosed with autism. Specifically for young children, if executive abilities can be reliably assessed during the preschool years, early intervention could be provided to possibly reduce repetitive and restricted behaviors, and improve language and social communication impairments found in children with autism. Early detection is also important not only for the individual and their family, but also for society at large. Children with autism require long-term care and services. Special education costs for a child with autism are estimated to be more than \$8,000 per year, with some specially structured programs costing about \$30,000, and care in a residential school costing \$80,000 - \$100,000 per year (Yeargin-Allsopp et al., 2003). It is the hope that early detection and interventions can reduce these costs by increasing the independence and daily functions of children diagnosed with autism and more effectively implementing less restrictive educational placements. In turn, early detection will ultimately reduce the long-term educational and residential costs associated with long-term care of individuals with autism.

Adequate identification of executive profiles in young children with autism is of critical concern, because executive functions have been demonstrated to contribute to academic and

behavioral difficulties in children with autism, independent of their general intellectual abilities (Espy et al., 2001). If executive functions can be assessed during the early stages of school entry, profiles might be established to detect specific childhood disorders earlier. Moreover, interventions can be provided earlier possibly to treat and reduce the symptoms of childhood disorders such as Attention Deficit Hyperactivity Disorder (ADHD), Down syndrome, Tourette's syndrome, and Pervasive Developmental Disorder (PDD), all of which present vulnerabilities in executive functioning.

It is of importance to focus on children with ASD, specifically, children with autism, because they have a greater risk of cognitive, emotional, and behavioral impairments compared to children with other developmental disorders (McEvoy, Rogers, & Pennington, 1993; Jordan, Libby, & Powell, 1995; Russell (ed.), 1996a; Dawson, Meltzoff, Osterling, & Rinaldi, 1998; Griffith et al., 1999; Coldren & Halloran, 2003; Ozonoff et al., 2004; Hill, 2004; and Joseph, McGrath, & Tager-Flusberg, 2005). Additionally, it is critical to continue to investigate these executive impairments in young children with autism given that the prevalence of the disorder has continually risen over the past decade.

### *Theoretical Model*

One cannot observe executive functions in young children without considering an integrative approach of both developmental psychology and neuropsychology. Isquith et al. (2005) stated "the developmentally oriented neurpsychologist, whether focused on clinical service delivery or research investigation, has an inherent interest in the earliest roots of disorders that are evident in later childhood and adolescence" (p. 210). Developmentally sensitive techniques need to be implemented to capture the earliest precursors of executive functions in preschool-aged children.

*Executive Dysfunction Theory*

The executive dysfunction theory was developed to explain the restricted and repetitive patterns of behavior and executive functioning impairments in individuals with autism-like characteristics. The theory was developed by Damasio and Maurer (1978) in a paper that compared the symptoms of individuals with autism to patients with injuries to the frontal lobes of the brain. They found a strong correlation between the two groups on tasks thought to measure executive functions, such as goal directed and action appropriate behaviors (Jordan et al., 1995; and Griffith et al., 1999). Since that time, people with autism have displayed more deficits in executive functions on neuropsychological measures than individuals with other developmental or neurological disorders.

The executive dysfunction theory makes several convincing arguments to understand the link between the functioning of the brain and the behavior in children with autism. First, the executive dysfunction theory of autism states that stereotyped behaviors develop from “self-stimulatory” behaviors that are presented during infancy. Consequently, individuals with autism fail to develop the more complex, mature behaviors that eventually replace the basic self-stimulatory behaviors (Lopez, Lincoln, Ozonoff, & Lai, 2005). Neurologically, Lopez, et al. (2005) suggested that deficits in frontal lobe functioning could impede one’s early development and the ability to appropriately react to the external environment, creating stereotyped or repetitive behaviors witnessed in individuals with autism.

Second, from the same neurological vein, Lewis and Baumeister (1982) explained that stereotyped behaviors “could result from an abnormality in the nigro-striatal dopamine tract in the basal ganglia” (Lopez, et al., 2005; p. 446). This theory provided initial evidence for a connection between repetitive/restricted behaviors and frontal lobe functioning. The repetitive

and restricted behaviors in autism are linked to executive dysfunction because the behaviors are characterized as perseverative errors, inability to generate novel solutions, shifting set, lack of problem-solving skills, and inhibiting an automatic/over-learned response. All of these weaknesses in executive skills are thought to be controlled by the frontal lobes.

Lastly, the executive dysfunction theory developed by Damasio and Maurer (1978) compared the symptoms of autism to individuals who experienced frontal lobe brain injuries through tests meant to measure executive functioning (Griffith, et al., 1999). Griffith et al. (1999) stated that since the “late 1970’s research has demonstrated that deficits in executive functions are a robust correlate of autism in adults, adolescents, and older children” (p. 817). Moreover, Jordan et al. (1995) reported that the work of Damasio and Maurier (1978) described the parallels between the “symptoms displayed by patients with neurological damage to their frontal lobes and adults with autism” (p. 298).

The connection between the frontal lobes of the brain and executive functions is that the frontal lobes have been associated with producing goal-oriented behaviors requiring execution of appropriate action plans (Jordan et al., 1995). These action plans are a necessity in an individual’s daily life because they allow one to complete tasks, adapt to different situations/environments, and regulate one’s behaviors. In studies observing individuals with frontal lobe damage and individuals diagnosed with autism, there appears to be a failure to complete flexible action plans and appropriately adjust to different situations (Jordan et al., 1995).

Griffith et al. (1999) and by Pennington et al. (1993) reported that several studies have demonstrated executive dysfunctions in adults, adolescents, and older children with autism. However, the research is limited in regards to preschool aged children (4-6 years of age). The

proposed study aims to investigate this executive dysfunction theory in preschool-aged children using both elicited measures and observational rating scales, which should represent an ecologically valid assessment battery.

### *Definition of Terms*

*Global executive functions.* Global executive functions describe brain-based skills that begin to develop in the first years of life. The term executive function is a complex domain containing multiple components of learning. Griffith et al. (1999) defined executive functions “as a flexible, strategic plan of action to solve a problem or attain a future goal” (p. 817). As a result of this broad multidimensional construct, executive functions have been broken down to include the specific abilities of working memory, mental flexibility/shifting sets, self-monitoring, inhibition, and planning/organization. In sum, global executive functions are defined as a combination of all five of the subdomains of executive functioning.

*Working memory.* The short-duration, limited-capacity memory system that simultaneously stores and manipulates information in order to accomplish a task.

*Shifting set.* Shifting set is defined as the ability to shift back and forth between multiple stimuli, operations, or mental sets.

*Self-monitoring.* Self-monitoring or “self-awareness” entails a self-evaluative and regulatory function that includes self-appraisal or self-control of one’s own cognitive processes, including the regulation of motor acts.

*Inhibition:* The term inhibition is generally defined in neuropsychology as the ability to deliberately inhibit automatic, dominant, over-learned responses when necessary.

*Organize/plan.* The ability to plan organize and problem-solving in an effective manner.

*Ecological validity.* “Ecological validity is the functional and predictive relation between the patient’s behavior on a set of neuropsychological tests and the patient’s behavior in a variety of real-world settings” (Isquith et al., 2005).

*Autism:* DSM IV-TR (American Psychiatric Association, 2000; p. 75).

- “A. A total of six (or more) items from (1), (2), and (3) with at least two from (1), and one each from (2) and (3):
- (1) Qualitative impairment in social interaction, as manifested by at least two of the following:
    - (a) Marked impairment in the use of multiple nonverbal behaviors such as eye-to-eye gaze, facial expression, body postures, and gestures to regulate social interaction.
    - (b) Failure to develop peer relationships appropriate to developmental level.
    - (c) A lack of spontaneous seeking to share enjoyment, interests, or achievements with other people (e.g., by a lack of showing, bringing, or pointing out objects of interest).
    - (d) Lack of social or emotional reciprocity.
  - (2) Qualitative impairments in communication as manifested by at least one of the following:
    - (a) Delay in, or total lack of, the development of spoken language (not accompanied by an attempt to compensate through alternative modes of communication such as gesture or mime).
    - (b) In individuals with adequate speech, marked impairment in the ability to initiate or sustain a conversation with others.
    - (c) Stereotyped and repetitive use of language or idiosyncratic language.
    - (d) Lack of varied, spontaneous make-believe play or social imitative play appropriate to developmental level.
  - (3) Restricted repetitive and stereotyped patterns of behavior, interests, and activities, as manifested by at least one of the following:
    - (a) Encompassing preoccupation with one or more stereotyped and restricted patterns of interest that is abnormal either in intensity or focus.
    - (b) Apparently inflexible adherence to specific, nonfunctional routines or rituals.
    - (c) Stereotyped and repetitive motor mannerisms (e.g., hand or finger flapping or twisting, or complex whole-body movements).
    - (d) Persistent preoccupation with parts of objects.
- B. Delays or abnormal functioning in at least one of the following areas, with onset prior to age 3 years: (1) social interaction, (2) language as used in social communication, or (3) symbolic or imaginative play.
- C. The disturbance is not better accounted for by Rett’s Disorder or Childhood Disintegrative Disorder.”

*Pervasive Developmental Disorder – Not Otherwise Specified: DSM-IV-TR*

(American Psychiatric Association, 2000; p. 84).

“This category should be used when there is a severe and pervasive impairment in the development of reciprocal social interaction associated with impairment in either verbal or nonverbal communication skills or with the presence of stereotyped behavior, interests, and activities, but the criteria are not met for a specific Pervasive Developmental Disorder, Schizophrenia, Schizotypal Personality Disorder, or Avoidant Personality Disorder. For example, this category includes "atypical autism" - presentations that do not meet the criteria for Autistic Disorder because of late age at onset, atypical symptomatology, or subthreshold symptomatology, or all of these”.

*Purpose of Study*

The purpose of this study was to investigate global and specific domains of executive functions in preschoolers with and without ASD; specifically Autistic Disorder and Pervasive Developmental Disorder-Not Otherwise Specified using elicited and ecologically valid neuropsychological instrumentation. A need exists to develop new methods of assessment that identify deficits of executive functions in preschool-aged children so that interventions can be implemented earlier. The existence of executive functioning assessment tools for preschoolers is limited. In addition, there is a need for the development of assessments that capture ecological validity in preschool children, in order to evaluate children’s capacity to learn during everyday activities. The examination of everyday behaviors is a complementary approach to using controlled or elicited instrumentation to assess executive functions in preschool children (Isquith, Gioia, & Espy, 2004). The child’s everyday environments, both at home, at school, and/or day care, are important venues for observing routine manifestations of executive functions. When using an assessment battery with ecological and elicited-based instrumentation, the likelihood of under-diagnosing or misdiagnosing young children with developmental disorders is reduced.

Many children diagnosed with childhood disorders including autism have more difficulties with executive functioning activities. A more ecologically valid battery evaluate executive functioning in preschool-age children will provide early detection of childhood disorders and improved interventions.

### *Research Questions and Hypotheses*

The first research question examined whether there are global deficits in executive functions in preschool-age children (4-6-years) with autism compared to same chronological-age children without autism. Several studies have examined global executive functioning deficits in both preschool children with and without autism (McEvoy et al., 1993; Bennetto et al., 1996; Ozonoff & Jensen, 1997; Dawson et al., 1998; and Ozonoff et al., 2004). In general, these studies have found global deficits across subdomains of executive functioning in the group with autism.

Ho1: Preschool age-children with autism will display lower performance scores on global executive functions measures (i.e., initiation/shifting set, inhibition, planning/organization, self-monitoring, and working memory) compared to preschoolers without autism.

The second research question examined whether there are one or more domains of executive functions, specifically working memory mental flexibility/shifting set, inhibition, self-monitoring, and planning/organization, which are quantitatively more impaired using the selected neuropsychological instrumentation in children with autism compared to the children without autism. A wealth of previous research has indicated that preschool children with ASD display more specific executive function deficits in the area of inhibition, mental flexibility/shifting set, and self-monitoring (McEvoy et al., 1993; Turner, 1996; Dawson et al., 1998; Coldren & Holloran, 2003; Hill, 2004; and Ozonoff et al., 2004). On a smaller scale, some research has

indicated that children with ASD have difficulty with planning/organizing on specific neuropsychological tests (Ozonoff et al., 1991; Bennetto et al., 1996; Ozonoff & Jensen, 1999; and Hill, 2004). However, there has been little to no research to that examines whether working memory vulnerabilities are present in preschool children with autism.

Ho2: Preschoolers with autism will display lower performance scores on executive function domain measures in the areas of inhibition, self-monitoring, shifting set, and planning/organizing compared to children without autism.

The third research question investigated group age differences in children with and without autism. The autism group subgroups consisted of six 4-year olds, twelve 5-year olds, and eleven 6-year olds. The without autism group consisted of six 4 year olds, seven 5-year olds, and seventeen 6-year olds. The study examined whether the autism group's performance would decline on executive functioning measures, compared to the performance of the without autism group.

Ho3: The interaction between measures and age will fit a different trend line for children with autism compared to children without autism.

The fourth and final research question focused on elicited/controlled executive functioning measures (*Dimensional Card Sorting Test*, *Day-Night test*, *Noisy Book*, *Tower of Hanoi-R*, and *Self-Control* task) compared to an ecologically valid measure (*BRIEF-P*). Using a testing battery that consisted of both elicited and ecologically valid tests of executive functioning, the question was whether both types of tests would measure executive functioning in preschoolers consistently across groups. Isquith et al. (2005) stated that the two types of instrumentation should be combined for a more comprehensive examination of childhood

executive functioning. Elicited tasks measure specific components of executive functioning; as observational tasks measure a child's level of functioning in an everyday context (Isquith et al., 2005).

Ho4: The measurement of executive functioning abilities will be the same for elicited and ecologically valid instruments for both groups of children.

### *Significance of Study*

Capacities of executive functioning are an important component of learning because they are linked to higher order mental processing, impulse control, mental flexibility, and organizing information. The emergence of executive functioning begins to be exhibited in the preschool years of life (3 to 6 years of age). Recent strides have been made to assess executive functioning skills in preschool children using developmental appropriate measures such as the *BRIEF-P*, *Dimensional Card Sorting Test*, and *Day-Night* test.

The use of more sensitive executive functioning instruments in young children with ASD is critical because these children have difficulty with learning and have clear weaknesses in executive function domains compared to their same aged peers (i.e., inhibition, mental flexibility, working memory and self-monitoring). It is of great importance to begin to assess executive functioning profiles in children with ASD since this population often characteristically displays more difficulties with executive functioning. Additionally, the number of children diagnosed with autism has increased over the past ten years from 4-5 individuals out of 10,000 in 1985 to approximately 40 out of every 10,000 in 1998 (Yeargin-Allsopp et al., 2003).

For these reasons, developmental researchers and neuropsychologists need to identify a more effective assessment battery for young children with ASD. Improved elicited and ecologically valid measures of executive functions will provide practitioners with an enhanced

understanding of vulnerabilities in executive functioning. In turn, further advancing more sensitive interventions to assist these children will improve their learning and executive functioning skills. Earlier detection of executive functioning vulnerabilities in preschool-aged children with ASD with appropriate intervention will help children improve their learning and their general quality of life.

## CHAPTER TWO

This chapter will begin with an examination of the definition of executive functioning followed by a review of each component of executive functioning. Subsequently, a review of the autism and the demographic, diagnostic and neurological features associated with the disorder will be discussed. A current review of the theories of autism is given, focusing primarily on the executive dysfunction theory and its relation to autistic disorder. Finally, this chapter will provide critique of current preschool-age-appropriate tools for the assessment of executive functions.

### Overview of Executive Functions

An overview of executive functions addresses the challenges with operationally defining executive functioning. A historical neurological perspective of executive functions is provided followed by a discussion to attempt to distinguish between executive functioning and cognitive functioning. Last, the individual components of executive functions will be examined.

#### *Introduction to Executive Functions*

In general, executive functioning has been defined as “the ability to maintain an appropriate problem-solving set for the attainment of a future goal” (Griffith et al., 1999). Additionally, Lezak et al. (2004) explained that executive functions are the capacities that allow an individual to engage successfully in independent, purposeful, self-serving behaviors. It is an umbrella term for mental abilities such as planning, working memory, inhibition, mental flexibility/set shifting, initiation, and self-monitoring of behaviors (Hill, 2004). Due to this broad definition, many researchers have attempted to denote further the specific subtypes of executive functioning mentioned above (McEvoy et al., 1993; Griffith et al., 1999; Espy et al., 2001; Espy, 2004; Hill, 2004; Isquith, et al., 2004; Senn, Espy, & Kaufmann, 2004; Goldberg et al., 2005; and

Isquith et al., 2005). Researchers have generally agreed executive functioning is categorized into five subdomains of inhibition, shifting mental set, working memory, self-monitoring, and planning/organization.

Historically, research on executive functions has its roots in neuropsychological studies involving frontal lobe brain injuries. Miyake et al. (2000) stated that a long, documented history of patients with damage to the frontal lobe, including the well-known case of Phineas Gage, demonstrated severe problems of control and regulation of their behavior and that they cannot function adequately in their everyday lives. Many of these patients displayed good performances on cognitive tasks and IQ tests, but they tended to show significant impairments on complex tasks of frontal lobe functioning or executive functions (Miyake et al., 2000). A growing body of neuroimaging and neuropsychological studies provided evidence indicating the involvement of the prefrontal cortex, as it is primarily activated during tasks requiring executive functions (Ozonoff & Strayer, 1997; Miyake & Shah, 1999; Miyake et al., 2000; Bull, Espy & Senn, 2004; Espy, 2004; Fassbender et al., 2004; Hill, 2004; Isquith et al., 2004; Levin & Hanten, 2005; Blair, Zelazo, & Greenburg, 2005; and Lopez et al., 2005).

Executive functioning differs from, and is often confused with, cognitive functioning. Lezak et al. (2004) stated that executive functioning involves solving problems, or asking how or whether a person goes about doing something (e.g., will you do it and, if so, how and when?). On the other hand, cognitive functioning answers questions such as what or the amount: (e.g., one's general knowledge of facts). In a similar vein, cognitive functioning is the processing of preexisting, factual knowledge, while executive functioning is the strategic abilities to process new learning, including problem-solving, planning, and initiation/motivation to process new information.

Cognitive functioning deficits usually appear in specific functioning areas or abilities, while executive impairments tend to be more global, usually affecting all aspects of performance (Lezak et al., 2004). Executive functioning deficits often lead to many different behavioral problems that can be quite observable. These signs can include “defective capacity for self-control or self-direction such as emotional lability or flattening, a heightening tendency to irritability and excitability, impulsivity, erratic carelessness, rigidity, and difficulty in making shifts in attention and in ongoing behavior” (Lezak et al., 2004; p. 36). Conversely, some executive functioning deficits may exist that are more difficult to detect at first glance, such as impaired capacity to initiate activity, decreased or absent motivation, and deficits in planning and carrying out the activity sequences that make up goal-directed behaviors (Lezak et al., 2004). Nonetheless, the term “executive functioning” is just an umbrella term often used to describe specific “high-order” processes.

Lezak et al. (2004) stated that as long as an individual has intact executive functioning, a person could sustain a considerable amount of cognitive loss and still continue to be independent, constructive, self-serving, and productive. However, if executive functions are compromised, an individual is likely to have difficulties engaging in social relationships, self-management, or interacting independently regardless of the degree of intact cognitive functioning. Executive functioning assists with the everyday processing and organization of new information. As a result, executive functioning impairments are more debilitating because individuals are unable to decide upon implement appropriate learning strategies. Individuals are able to compensate better with cognitive functioning deficits given such deficits appear to apply to only factual knowledge and previously learned information.

*Components of Executive Functions*

In general, many researchers categorize and breakdown executive functioning into five different components: working memory, inhibition, initiation/shifting set, mental flexibility, and planning/organizing information. In the next section each component of executive functioning will be defined and described.

*Working memory.* Working memory is a brain-based mechanism underlying the maintenance of task relevant information while engaged in a cognitive task. The theoretical construct of working memory has been used in cognitive psychology and more recently in neuropsychology. It refers to the system or mechanism underlying the maintenance of task-relevant information during the performance of a cognitive task (Miyake & Shah, 1999). It has implications in everyday tasks requiring multiple steps as it has been implicated in helping individuals to mentally hold information temporarily for them to accomplish the targeted task successfully. Calculating tips, reading a newspaper article, multi-tasking several chores at one time, remembering phone numbers, and mentally rearranging furniture in one's mind before physically moving it, are all everyday examples that require multiple steps that need to be held in mind to successfully complete the targeted goal. Some components of attention also are required to complete many working memory tasks, as the individual needs to attend to two competing stimuli for successful completion.

Baddeley (1986) and Miyake et al. (2000) stated that the working memory is responsible for the control and regulation of executive functions, and it is often linked to the functioning of the frontal lobes. More specifically, Lezak et al. (2004) reported the left dorsolateral prefrontal cortex is activated during verbal working memory tasks, and the right dorsolateral prefrontal cortex is activated for spatial working memory tasks.

Nelson et al. (2000) reported that 6-month old children displayed holding information in working memory for as long as 4 seconds, which indicate that working memory skills begin to develop in early infancy. The majority of research on the development of working memory skills reported continual increases in performance across age groups from 4-years of age through adolescence (Nelson et al., 2000). Similarly, Miles, Morgan, and Moris (1996) found 10 and 11-year olds did not perform as well as adults on tasks of verbal working memory compared to young adults. However, children as young as 2.5 to 4-years are able to complete successfully the *A-not-B task*, *Delayed Alternation*, *Spatial Reversal*, and *Color Reversal*, which are tasks that requiring working memory skills (McEvoy et al., 1993; Dawson et al., 1998; Espy et al., 1999; Griffith et al., 1999; Espy et al., 2001; and Senn et al., 2004). In general, the results from the development of working memory suggest that working memory skills can be reliably assessed in preschool aged children with age group improvements through adulthood.

*Inhibition.* The term inhibition is generally defined in neuropsychology as the ability to deliberately inhibit automatic, dominant, over-learned responses when necessary. Forms of inhibition include “withholding or suppressing a dominant but no longer relevant response, stopping a response in progress, suppressing retrieval of irrelevant information from memory, resisting interference mediated by memory of previous events, or perceptual interference in the form of distraction” (Levin & Hanten, 2005; p. 82). Successful completion of inhibition tasks has been documented in individuals as young as 3-years old with age group improvements across the lifespan (Espy, 1997; and Levin & Hanten, 2005).

Previous research has shown that several measures of inhibition are sensitive to lesions in the frontal lobes and other types of neurological disorders in both adults and children (Ozonoff & Strayer, 1997; Miyake et al., 2000; Fassbender et al., 2004 and Levin & Hanten, 2005). More

specifically, age-related improved in inhibition has been attributed to the maturation of brain-based networks including the dorsolateral prefrontal cortex, orbito-frontal cortex, anterior cingulate, and a striato-basal ganglia-thalamo-frontal loop (Levin & Hanten, 2005).

Vulnerabilities in inhibition are often noted as perseverative responses, problems with stopping action, repetitive behaviors, and mental rigidity (Ozonoff et al., 1991; and Turner, 1996). Lezak et al. (2004) reported that problems with inhibition can lead to “problems braking or modulating ongoing behavior, impulsivity, over-reactivity, and difficulties holding back a wrong or unwanted response, particularly when it may either have a strong associative value or be part of an already ongoing response chain” (p. 84). Individuals with impairments in inhibition often have difficulties delaying gratification and are seen as having control problems (Lezak et al., 2004).

Overall, many instruments have been designed to assess inhibition in young children as young as 2.5 to 3 years of age. These instruments include Piagetian tasks, such as *A-not-B task* and *Delayed Alternation task*, and more recent neuropsychological tasks like the *BRIEF-P* and *School Shape* test.

*Shifting set*. Shifting set is defined as the ability to shift back and forth between multiple stimuli, operations, or mental sets. It is also known as “attention switching”, “mental flexibility” or “task switching”. In sum, shifting set is the process that involves the disengagement of an irrelevant task and the active engagement of a relevant task. Problems with shifting set can lead to the inability to shift to a different thought or action according to changes in a situation (Miyake et al., 2000). The capacity for switching from one response to another can place simultaneous demands on working memory and inhibition (Levin & Hanten, 2005). The ability to shift cognitive set has a developmental trajectory that begins to become observable through

executive function measures at approximately 3 to 4-years of age (Espy, 1997; Espy et al., 2001; Espy & Cwik, 2004; Senn, et al., 2004; Isquith et al., 2005; and Levin & Hanten, 2005).

Several research studies indicated that shifting between tasks or mental sets involves the frontal lobes of the brain, in particular, the prefrontal dorsolateral cortex (Ozonoff & Strayer, 1997; Miyake & Shah, 1999; Miyake et al., 2000; Espy, 2004; Fassbender et al., 2004; Isquith, et al., 2004; Lezak, et al., 2004; Levin & Hanten, 2005; Blair et al., 2005; and Lopez et al., 2005). One key symptom of frontal lobe impairments is the presence of perseverative behaviors (i.e., repeating the same response over and over even when it is clearly no longer appropriate). It is often interpreted as an inability to switch mental sets (Miyake et al., 2000; Fassbender et al., 2004; and Hill, 2004). In addition, the inability to shift set accurately can lead to perseverative, stereotyped behaviors, and difficulties in the regulation and modulation of motor actions (Hill, 2004). Rogers et al. (1998) reported that patients with damage to their left frontal lobes demonstrated a significant impairment in shifting in addition to and perseverative behaviors compared to same age and IQ controls.

*Self-monitoring.* Self-monitoring or “self-awareness” entails a self-evaluative and regulatory function that includes self-control of one’s own cognitive processes, including the regulation of motor acts (Hill, 2004; Lezak, 2004; Levin & Hanten, 2005). Levin and Hanten (2005) explained that self-monitoring abilities begin to manifest in children beginning at the age of four. On the developmental continuum, children at the age of four to five begin to understand simple self-monitoring (i.e., remembering where forgotten items are located). More advanced self-management or metacognition skills emerge around the age of 6 to 7 years of age (i.e., implementing learning strategies). By the age of 9 children develop more sophisticated strategies such as categorization (Flavell, 1999; and Levin & Hanten, 2005).

The ability to self-monitor one's thoughts and actions has been associated with the prefrontal cortex, particularly the dorsolateral prefrontal cortex of the brain (Fassbender et al., 2004; and Lezak et al., 2004). More specifically, aspects of self-monitoring and error detection, has been associated in frontocentral regions including the anterior cingulate cortex (Fassbender, et al., 2004). In a similar vein, frontal lobe lesion patients often display little or no anxiety, to display impulsivity, and to display minimal concern regarding social norms (Lezak et al., 2004). Even the very sense of self is vulnerable in individuals with frontal lobe lesions (Lezak et al., 2004). The failure to monitor and properly respond to social and emotional reinforcers may be the true impairment leading to these inappropriate behaviors.

*Planning/organization.* Planning is the capacity to mentally “see ahead” during periods of problem solving. The planning domain has been referred to as a “complex, dynamic operation that a sequence of actions must be constantly monitored, re-evaluated and updated” (Hill, 2004, p. 28). An individual must be able to “conceptualize changes from present circumstances, deal objectively with oneself in relation to the environment, and view the environment objectively” (Lezak et al., 2004; p. 614). Developmentally, at the age of four, children begin to display some basic aspects of planning on test measures, while age related performance increases at least to 15-years of age (Levin & Hanten, 2005). Impairments in the domain of planning/organization have been observed in children, adolescents, and adults. In addition, these impairments are usually maintained over time (Hill, 2004). The tests that have been used included the “Tower tasks” (e.g., *Tower of London*, *Tower of Hanoi*, *D-KEFS Tower* subtest, and *NEPSY Tower* subtest).

Some researchers have suggested that young children use less planning skills than inhibition to complete planning-based tasks because younger children seem to rely more heavily

on inhibition, particular for young children who display more limited cognitive capacities (Miyake et al., 2000; and Bull et al., 2004). A reason for this hypothesis is that younger children are thought to have more limited cognitive capacity and metacognition skills; they need to rely more on inhibition to guide tasks requiring multi-step problem-solving. Planning has been linked by functional brain imaging to dorsolateral prefrontal cortex in adults and children using various neuropsychological planning tasks (Fassbender et al., 2004; and Levin & Hantén, 2005).

### Overview of Autistic Disorder

An overview of the autistic disorder including the neurological and diagnostic features of the disorder is presented in this section. A review of the recent prevalence rate, specific age/gender features, and characteristics of children at risk for developing autism are discussed.

#### *Autism*

Autism is a Pervasive Developmental Disorder (PDD) affecting areas of development including, but not limited to, language, social interaction, and behavior. The DSM-IV-TR describes the autistic disorder as “markedly abnormal or impaired development in social interaction and communication and a markedly restricted repertoire of activities and interests” (American Psychiatric Association, 2000; p. 70). The characteristic and diagnostic features of autism rely on the developmental level and chronological age of the individual. In this section, the prevalence rate of autism, onset age and gender features, and children at risk for the autistic disorder are described.

In many cases of individuals diagnosed with autistic disorder, there is an associated diagnosis of mental retardation ranging from mild to profound (American Psychiatric Association, 2000). The dual diagnosis of mental retardation and autism often include

abnormalities in the development of cognitive skills. The profile of cognitive deficits that are obtained usually uneven, regardless of the general level of intelligence, with verbal skills typically weaker compared to nonverbal skills (American Psychiatric Association, 2000). Scheuffgen, Happe, Anderson, and Frith, (2000) reviewed several studies and found a general trend suggesting that 75 percent of children and adults diagnosed with autism are mentally retarded on assessments that have proven stability over time. However, cognitive deficits and/or low intelligence are not included in the diagnostic criteria of autistic disorder. In fact, one-quarter of individuals with autism are assessed in the average range of intelligence or higher.

Individuals with autism may have a range of behavioral symptoms, including hyperactivity, short attention span, impulsivity, aggressiveness, self-injurious behaviors, and, particularly in young children, temper tantrums (American Psychiatric Association, 2000). The American Psychiatric Association (2000) described these behavioral symptoms in more detail:

“There may be odd responses to sensory stimuli (e.g., a high threshold for pain, over sensitivity to sounds or being touched, exaggerate reactions to light or odors, fascination with certain stimuli). There may be abnormalities in eating (e.g., limiting diet to a few foods, Pica) or sleeping (e.g., recurrent awakening at night with rocking). Abnormalities of mood or affect (e.g., giggling or weeping for no apparent reason, an apparent absence of emotional reaction) may be present. There may be a lack of fear in response to real dangers, and excessive fearfulness in response to harmless objects. A variety of self-injurious behaviors may be present (e.g., head banging or finger, hand, or wrist biting)” (p. 72).

### *Diagnostic Features of Autism*

The DSM-IV-TR explained three specific diagnostic criteria for autism: social interaction impairment, communication impairment, and restricted repetitive and stereotyped patterns of behavior, interests, and activities. This section will offer a descriptive explanation for each of the three DSM-IV-TR diagnostic criteria and provide a rationale for the specific criteria related to executive functioning.

*Social interaction impairment.* Social interaction impairments of individuals diagnosed with autism are usually lifelong and sustained throughout the lifespan. The DSM-IV-TR details several marked social impairments; they are the “use of multiple nonverbal behaviors, to regulate social interactions and communication, and failure to develop peer relationships appropriate to developmental age level” (American Psychiatric Association, 2000; p. 70). In addition, younger children could possibly have little interest in developing friendships. “There may also be a lack of spontaneous seeking to share enjoyment, interests, or achievements with other people and a lack of social and emotional reciprocity may be present” (American Psychiatric Association, 2000; p. 70). Often individuals with autism are unaware of other individual needs or may not notice other’s emotions.

*Communication impairment.* Similar to social interaction impairments, communication impairments in children with autism (both verbal and non-verbal) also are marked and sustained throughout the lifespan. The DSM-IV-TR described communication impairments as:

“There may be delay in, or total lack of, the development of spoken language. In individuals who do speak, there may be marked impairment in the ability to initiate or sustain a conversation with others, or a stereotyped and repetitive use of language or idiosyncratic language. There may also be a lack of varied, spontaneous make-believe play or social imitative play appropriate to developmental level. When speech does develop, the pitch, intonation, rate, rhythm, or stress may be abnormal. Grammatical structures are often immature and include stereotyped and repetitive use of language or idiosyncratic language. Language comprehension is often very delayed, and the individual may be unable to understand simple questions or directions. A disturbance in the social use of language is often evidenced by an inability to integrate words with gestures or understand humor or nonliteral aspects of speech such as irony or implied meaning. Imaginative play is often absent or markedly impaired. These individuals also tend not to engage in the simple imitation games or routines of infancy or early childhood or do so only out of context or in a mechanical way” (American Psychiatric Association, 2000, p. 70-71).

*Restricted repetitive pattern of behavior.* The third and final criterion for autistic disorder is restricted repetitive and stereotyped patterns of behaviors, interests, and activities. These

repetitive behaviors include: a possible preoccupation with one or more stereotyped and restricted patterns of interest that is abnormal either in intensity or focus; an apparently inflexible adherence to specific; nonfunctional routines or rituals; stereotyped and repetitive motor mannerisms; or a persistent preoccupation with parts of objects (American Psychiatric Association, 2000). Individuals are usually marked by restricted range of interests and may be limited to just one play activity. Younger children may also line up an exact number of playthings in the same manner over and over again. They may request sameness in routine and interests or show resistance to activities outside of their regular routine. The DSM-IV-TR explained that individuals with autism may display stereotyped body movements, which include use of the hands (clapping, finger flicking), the whole body (rocking, dipping, and swaying), or abnormalities of posture such as, walking on tiptoe, odd hand movements and body posture (American Psychiatric Association, 2000). Individuals may also display a preoccupation for specific parts or movements of objects in which the individual may adapt a specific attachment to the object (American Psychiatric Association, 2000).

### *Prevalence*

The exact rate of prevalence of autism in the United States is currently undetermined due to the limited research and small sampling of individuals with autism. Traditionally, research in autism prevalence has been limited until approximately 15 years ago. More recently, investigators are making greater strides in developing a clearer understanding of autism, which has gained popularity within the last 15 to 20 years in the area of child psychiatry within the United States. The Diagnostic and Statistic Manual of Mental Disorders (DSM-IV-TR) reported that the median rate of autistic disorder in epidemiological studies is 5 cases per 10,000 individuals, ranging from 2 to 20 cases per 10,000 individuals (American Psychiatric

Association, 2000). The majority of prevalence of autism studies have estimated the range from 4 to 61 per 10,000 children, depending on the place, time and population under investigation (Prior, 2003).

A study of prevalence of autism among 289,456 children aged 3 to 10 years in Atlanta, Georgia conducted by Yeargin-Allsopp et al. (2003) found the rate of autism was 3.4 per 1000; 987 children met DSM-IV criteria for a pervasive developmental disorder. Yeargin-Allsopp et al. (2003) concluded that the rate of autism was higher than the previous rates reported in the studies conducted in the United States during the 1980's and early 1990's. Newschaffer et al. (2005) investigated prevalence rates using national special education of cohorts 6 to 17 years old born in the United States between the 1992 and 2001. The study's findings suggested the prevalence of autism over time has increased, as evident by higher rates in younger birth cohorts (Newschaffer et al., 2005). Regardless of research design and sampled populations, all researchers studying the prevalence rate of autism reported a marked increase of autism within the past 10 to 15 years (Newschaffer et al., 2005; Yeargin-Allsopp et al., 2003; Prior, 2003; Fombonne, 2003; and American Psychiatric Association, 2000). The increasing rate of autism has sparked a debate regarding a possible epidemic of autism.

Several ideas have been developed to explain for the increasing rate of autism in the United States. First, diagnostic criteria and the definition of autism have changed since Kanner's first description of autism in 1943 (Prior, 2003). In general, there has been a broadening of the diagnostic criteria and the recognition that autistic characteristics fall into a spectrum. Prior (2003) stated that the autistic spectrum encompasses a range from classical autism, to Asperger's syndrome or "high functioning" autism, and it can include a broader classification known as Pervasive Developmental Disorder – Not Otherwise Specified (i.e., the presence of similar

behaviors, but at a level below the threshold for diagnosis). Second, autism has recently been more widely associated with other neuropsychological and developmental conditions. It has become clearer in recent history that individuals diagnosed with autism can vary in range of intellect (from mentally retarded to above average intelligence).

Third, our society has become increasingly aware of autism. As a result, autism is diagnosed much earlier, to include children as young as approximately 2 years of age. Prior (2003) reported that the former diagnosis of autism was rare until the age of 5 years; children experiencing autism went undiagnosed or were given alternative diagnoses. Finally, claims have been made that the increase in autism can be at least partially attributed to ecological influences such as the increase in environmental pollutants and toxins. However, several researchers have ruled out the claim that immunizations like mumps, measles and rubella (MMR) cause or increase the risk of an ASD diagnosis. Taylor, Miller, and Farrington (1999) and Rutter (2000) reported no connection between autism and the MMR vaccinations. They claimed that in almost all cases autism is present since birth. The reasons for the increase in the rate of autism are highly debatable and important to recognize. Conversely, the reasons for the increase are not as important as our ability to diagnosis correctly and to provide interventions for the children with autism.

### *Specific Age and Gender Features*

It is likely that the age and gender characteristics of autism may change over an individual's stages of development. The DSM-IV-TR stated that infants may display symptoms such as failure to cuddle; an indifference or aversion to affection or physical contact; a lack of eye contact, facial responsiveness, or socially directed smiles; and a failure to respond to their parents' voices (American Psychiatric Association, 2000). As a result, many parents may believe

that their child is deaf, which could be an early indicator of autism. The DSM-IV-TR further stated that young children diagnosed with autism may treat adults as interchangeable, may cling mechanically to a specific person, or may use the parent's hand to obtain desired objects without ever making eye contact.

“Over the course of development, the child may become more interested in social interactions. However, even in such instances, the child tends to treat other people in unusual ways: expecting other people to answer ritualized questions in specific ways, having little sense of other people's boundaries, and being inappropriately intrusive in social interactions” (American Psychiatric Association, 2000; p. 73).

The rates of diagnosed autism are four to five times higher in males than in females. However, a female child with autism is more likely to exhibit more severe mental retardation (American Psychiatric Association, 2000). Currently, there are no empirical data on the prevalence of autism across races and demographic areas.

### *Children at Risk*

Children with a sibling history of autism are at greater risk for exhibiting the condition. The DSM-IV-TR reported that there appears to be a risk for children with a sibling history to experience various other developmental difficulties, with approximately 5% of siblings also exhibiting the condition (American Psychiatric Association, 2000). There also appears to be risk for various other developmental difficulties in affected siblings. In addition, Tomblin, Hafeman, and O'Brien (2003) reported that siblings of children with autism have increased rates of atypical autism vulnerabilities in language such as spoken and written speech.

### Neurological Explanation of Autism

Several neurological explanations of autism have been presented over the past 30 years. In this next section a review of the neuroanatomical features of the disorder are described. In

addition, two theories of autism will be presented. The theory of mind is a cognitive theory of autism, while the executive dysfunction theory is a neuropsychological theory of autism.

### *Neuroanatomy of Autism*

The neuropsychological definition of autism is as a pervasive neurodevelopmental syndrome, mainly characterized by poor social communication, inadequate response to others' emotions, and stereotypic and repetitive behaviors (Brambilla, et al, 2004). Brambilla et al. (2004) stated that structural magnetic resonance imaging (MRI) investigations have documented increased total brain, parieto-temporal lobe, and cerebellar hemisphere volumes in individuals diagnosed with autism. Magnetic resonance spectroscopy (MRS) studies have also found a decreased synthesis and increased degradation of prefrontal cortical membranes, and reduced concentration of N-acetylaspartate (NAA) in the amygdala, hippocampus, cingulate, Wernicke's area, and the cerebellum in subjects diagnosed with autism (Brambilla et al, 2004). The decreased synthesis and increased degradation of the prefrontal cortex is important in the study of autism because this area of the brain has been thought to have significant control of executive functions and goal-oriented behaviors.

In addition, Bennetto, Pennington, and Rogers (1996) noted executive functioning deficits are at least correlated and possibly a cause of the disruptions in complex behaviors seen in neurological disorders, implying all the disorders involve prefrontal cortex dysfunction. Further evidence suggests the structure and function of the prefrontal cortex changes significantly in the preschool period, including the majority of development of synaptic connections and maturation of subcortical prefrontal myelination (Espy et al., 2001).

Espy et al. (2001) also stated that "studies using EEG recordings have identified a cycle of brain electrical signal development between 1 to 5 years of age, characterized by (1) increased

coherence in electrical activity between the short distance, anterior electrode recording sites, (2) lengthened fronto-lateral connections that became synchronous prior to frontal dorsomedial and central sites in the left hemisphere, and (3) lateral to medial differentiation of long distance connections to shorter fibers in the right hemisphere” (p. 47). The evidence they provided supports the notion that the human brain is quite plastic, especially throughout early development (birth to 10-years). As a result, this age range is particularly important in children’s development.

Results from recent studies observing executive functioning deficits in school age children are correlated to prefrontal damage in many clinical populations, such as in children with head injuries and children with fetal alcohol syndrome (Espy et al., 2001). More specifically, neuroanatomical evidence also supports the claim that individuals diagnosed with autism will likely have more difficulties on executive functioning tasks compared to same age children without autism.

### *Theories of Autism*

Researchers offer two varying theories to explain the autistic behaviors that are characteristic of individuals diagnosed with autistic disorder. In this next section, both the executive dysfunction theory and the theory of mind will be reviewed.

Two dominant theories of autism are presented in this section. The theory of mind is a cognitive theory that attempts to explain the social and language deficits in autism. The executive dysfunction theory is based in neuropsychological principles and attempts to explain the repetitive and restricted behaviors observed in individuals with autism.

*Theory of mind.* Over the past 15 to 20 years, the theory of mind has been one of the most widely accepted theories explaining the characteristics of autism. The mind, as humans know it, is a cognitive construct consisting of beliefs, emotions, desires, perceptions, and intentions. The

theory of mind is generally defined as the ability to attribute mental states to self and others (Hughes & Graham, 2002). It requires making a distinction between the real-world, mental representations of the world, and between the self and others. Individuals diagnosed with autism have difficulties in drawing distinctions between these mental representations (Jordan, et al., 1995; Russell, 1996a; Hughes & Graham, 2002; Perner, Kain, & Barchfeld, 2002; and Hill, 2004).

The theory of mind has been used to explain the language and social communication characteristics of autism. The lack of mental representation in children with autism has been tested using “false belief” tasks (Jordan et al., 1995). False beliefs are the ability to comprehend other people’s beliefs (i.e., face expressions, emotions, and body communication). Jordan et al. (1995) reported that many individuals with autism have difficulty on tasks involving false beliefs. Therefore, it has been proposed that individuals with autism have difficulties developing a theory of mind.

It has been proposed that the theory of mind begins to develop early in life. In children, false beliefs have been observed beginning approximately at the age of 4, but may have neurological and developmental roots even earlier (Jordan et al., 1995; Hughes & Graham, 2002; and Perner et al., 2002). The theory of mind deficit often continues through the lifespan, as individuals with autism regularly display difficulties interpreting social communication and aspects of language.

Besides social communication and language impairments, the theory of mind has been less implicated in the third characteristic of autism – repetitive and restricted behaviors (Jordan et al., 1995; Turner, 1996; and Hill, 2004). Baron-Cohen, reported in Turner (1996), suggested the inability for individuals with autism to understand the world around them (theory of mind) is

often scary for them. As a result, individuals with autism use repetitive and restricted behavior as a way to cope with their environments and make sense of the world around them. It takes a well-developed understanding of social behaviors to be able to form socially acceptable interests. Turner (1996) stated the odd-like or non-socially accepted interests seen in individuals with autism are a result of an “impoverished appreciation of the social environment leaving the person with autism little choice, but develop interests and behaviors around non-social topics” (p. 66).

The theory of mind has been less able to clarify the repetitive and restricted behaviors associated with autism. Using the theory of mind to explain restricted and repetitive behaviors/interests, one could infer that individuals with autism display higher levels of restricted and repetitive behaviors during novel or unpredictable social situations, and lower when the individual is in a more comfortable, familiar environment that does require interactions with others. Turner (1996) reported that several studies have compared the rate of stereotyped behaviors during periods of social interaction and during times of limited social interaction. The results were in conflict with the theory of mind explanation for these behavior characteristics in individuals with autism; the children displayed an increase in restricted and repetitive behaviors during limited social interactions in a familiar environment.

Turner (1996) also tested a second prediction taken from the general premise that if a cognitive deficit or “false belief” lies at the root of repetitive behaviors, than a lack of theory of mind would also be associated with an increase in repetitive behaviors. She stated “if a lack of mentalizing skill is causally responsible for the high rates of repetitive behavior observed in autism, it must be predicted that those individuals who display some mental-state understanding should engage in relatively less repetitive behaviors than those who have little or no ability to understand and infer the mental states of others” (Turner, 1996; p. 67). Her prediction was that

individuals with autism who were able to display some ability of mental-state understanding, by passing standard first-order theory of mind tests, would display less repetitive behaviors than individuals with autism that could not pass these theory of mind tests (Turner, 1996). The results indicated that both groups of “passers” and “failers” demonstrated the same level of repetitive behaviors, based on four domains of repetitive and restricted behaviors (Turner, 1996).

The results documented by Turner (1996) do not support the premise that the theory of mind is at all associated with the repetitive and restricted behaviors observed in individuals with autism. Furthermore, it is difficult to support the theory of mind’s explanation for the characteristics beyond repetitive behaviors, such as social interaction difficulties and the social play compared to other children without autism. In conclusion, another theory is needed to help explain repetitive and restricted behaviors in individuals with autism.

*Executive dysfunction theory.* Individuals diagnosed with autistic disorder can have difficulties in learning beginning at birth, but these difficulties usually become more evident by two to five years of age. Being diagnosed with autism implies clear social, language and executive functions impairments that hinder children’s development and academic achievement throughout the course of their lives. It is understandable to see how impairments in a child’s higher-order mental processing can create repetitive and restricted behaviors, but they also can create difficulties in skills requiring multi-component processing such as language, reading, and social/communication abilities. Moreover, Griffith et al. (1999) suggested that executive dysfunction might cause autism-specific deficits in other cognitive domains that are more related to language and social skill development. Specifically, executive functioning also could be directly tied to language and social functioning such as perseverative and rigid/inflexible characteristics associated with autism-like oddities.

Many researchers have asserted that difficulties in executive/mental control, problem-solving, inhibition, and mental flexibility are the cause of the restricted and repetitive behaviors symptoms seen in individuals with autism (Hill, 2004; Lopez et al., 2005; and South, Ozonoff, & McMahon, 2005). Executive functions require a “higher-order” level of functioning that is mainly processed in the frontal lobe regions of the brain. Higher-order mental processing consists of information that does not exist in the individual’s external environment. These frontal lobe functions consist of specific rules, generalizations, and concepts that “allow the individual to respond in a creative manner to novel stimuli or situations that are not directly dictated by the environment” (Lopez et al., 2005; p. 446). When an individual responds to his or her environment (i.e., responding to commands, gathering information, decision making), the frontal lobes must engage a “higher-order” mechanism to react to external stimuli. Lopez et al. (2005) stated that if this higher-order mechanism is not performed properly, then a perseveration or stereotyped behavior is observed. The higher-order mental processing flaw that results in the repetitive and restricted behaviors is often observed in individuals with autism.

A great deal of recent evidence has suggested that older children and adults diagnosed with autism have difficulty with learning as a result of impaired abilities to execute the mental control that is necessary for problem-solving and the obtainment of future goals (Ozonoff & Strayer, 1997; Dawson et al., 1998; Ozonoff & Jensen, 1999; Ozonoff et al., 2004; Russell, Jarrold & Hood, 1999; Hill, 2004; Goldberg et al., 2005; and Lopez et al., 2005). Unfortunately, less research has been conducted to examine executive impairments in younger children. However, the research on young children with autism has indicated weaknesses in shifting set inhibition leads to observed perseverative response behavior beginning at approximate the age of two (McEvoy et al., 1993; and Griffith et al., 1999). It appears of critical importance to uncover

the deficits of executive functions in young children to develop earlier diagnostic markers and appropriate interventions in the hope to improve their quality of learning and development.

Many theories were developed in an attempt to explain repetitive/restricted behaviors and executive function impairments in autism. In the same vein, these theories were developed from a developmental perspective as autistic disorder is rooted in early infancy with a developmental course through the lifespan. First, the theory of restrictive, repetitive behaviors in autism states that stereotyped behaviors develop from “self-stimulatory” behaviors that are presented during infancy. Consequently, individuals with autism fail to develop the more complex, mature behaviors that eventually replace the basic self-stimulatory behaviors (Lopez et al., 2005). Lopez et al. (2005) suggest that deficits in frontal lobe functioning could impede one’s early development and the ability to appropriately react to their external environment, creating the stereotyped behaviors.

Second, from the same neurological vein, Lewis and Baumeister (1982) explained that stereotyped behaviors “could result from an abnormality in the nigro-striatal dopamine tract in the basal ganglia” (Lopez et al., 2005; p. 446). This theory provided initial evidence for a connection between repetitive/restricted behaviors and frontal lobe functioning. The repetitive and restricted behaviors in autism are linked to executive dysfunction because the behaviors are characterized as perseverative, including the inability to generate novel solutions, weaknesses in shifting mental set, weaknesses in problem-solving skills, and problems inhibiting an automatic response, which are all thought to be controlled by the frontal lobes.

Last, the executive dysfunction theory developed by Damasio and Maurer (1978) was used in studies that compared the symptoms of autism to individuals who experienced frontal lobe brain injuries through tests meant to measure executive functioning (Griffith et al., 1999). It

is only recently that researchers have suggested individuals with autism have executive functioning deficits (Jordan et al., 1995). Griffith et al. (1999) stated that beginning in the late 1970's research has demonstrated that deficits in executive functions are a robust correlate in individuals with autism including adults, adolescents, and older children. Moreover, Jordan et al. (1995) reported that the correlation described the parallels between the symptoms displayed by patients with neurological damage to their frontal lobes and adults with autism.

The connection between the frontal lobes of the brain and executive functions is that the frontal lobes have been associated with producing goal-oriented strategies and behaviors, which require the execution of appropriate action plans (Jordan et al., 1995). These action plans are a necessity in an individual's daily life because they allow one to complete tasks, adapt to different situations/environments, and regulate behaviors. In studies observing individuals with both frontal lobe damage and individuals diagnosed with autism, a failure to complete flexible action plans and properly adjust to different situations was identified (Jordan, et al., 1995). More specifically, individuals with autism exhibited a decreased performance on tasks requiring inhibition, self-monitoring, shifting set, and planning/organizing compared to individuals without autism (Ozonoff et al., 1991; McEvoy et al., 1993; Bennetto et al., 1996; Turner, 1996; Dawson et al., 1998; Ozonoff & Jensen, 1999; Coldren & Holloran, 2003; Hill, 2004; and Ozonoff et al., 2004). In contrast, deficits in working memory were identified as less significant when compared to other individuals without autism or individuals diagnosed with attentional disorders (i.e., ADHD and sleep disorders) because working memory relies heavily on attention and vigilance (Jordan, et al., 1995; Russell, et al., 1999; and Lopez, et al., 2005).

Of further importance is the empirical research that explored the executive dysfunction theory. A wealth of evidence has suggested that individuals diagnosed with autism have an

increased impairment in executive functions compared to individuals with other neurological, developmental disorders, and compared to individuals without autism (McEvoy et al., 1993; Pennington & Ozonoff, 1996; Ozonoff & Strayer, 1997; Dawson et al., 1998; Griffith et al., 1999; Ozonoff & Jensen, 1999; Russell et al., 1999; Coldren & Halloran, 2003; Bieberich & Morgan, 2004; Goldberg et al., 2005; and Lopez et al., 2005).

The sense of “agency” or awareness of other individuals’ thoughts/feelings is a key component to the theory of executive dysfunction. The term agency is the ability to be aware of one’s capacity to act in the world and produce change at will, or one’s psychological self-awareness (Jordan et al., 1995; and Russell, 1996b). The difference of the sense of “agency” in the executive dysfunction theory compared to the theory of mind is that agency is gained through executive functioning and thus gives one the ability to monitor his or her thoughts, actions, and feelings through their environment. The term executive functioning is defined as a set of mental processes (i.e., language and communication are believed to be higher order mental processes) necessary for the control of action.

It is reasonable to expect an individual of normal development to develop a sense of agency/awareness naturally through his or her experiences. Similarly, the more one experiences self-awareness, the richer their cognition, language, behavior, and social interactions will become. For an individual with autism, it appears deficits in executive functioning exist (i.e., self-monitoring, inhibition, set shifting, and planning). In turn, the sense of agency in these individuals becomes impaired. The lack of agency disrupts the ability to monitor and learn appropriate thoughts, behaviors, language, and feelings through their environments and experiences. Over the course of development, an individual with autism will form distorted views

of the world creating the typical profile observed in the population (i.e., impaired social interactions, language skills, and repetitive/restricted behaviors).

Thus far, the executive dysfunction theory has appeared to provide a reliable explanation for the impairments in executive abilities in individuals with autism. However, the research is limited in regard to preschool-aged children with autism (3-6 years of age).

#### Executive Function Research in Preschool Children with Autism

Research studies have demonstrated that there are clear executive function impairments in adults, adolescents, and older children with autism (Bennetto et al., 1996; Hughes & Russell, 1993, Griffith et al., 1999; Prior & Hoffman, 1990; and Ozonoff, Pennington, Rogers, 1991). A review of the literature by Pennington and Ozonoff (1996) indicated that adults diagnosed with autism performed significantly worse than control groups on 25 out of 32 executive function tasks across 14 different studies, with an average effect size of .98. Executive functioning deficits in individuals with autism are pervasive; they are also worse in severity compared to individuals diagnosed with other neurological disorders (Pennington & Ozonoff, 1996; and Ozonoff & Jensen, 1999).

Less clear is whether executive dysfunctions are present in younger children. One problem centers on the evaluation of impairments in infants with autism. Evaluation of infants is virtually impossible because the autistic disorder cannot be diagnosed at birth. In addition, young children are quantitatively and qualitatively different from older children and adults. Preschool-age children are ever-developing their skills and abilities. These children are learning how and where to apply their knowledge and when to implement effective strategies.

Few researchers have attempted to identify executive dysfunctions in young (preschool age) children with autism. The following section will include a review of four studies that

examined executive dysfunctions in preschool-age children with autism (McEvoy et al., 1993; Dawson et al., 1998; Griffith et al., 1999; and Dawson et al., 2002). The results of these limited studies have mixed results, further complicating the question of executive dysfunction in preschool children with autism.

In the first study, McEvoy et al. (1993) examined: 17 children with autism (based on the DSM III-R criteria); 13 with developmental delays (i.e., mental retardation, learning disabilities, or developmental language delays of various etiologies); and 16 typically developing children that were selected to be of the similar non-verbal mental skills. The age of the children with autism ranged from 40-80 months ( $m=60.65$ ), while the typical group age ranged from 30-81 months ( $m=50.38$ ). McEvoy et al. (1993) compared children with autism, other children with developmental delays, and a control group. They examined deficits in executive functions (specifically shifting set and self-monitoring), joint attention (i.e., the ability to use eye contact and pointing for the social purpose of sharing experiences with others), behavioral regulation, and social interaction in young children with autism.

McEvoy et al. (1993) used four executive function tasks (i.e., *A-not-B task*, *Delayed Response task*, *Spatial Reversal task*, and *Alternation task*) to measure executive functions. Using a regression analysis, children without autism were observed as performing the best on executive functioning tasks, followed by children with other developmental delays, then children with autism. Significant relations were found among executive dysfunction, joint attention, and social interaction in the children with autism. Overall, McEvoy et al. (1993) concluded that the children with autism had selective deficits in the shifting set and self-monitoring domains of executive functioning when compared to the two comparison groups. However, the children with autism performed equally as well on tasks of visual motor skills and behavior regulation

(McEvoy et al., 1993). In addition, the children with autism displayed an inflexible problem-solving style and a perseverative response style, specifically the spatial reversal task, which decreased their ability to solve problems.

In the second study, Dawson et al. (1998) examined the performance on neuropsychological tasks in children with autism or Pervasive Developmental Disorder - Not Otherwise Specified ( $n = 20$ ,  $M = 64.6$  months), children with Down syndrome ( $n = 19$ ,  $M = 65.3$  months), and children of typical development ( $n = 20$ ,  $M = 30.9$  months). Verbal ability (*Preschool Language Scale*) and mental age (*Vineland*) were also evaluated.

They used two types of neuropsychological measures, one known to be mediated by the limbic system (*Delayed Non-Matching sample*), including the medial temporal lobe and orbital prefrontal cortex; and the other, (*Delayed Response*), known to be mediated by the dorsolateral prefrontal cortex (Dawson et al., 1998). Both measures were used to observe the relationship to early impairments in domains emerging in core symptoms of autism. The symptom domains included “orienting to social stimuli, immediate and deferred motor imitation, response to emotional stimuli, shared attention, and symbolic play” (Dawson et al., 1998; p. 1277). The authors hypothesized that the core symptoms of autism would be more closely related to performance on tasks requiring the use of the limbic system rather than the use of the dorsolateral prefrontal regions, based on a hypothesis that these symptoms of autism are linked to dysfunction in the limbic system, specifically the amygdala and hippocampus.

Their results indicated that children with autism performed worse on both executive functioning tasks that activate the limbic system and the dorsolateral prefrontal cortex compared to children with other developmental disorders and children without autism (Dawson, et al., 1998). Children diagnosed with autism also displayed poorer social orientation, poorer immediate

and deferred imitation, decreased shared attention, poorer responses to emotional cues, and decreased symbolic play. The authors found that children with autism were more impaired than the two comparison groups on the task that require the use of the limbic system compared to the task measuring the dorsolateral prefrontal cortex. The findings of this study contradict the executive dysfunction theory, specifically that the core deficits of autism (i.e., repetitive behaviors, social skills, and language development) are a result of executive dysfunctions in the prefrontal cortex.

Dawson et al. (1998) results need to be interpreted with caution as this study tested participants on only two measures of executive functioning (two different versions of the *Delayed Alternation* task). Improvements in this study would include: (1) assessing multiple domains of executive functioning by using a more extensive assessment battery, (2) an age group difference comparison to examine whether older children with autism decreased displayed more deficits in performance on tasks compared to the control groups, and (3) examining the executive functioning and cognition in same chronological-age children with and without autism.

In the third study, Griffith et al. (1999) presented two sub-studies focusing on executive dysfunctions in preschoolers with autism. The first sub-study aimed to investigate the contradictory finding found in previous research regarding executive functioning in young children with autism. The focus was to expand the battery of executive functioning measures. Griffith's et al. (1999) second sub-study examined the hypothesis that children with autism perform more poorly on executive functions measures as they get older. The same sample of participants was used in both studies, consisting of 18 children diagnosed with autism ( $M = 51$  months), and 17 children without autism but with other developmental delays, including Down syndrome, general cognitive delays, and speech and language delays ( $M = 51$  months).

The tasks that were used in Griffith's et al. (1999) the first sub-study were *Spatial Reversal*, *A-not-B*, *Object Retrieval*, and *Boxes* (3 Boxes Stationary, 3 Boxes Scrambled, 6 Boxes Stationary, and 6 Boxes Scrambled). All tasks had been linked to prefrontal cortex functioning; they required appropriate set maintenance to achieve a future goal.

An analysis of group differences on each executive functioning task found that there was only one significant difference between children with autism and children with other developmental disorders. Children with autism had fewer failures to maintain set in the *Spatial Reversal* task. In addition, out of the three groups, the children with autism performed better on the *3-Boxes Scrambled* task for the groupwise matched groups, Verbal Mental age (VMA) matched groups, and for the Non-Verbal Mental age (NVMA) matched groups. The analysis of pairwise groups found two variables that exhibited significant differences. In sum, children with autism had fewer maximum number of reaches to the same location in the *3-Boxes Scrambled* than did the control group in both the VMA and the NVMA matched pairs.

Griffith et al. (1999) suggested that the children in the control group (i.e., children without developmental delays) were more perseverative than the children in the autism group. Despite these few differences between groups, the mean performances on all executive functioning tasks were virtually identical. The results appeared to contradict the results of the Dawson et al. study (1998). Griffith et al. (1999) reported one exception, which was poor performance similar to Dawson et al. (1998) on the *A-not-B task*. Even though the children with autism performed more poorly on this task in this study, the total variance was significantly larger and the mean differences were not significant in all groups compared to the Dawson et al. (1998) study. The contradiction is that the children with autism in general performed better overall on tasks compared to the control group. Both groups, however, did appear to perform below age

expectations across tasks. The performance on many of the executive functioning tasks in both groups was significantly correlated to verbal and non-verbal abilities (Griffith et al., 1999), which suggested that the children with autism more poorly on executive functioning tasks regardless of verbal abilities.

Several explanations of the differences between Dawson et al. (1998) and Griffith et al. (1999) studies are as follows: (1) slight variations in administration and scoring of executive functioning tasks were noted across studies; (2) children in the control group in the Griffith et al. (1999) study had significant IQ impairments that may have produced similar executive functioning scores between groups; and (3) both studies did not assess all five executive functioning domains, which may have resulted in undiagnosed executive deficits that were under diagnosed.

Griffith et al. (1999) conducted an age-based in the second sub-study comparison. They examined a subgroup of the children from the first study, who were given the *Spatial Reversal* task at two points, approximately one year apart. Griffith et al. (1999) predicted that the children with autism compared to children with other developmental delays would perform worse over time. Results indicated there was no significant difference in performance over time. Griffith et al. (1999) suggested that the young children with autism did not exhibit an autism-specific deficit on the *Spatial Reversal* at very young ages (40 months) or at slightly older ages (55 months).

In the fourth and final study, Dawson et al. (2002) assessed three groups of preschool children using both executive functioning tasks and joint attention. The sample consisted of three groups: (1) 72 children with pervasive developmental disorders (mean age = 43.5 months), which included 49 children with autism and 23 children with Pervasive Developmental Disorder – Not Otherwise Specified; (2) 34 children with developmental disorders without autism ( $M = 44.8$ );

and (3) 39 children without developmental disorders (mean age = 27.1). Groups were matched based on mental age scores from the *Mullen Scales of Early Learning* (Mullen, 1995).

The executive function tasks used in Dawson et al. (2002) study were the *A-not-B task*, *Delayed Alternation task*, *Spatial Reversal*, and *Object Discrimination Reversal* (similar to the *Delayed Alternation task*). The *Delayed Alternation* and *Object Discrimination Reversal* tasks have been linked to the ventromedial prefrontal cortex, while the *A-not-B task* and *Spatial Reversal* task has been linked to dorsolateral prefrontal cortex functioning (Dawson et al., 2002).

Group differences of univariate analyses of variance were conducted to determine whether young children with autism perform less well on ventromedial prefrontal tasks than both control groups. On the ventromedial tasks there were no significant group differences. However, the children's performance on the *Spatial Reversal* task had a significant floor effect on all groups. As a result, the scores from the task need to be interpreted with caution. On the remainder of the neuropsychological tasks, only the children's performance on the *Object Discrimination Reversal* task, exhibited group differences for perseverative errors  $F(2, 131) = 2.77, p = .066$ , and overall errors:  $F(2, 131) = 4.31, p = .015$ . In contrast, a Tukey post hoc analyses on these two variables indicated that no pairwise comparison among the three groups were beyond  $p < .01$ .

The children with autism and the children with developmental disorders groups displayed deficits in executive functioning and joint attention when compared to the children without developmental disorders. However, both the children with autism and the children with developmental disorders performed similarly on all executive functioning tasks, with the exception of *Spatial Reversal*. Based on the findings, Dawson et al. (2002) concluded that deficits in executive functioning deficits were not limited to children with autism.

In the Dawson et al. (2002) study, the authors used assessment tools to test ventromedial and dorsolateral prefrontal cortexes. A limitation is that they used only *Delayed Alternation* (working memory and shifting set), *Spatial Reversal* (shifting set), and A-not-B (inhibition and working memory) tasks, which did not test all executive functioning domains (Goldman, Rosvold, Vest, & Galkin, 1971; Diamond, 1998; and Kaufmann, Leckman, & Ort, 1989). The *Delayed Alternation* and *A-not-B* tasks require an element of working memory to complete the tasks successfully. Research has indicated individuals with autism do not have significant working memory deficits, partly since working memory requires attentional processes. Working memory deficits are typically characteristic of individuals with attentional disorders, such as Attention Deficit Hyperactivity Disorder (Ozonoff & Jensen, 1999; Perner et al., 2002; Lezak et al., 2004; and Goldberg et al., 2005).

In general, the review of the four extant research studies of executive dysfunction in preschool children with autism demonstrated mixed results. Each of these studies did not use similar or comprehensive measures, sample sizes, participant selection criteria, or age difference group comparisons. In addition, there are several other possible reasons for the mixed results across studies: (1) no study accounted for ecological validity as there were no ecologically valid, observational measures included in the testing battery; (2) on several of the measures (i.e., *Delayed Alternation*, *A-not-B*, and *Spatial Reversal*) researchers used slightly different variations in of administration and scoring; (3) the *Spatial Reversal* and *Delayed Alternation* tasks have been tested as having a significant floor effect, while the *Delayed Alteration* task has a ceiling effect; (4) all four studies did not assess all five subdomains of executive functioning; and (5) the age range in the autism groups and control groups varied across studies, while only one study conducted a age group difference comparison. These results suggested that no single method of

assessing the complex domain of executive functioning is adequate in isolation, especially in preschool-age children. Accordingly, an executive functioning test battery that contained a comprehensive array of controlled/elicited tasks and that included ecologically valid, observational instrumentation would be more appropriate for exploring deficits in executive functioning.

### Measures of Executive Functions in Preschoolers

Traditionally, much of the psychological assessment methods for measuring executive functioning were first developed for adults. These adult-oriented tasks were then modified for adolescents and eventually for children in a “top-down” approach (Isquith et al., 2005). In recent years, developmental neuropsychologists have formulated more assessment tools of executive functioning from the “bottom up” approach or from a developmental perspective. Recently, a developmental neuropsychological focus has concentrated on two types of assessment tools: first, laboratory, performance-based tasks that evaluate specific process components of executive functioning; and second, naturalistic, observational, assessment tools that evaluate more broad real-world executive functioning behaviors. In this section both types of instruments will be reviewed.

A review and critique of both types of current executive functions instruments in preschool-aged children between the age ranges of 3 to 6 years of age will be evaluated in the following section. The review will consist of a description including the purpose, norms, validity and reliability (if available), and a critique of each instrument, included its usage with children diagnosed autism. At the end of the section, a summary of the instrumentation will focus the ecological validity, age-appropriateness, and construct validity (i.e., the instrument tests what it

was designed to test). A brief description of the reviewed executive functioning instrumentation is outlined in Appendix B.

### *Elicited/Controlled Measures*

In this section, the review and critique will focus on elicited or “laboratory-based” measures. For the purposes of this study, laboratory or performance-based measures are defined as assessment tools that measure an individual’s specific performance or behavior in a contrived and controlled setting. The following review will include laboratory instruments used to evaluate executive functioning in preschool-age children.

*NEPSY - Developmental Neuropsychological Assessment* (Korkman, Kirk, & Kemp, 1998). The *Developmental Neuropsychological Assessment (NEPSY)*, a developmental neuropsychological assessment, assesses the neuropsychological development of children between the ages of 3 and 12 including children with developmental disabilities such as autistic disorders, children with learning disabilities, ADHD, and speech and language impairments.

The *NEPSY* contains five functional domains/subtests: Attention/Executive Functions, Language, Sensorimotor Functions, Visuospatial Processing, and Memory and Learning (Kemp, Kirk, & Korkman, 2001; and Isquith et al., 2004). Examiner qualifications include graduate-level training and experience in the administration and interpretation of standardized clinical instruments. The examiner may select from the pool of tests from the five functional domains. All of the *NEPSY* subtests have been normed together by age based on a sample of 1,000 U.S. children. The proportions of White, African American, and Hispanic populations were respectively proportioned in the U.S. in the year of 1995. The *NEPSY* manual reports reliability statistics, including inter-rater and inter-scorer agreement, subtest internal consistency, and test-retest stability. Validity data include content and construct validity, as well as studies with

children diagnosed with learning disabilities, attention deficit hyperactivity disorders, traumatic brain injury, autistic disorders, and speech and language impairments (Korkman et al., 1998).

According to Ahmad and Warriner (2001), the *NEPSY* was designed for four main purposes: (1) “to provide an instrument for the detection of deficits that interfere with learning, within and across the five functional domains in the targeted age range, (2) to provide a tool for identifying and assessing brain damage, dysfunction, and the extent to which they affect the five functional domains... (3) to provide researchers and clinicians with a tool for long-term follow up in to identify and clarify the developmental dynamics of specific types of brain damage or dysfunction, and 4) to provide a tool that had been standardized on a single sample of children and that would result in a reliable and valid instrument utilized for investigating both normal and atypical neuropsychological development for the targeted age range” (p. 240-241).

The Attention/Executive Functions subtest is designed to assess inhibition, self-regulation, monitoring, vigilance, selective and sustained attention, maintenance of response set, planning, flexibility of thinking, and figural fluency. A total of six subtests can be selected for administration in the attention/executive function section, *Statue*, *Tower*, *Visual Attention*, *Auditory Attention and Response Set*, and *Design Fluency*. The Statue subtest may only be administered to children between the ages of 3-4, whereas the Tower and Auditory Attention and Response Set subtests may be administered only to children between the ages of 5-12 years. Stability coefficients for the attention/executive function domain are .68. Ahmad and Warriner (2001) reported that out of the five functional domains, the attention/executive functioning domain is the most problematic. Many researchers view this functional domain as problematic due to the inconsistent definition of executive functioning and whether young children (3-12) truly exhibit executive functioning skills. However, the validity of the *NEPSY* when compared to

other neuropsychological batteries and tests show moderate correlations in areas of attention, executive functioning, language, visuospatial processing, and memory (Ahmad & Warriner, 2001; and Kemp et al., 2001). Nonetheless, the validity research of the *NEPSY* is limited; in turn, confidence estimates may be premature.

The strengths of the *NEPSY* are the flexible selection and administration of the subtests, standardization of norms for each functional domain, application of use in a young age group (3-12), usage in young children with autism, variety of subtests within functional domains, and minimal user qualifications and training. The weaknesses of the *NEPSY* include limited research in its convergent and discriminant validity, individual subtests are not highly correlated with core domain scores, complex administration and recording procedures, time consuming scoring system, and a somewhat dated normative sample last updated in 1995.

*Trails-P* (Espy & Cwik, 2004). *Trails-P* was designed to assess ability to shift cognitive set in preschool aged children from 3 to 6 years old. *Trails-P* is based on the widely used *Trails Making Test (TMT)*. The *TMT* has been used extensively in adult neuropsychological assessment of psychomotor, speed, complex attention, and executive functions. In the adult version of *Trails A*, the subject is required to connect a series of numbers in sequence as rapidly as possible. *Trails B* involves the connection between both numbers and letters in alternating fashion while keeping both numbers and letters in sequence (1, A, 2, B, 3, C...), which requires the individual to switch cognitive set from an automatized sequence. In both conditions, time is a dependent measure with the amount of errors taken into consideration.

Preschool children have a limited ability to complete the original *TMT*, as the number and letter sequences are not sufficiently automatic. In the *Trails-P*, children are presented with a book with colorful dog characters. The examiner states to the children “Here is a family of

doggies, the littlest one is the baby dog, the sister dog, the brother dog, the mommy dog is here, and the biggest dog, the daddy dog is right here” (Isquith et al., 2005; p 211). Children are provided with an ink stamp and instructed to stamp the order of dogs from smallest to biggest (Condition A/Control). Condition B (Switch) introduces different size bones; the child is instructed to switch from the smallest dog to the smallest bone up until the biggest dog and bone, always switching back and forth. Condition C (Reversal) involves the child stamping the dogs in order of size, but ignoring the bones. Condition D (Distraction) assesses the effects of distraction by introducing cat stimuli as distracters, while the targets are the dogs and bones stamped in alternating fashion. For each condition the examiner corrects the subject if an error is made.

In a study conducted by Espy and Cwik (2004) of 103 normally developing preschool aged children between the ages of 2 and 6, younger children (3-year olds) took more time to complete all conditions compared to 4 and 5 year old children. The 3-year old children were also disproportionately slow to complete the switching condition with an additional distracter. The number of errors only differed in the 5-year olds’ performance compared to younger children (Espy & Cwik, 2004). The temporal stability of the *Trails-P* was examined with test-retests of 30 children with a one-month retest period. The test-retest reliability demonstrated correlations ranging from 0.45 to 0.77, with a mean of 0.64 across the four conditions (Espy & Cwik, 2004; and Isquith et al., 2005). Espy and Cwik (2004) concluded that their findings suggested that executive abilities can be assessed using the *Trails-P* in preschool children as young as 3-years old.

Isquith et al. (2005) reported, “although the *Trails-P* appears to have good psychometric properties and performance varies as a function of condition task demands and child age, evidence for convergent and discriminant validity with other standardized instruments must be

demonstrated before more widespread clinical application is undertaken” (p. 211). Furthermore, Isquith et al. (2005) concluded that the *Trails-P* may offer a promising tool to assess the processes involved in executive control in preschool-aged children with neurological, psychiatric, and developmental disorders. However, no such research has been conducted to date.

The strengths of the *Trails-P* is the developmentally adaptive format for preschool-aged children taken from the well researched adult *Trails-Making Test*, the colorful, appealing stimuli that following a storybook format, potential usage with diverse preschool populations, initial test-retest reliability, and sound theoretical basis of executive functioning. The weaknesses of the *Trails-P* included limited normative base, limited convergent and discriminant validity, no previous documented usage with preschool-aged children with developmental, psychiatric, and neurological disorders. Finally, the test is currently inaccessible to researchers and psychologists due to the test’s pending copyright.

*Shape School* (Espy, 1997). The *Shape School* task is a measure of inhibition and switching set in preschoolers aged from 3 to 5 years old. The *Shape School* task is similar to the *Stoop Test* of inhibition and switching for adults.

*Shape School* is designed in a storybook, paper format, depicting child-like figures in a schoolyard setting, with colorful circle and square figures playing (Espy, 1997; Espy et al., 2001; and Isquith et al., 2005). It contains four conditions: Control, Inhibit, Switch, and Both. In condition A (Control) the child is told that the figure’s name is the color (i.e. red, blue, or yellow). The examiner informs the child that the students (figures) are lining up to enter the school from the schoolyard. The child is asked to state the name of the students as quickly as possible without making any errors. The Control condition establishes the baseline speed between color and response. In Condition B (Switch) the figures have both happy and frustrated

facial expressions depending on whether they are ready for lunch or not. The child is instructed to name only the figures (color) that are ready for lunch and not the students that are not ready. This condition is designed to measure response suppression. In conditions C and D, another classroom was added to the story, and half of the students (figures) are wearing hats. In condition C, none of the students have facial expressions. The child is instructed to name the color for students with hats and the shape for students without hats, which measures cognitive shifting. The final condition D includes students with happy and frustrated faces, and with and without hats. The child is told that not all students are ready for art, and to name only the happy faced students that are ready (i.e., the appropriate color or shape name).

Both conditions B and C require constant working memory skills by maintaining two rules in mind with cues present that signal the correct stimulus response mapping, and include interference from the previous set. Comparing performance on Conditions B and C in young children of different ages allows one to observe whether inhibition skills are developed uniquely or as a shared developmental experience (Espy, 1997; and Isquith et al., 2005). In addition, comparing Conditions B, C, and D to A provides a comparison of inhibition speed to baseline naming speed (Condition A).

In Espy's (1997) original study of the *Shape School* task, 70 children between the ages of 3 and 5 were administered the task. The results indicated that there were significant overall group age effects on efficiency for all four conditions (all condition  $p < .05$ ). In the control condition, efficiency varied significantly across age groups,  $F(2, 69) = 10.67, p < .001$ . Espy (1997) found that on an priori test the results revealed that the 4-year olds were significantly more efficient compared to the 3-year old group,  $F(1, 69) = 16.33, p < .001$ . However, there were no differences in efficiency in the control condition between the 4 and 5 year old age

groups. Furthermore, a similar pattern was found on the inhibition condition, with a significant overall age effect,  $F(2, 65) = 32.53, p < .001$ , and 4-year old children significantly outperforming 3-year olds,  $F(1, 65) = 50.71, p < .001$  (Espy, 1997). Four and 5 year olds were comparable in efficiency scores in the inhibition condition. On the switching condition, efficiency scores varied with age groups,  $F(1, 27) = 4.14, p < .05$ , with a greater efficiency scores observed in the older children. In general, the 5-year olds were more efficient than the 4-year old children,  $F(1, 26) = 5.01, p < .05$ .

On a more recently study conducted by Espy, Bull, and Senn (2004), reported in Isquith et al. (2005), 219 children completed the *Shape School* task 3.5 to 5.5 years of age. The results indicated that there were developmental differences in performance on the control condition (Condition A); the time to complete Condition A, B, C, and D varied by the child's age, but not the amount of stimuli correctly named. Of further importance is the high degree of naming accuracy reported across conditions and across age groups. Espy et al. (2004) suggested that the accuracy rate indicated that basic verbal demands of the task were not sufficiently challenged as to impair the measurement of the executive components of the task performance (Isquith et al., 2005). In a comparison across groups, completion time differed significantly with the older children completing the task quicker. More specifically, in Condition B there was a consistent decrease in time to complete the task, as the older children took less time to complete the condition than the middle age group, who in turn took less time than the younger age group (reported in: Isquith et al., 2005). On condition C, the middle-aged children took more time to complete the task than the youngest group, but they completed the condition in less time than the older age group.

Isquith et al. (2005) examined the reliability of the *Shape School* test by calculating the test-retest reliability coefficients for each condition with 18 young children who were administered the *Shape School* twice. The internal consistencies (Cronbach's alpha coefficients) and the Spearman correlations were used on each condition. The test-retest correlations for completion time range from 0.65 to 0.78 (Condition C was below acceptable test standards). The dependent measure for each condition was the number correct and the time required to name all pertinent figures. The scores were then translated into efficiency scores (efficiency scores = the number of correct - the number of errors / total time). Espy (1997) identified, in a study of 35 boys and 35 girls aging from 32 months to 68 months, differences in performances between 3, 4, and 5 year old children, with the older children outperforming the younger. The children's performance on the *School Shape* task indicated that preschoolers exhibit both inhibition and switching functions.

Similar to the *Trails-P* test, Isquith et al. (2005) stated that the *Shape School* test might be an effective measure of executive functioning in preschool children. However, the *Shape School* test has not been tested on preschool children diagnosed with neurological, medical, psychiatric, or developmental disorders compared to typically developing preschool children. In summary, the *Shape School* test has several strengths including its ability to measure inhibition and set shifting in preschool children, its developmentally adaptive format for preschool-aged children, its colorful, appealing stimuli, potential usage with diverse preschool populations, and its sound theoretical basis of executive functioning. The weaknesses of the *Shape School* include a limited normative base, limited convergent and discriminant validity, and no previous documented usage with preschool-aged children with developmental, psychiatric, and neurological disorders.

Moreover, the test is currently inaccessible to researchers and psychologists due to the test's pending copyright approval.

*The Day-Night Task* (Gerstadt Hong, & Diamond, 1994). The *Day-Night* task is adapted from the adult Stroop test. It requires the individual to inhibit an automatic, over-learned response. Similar to the *School Shape* task, the *Day-Night* task was designed to assess inhibition without including a reading component found in the *Stroop* test. The *Day-Night* task has been used with preschool-aged children ranging from 3.5 to 7-years of age.

In the *Day-Night* task, the subject is required to say the word "day" when presented with a card showing a night sky (a moon with stars), and the word "night" when shown a picture of a sun. In the control condition the subjects have to attach these words to arbitrary designs (Gerstalt et al., 1994; and Russell, 1996b p.289). Subjects are presented with eight moon and eight sun stimuli in a pseudo-random order for a total of 16 test trials for both the experimental and control conditions. In the control condition, half the subjects are told to say "day" to a squiggle design card, and to say "night" for a checkerboard-like design card. The dependent measures were whether a response on a given trial was correct or not, the number of correct responses over a session, response latency on each trial, and response latency over all trials within a session. Response latency was measured from the time the child first saw the "day" or "night" card until they gave a verbal response (Gerstalt et al., 1994).

In a study conducted by Gerstalt et al. (1994), 240 the *Day-Night* task was administered to typically developing preschool-aged children between the ages of 3.5 and 7-years old. In addition, an age group differences comparison was conducted, comparing 3.5, 4, 4.5, 5, 5.5, 6, 6.5, and 7-year olds. In general, the children performed better on the control condition compared to the experimental condition as assessed by their response latency and ease at passing the pre-

test. This result was true for each age group, 3.5 years:  $t(38) = 3.09, p < .01$ ; 4 years:  $t(38) = 4.22, p < .01$ ; 4.5 years:  $t(38) = 4.63, p < .01$ ; and 5 years:  $t(38) = 3.07, p < .01$ . A comparison of 3.5 to 5-year olds only was conducted because children between the ages of 5.5 and 7-years were not given the control condition. On the experimental condition, children under the age of 5-years had difficulties completing the task. One explanation is that the word-picture associations were not sufficiently automatized.

In a study conducted by Russell (1996), children between the ages of 5 and 8-years with and without autism were administered the *Day-Night* task and displayed similar performances. One explanation of similar performance may be a ceiling effect. The children with autism were neither less accurate nor slower than the control groups. In the *Day-Night* task children are required to inhibit and switch simultaneously. In young children, it may be that these processes differ by age and contribute to executive functioning development (Espy, 1997).

In general, the *Day-Night* task has been adapted from reliable adult neuropsychological test (*Stroop*), which has been proven to assess inhibition in adults, adolescents, and older children. In addition, it does not include a reading component like the adult *Stroop test*, making it easier for preschool-aged children. However, in the two studies reviewed, the *Day-Night* task has not been sensitive to age group differences under 5-years old. Furthermore, the *Day-Night* task may rely more heavily on the control of verbalization, rather than the control of action. Children diagnosed with autism may have more difficulty completing this task because they often display an increased difficulty with verbalization compared to same-aged, typically developing children.

*Tower of Hanoi-Revised* (Welsh, Pennington, & Groisser, 1991). The *Tower of Hanoi* (*TOH*) is a measure of problem solving planning ability, which can be used with young children

approximately aging from 2.5 to 9 years old. Senn et al., (2004) and Bull et al. (2004) stated that preschool children do not seem to possess overt planning skills. Therefore, *TOH* likely taps problem solving to a greater degree than planning in the preschooler age range. In addition, Bull et al. (2004) suggested that preschool children rely more on working memory and inhibition in contrast to adults who rely more on cognitive flexibility and planning.

The *TOH* contains three discs that fit over three pegs. The child is instructed to move the discs across the pegs according to certain rules to form a particular design that is formed by the examiner. In the preschool version of the *TOH*, a story is usually associated with the task, which explains that three monkeys (discs) of different sizes (daddy, mommy, and baby) jump trees (pegs). A child is given two points for correctly solving a two-move problem, and three points for solving the problems that require three moves, and so on. If the child solves the problem using the fewest amount of moves, a 25% bonus is awarded to their score. A total score is obtained by summing the total points across six problems. The dependent measure is the total number of problems solved in the minimal prescribed number of moves. Bull et al. (2004) reported a test-retest reliability for *TOH* of .72 in 5-year-old children; however, the test-retest interval was only 25 minutes. Bull et al. (2004) also reported test-retest reliability of .53, over an interval of 30 to 40 days, in a sample of children aged 7-10 years from a study conducted by Bishop, Aamodt-Leaper, Creswell, McGurk, & Skuse, (2001). Currently, there are no published norms for the preschool version for the *Tower of Hanoi* test. However, the Tower subtest of the *NEPSY* in the attention/executive functioning domain provided established validated norms with similar administration and scoring.

Overall, the strengths of the *Tower of Hanoi* test includes the documented use with preschool-aged children, strong theoretical background of executive functioning based on the

adult version of the *TOH* test, a format for child administration, and minimal training required for scoring and administration. On the other hand, the *TOH* test's weaknesses include lack of standardized norms for preschool aged children; limited use with children diagnosed with neurological, psychiatric; or developmental disorders, lack of clarity regarding the particular components of executive functioning required to complete the *TOH*, and a variable scoring system across research studies (Espy et al., 2001; Bull et al., 2004; and Senn et al., 2004).

*A-not-B task* (Diamond, 1988). Several studies indicated that working memory and inhibition are two necessary skills needed to successfully complete the *A-not-B task* (Espy, Kaufmann, McDiarmid, & Glisky, 1999; and Espy et al., 2001). The *A-not-B task* has been used to assess children with autism ranging in age from 3 to 7 years of age (McEvoy, et al., 1993; Griffith et al., 1999; and Dawson et al., 2002). When administered to children without developmental disabilities, the age of successful completion decreases by 5 to 7 months.

In studies with animals, typically developing infants, and children with clinical conditions, the *A-not-B task* is believed to rely on dorsolateral prefrontal cortex (Espy et al., 2001). More specifically, the *A-not-B task* has been used largely in cognitive developmental research in infants (Espy et al., 1999). First theorized by Piaget in 1954 coined the identification of A not B error, infants observed and retrieved a reward hidden at location A for several trials. The trials are then reversed by hiding the reward in location B. Piaget found that on the reversal trial, 8-12 month old infants search for the reward at location A while infants older than 12 months tend to correctly retrieved the reward at location B. Piaget concluded that incomplete development of object permanence was the cognitive mechanism underlying poor AB performance in the younger infant.

More recently, developmental neuropsychologists have examined the *A-not B task* more closely, specifically perseverative error patterns in adult monkeys, infant monkeys, and 7 to 12 month human infants (Espy et al., 1999; and Espy et al., 2001). In the modern version of the *A-not-B task*, the child watches the examiner hide a reward in one of two shallow wells on a testing board; then two identical cups are used to cover the wells simultaneously. The testing board is then placed out of the child's view to prevent location cueing. The examiner counts aloud for ten seconds (10 second delay). At the end of the delay, the testing board is returned to the table. The child is then asked to choose the cup he or she believes the reward is in. The reward is switched to the opposite cup once the child correctly chooses the reward cup on two consecutive trials.

In studies that have used this task, the number of trials varied across studies (McEvoy et al., 1993; Griffith et al., 1999; Espy et al., 2001; and Senn, et al., 2004). The score of the test is the number of correct reaches over  $n$  trials. The pattern of errors also can be recorded across the three types of trials: reversal trials, trials following an error, and trials following a correct response (Griffith et al., 1999). Across empirical research, investigators have used different scoring systems with varied dependent variables (McEvoy et al., 1993; Espy et al., 1999; Griffith et al., 1999; and Espy, et al., 2001).

Espy et al., (1999), tested 117 preschool children ranging from 23 to 66 months were tested on several executive functioning tests including the *A-not-B task*. Their findings indicated that older preschool children retrieved more rewards and committed less perseverative errors than younger children on the *A-not-B task* and was not related to intelligence (Espy et al., 1999).

Performance on the *A-not-B task* was measured in preschool-aged children with autism by McEvoy et al. (1993) and by Griffith et al. (1999). In the McEvoy et al. (1993) study, children with autism displayed deficits in executive functioning on this task compared to two control

groups. Furthermore, the children with autism exhibited an inflexible, perseverative response style compared to both control groups. In the study conducted by Griffith et al. (1999), children with autism performed slightly better on the *A-not-B task* compared to a control group of children with developmental delays. The autism group improved performance included wrong reversal trials, wrong following errors, and wrong following correct. One explanation for this discrepancy is the 30-month mean age difference in the children between the two studies. The mixed results of these studies in using the *A-not-B task* warrant further investigation between preschoolers with autism compared to a group of controls.

The strengths of the *A-not B task* include age-appropriateness in preschoolers, population appropriateness in preschoolers with developmental disorders, and the instrument's ability to measure working memory and inhibition. Conversely, the weaknesses of the *A-not-B task* are its high ceiling effects, varied scoring and administration systems across empirical research, lack of standardized norms, a complex scoring system, and limited convergent and discriminant validity.

*Delayed Alternation* (Goldman et al., 1971). Over the past 15 years, variations of the *Delayed Alternation* task have been one of the most widely used measures of executive function in preschool-aged children. The *Delayed Alternation* task was designed to assess working memory and shifting set since it requires young children to hold information from previous trials in mind to guide correct responses on the current trial. Similar to the *A-not B task*, several studies have used the *Delayed Alternation* task to assess children with autism ranging in age from 3 to 7 years of age (McEvoy, et al., 1993; Dawson et al., 1998; and Dawson et al., 2002). When administered to children without developmental disabilities, the age of successful completion decreases approximately by 5 to 7 months.

Senn et al. (2004) reported the *Delayed Alternation* task has well demonstrated connections with the dorsolateral prefrontal cortex as evident from previous human and animal neuroscience investigations. *Delayed Alternation* is considered a measure of working memory because the task requires the preschool-aged child to hold information online to guide correct responses on the subsequent trial. Unlike the *A-not B task*, the reward (candy, pennies, or stickers) is hidden out of the child's vision in one of two shallow wells on a testing board. Identical cups cover both wells. A pretrial is administered to determine the side of hiding during the actual test. After a 10 second delay the child attempts to retrieve the reward from the correct well. Similar to the *A-not B task*, the number of trials, delay time, and scoring criteria differ throughout the literature (McEvoy et al., 1993; Dawson et al., 1998; Espy et al., 2001; and Senn et al., 2004). After correctly retrieving the reward, the reward is hidden in the alternate well. The number of correct retrievals is scored, depending on the number of trials used during the assessment.

McEvoy et al. (1993) and Dawson et al. (1998) examined the performance on the *Delayed Alternation* task in preschool-aged children with autism. In the McEvoy et al. (1993) study, children with autism displayed more deficits on the *Delayed Alternation* task as compared to a typically developing control group. In the same vein, in the Dawson et al. (1998) study, the preschool children with autism also performed significantly worse on the *Delayed Alternation* task compared to both a typically developing group and a Down syndrome group. In contrast, Griffith et al. (1999) found no differences on perseveration errors across children with autism and a control group on the task; however the children with autism displayed fewer failures to maintain a set. An across age comparison has not been conducted in preschool-aged children with

autism using the *Delayed Alternation* task to identify whether the measure is sensitive to age-related differences.

The strengths of the *Delayed Alternation* task include its age-appropriateness for preschoolers, its use with preschoolers diagnosed with developmental disorders, and its ability to measure working memory and shifting set. Conversely, the weaknesses of the *Delayed Alternation* task are its low floor effects, varied scoring procedures, different response times and administration system across empirical research, lack of standardized norms, lack of research regarding the instrument's sensitivity to age-related differences, and limited to poor convergent and discriminant validity across research studies.

*Spatial Reversal* (Kaufmann et al., 1989). *Spatial Reversal* is quite similar to *Delayed Alternation* and *A-not-B task* because it is used to mainly measure shifting set, as the young child is required to shift among response sets. *Spatial Reversal* has been used with preschoolers between 2.5 and 6 years of age (McEvoy et al., 1993; Espy et al., 1999; Griffith et al., 1999; Espy et al., 2001; and Senn et al., 2004). When assessing young children with autism, the age of use increases to approximately 3 to 7 years of age (McEvoy et al., 1993; Griffith et al., 1999).

In this task the child does not see where the reward is hidden and must develop a simple response pattern to retrieve the reward successfully without a delay time period (McEvoy et al., 1993). The reward is switched once the child has located it successfully on four consecutive trials. *Spatial Reversal* measures whether the child can flexibly change cognitive sets when his/her response is no longer successful. Like *A-not B* and *Delayed Alternation*, the number of trials differed across research studies (Espy et al., 2001; Senn et al., 2004; McEvoy et al., 1993; and Griffith et al., 1999). The number of correct responses and perseverative responses after change of reward are totaled and scored.

The *Spatial Reversal* task has been used to assess executive functions in children with autism with an average age range between 60 and 67 months (McEvoy et al., 1993; and Coldren & Halloran, 2003). In the McEvoy et al. (1993) study, the children with autism made more perseverative errors by using a previously rewarded response when it was no longer correct. Coldren and Halloran (2003) also found that the children with autism in their study performed worst on the *Spatial Reversal* task than the control groups based amount of errors. A limitation is that each participant group only contained a sample size of 7.

The strengths and weaknesses of the *Spatial Reversal* task are quite similar to the *Delayed Alternation* task. In general, the strengths of the task are its age-appropriateness in preschoolers, its use with preschoolers diagnosed with developmental disorders including autism, and the instrument's ability to measure inhibition and shifting set. On the other hand, the weaknesses of the *Spatial Reversal* task are its varied scoring and administration systems across executive function research, lack of standardized norms, lack of research regarding the instruments sensitivity to age-related differences, and limited convergent and discriminant validity across research studies.

*Color Reversal* (Kaufmann et al., 1989). Similar to the *Spatial Reversal*, *Color Reversal* measures shifting set or initiation as the child is required to shift between two different response sets. The *Color Reversal* task has been used with preschool-aged children without developmental disabilities ranging from 2 to 6 years of age (McEvoy et al., 1993; Espy et al., 1999; and Griffith et al., 1999). However, when researchers have assessed young children using the *Color Reversal* with autism the age increases to 3 to 7 years of age (McEvoy et al., 1993, Griffith et al., 1999).

The difference between the two tasks is the nature of the hiding rule for the reward. Instead of using two identical cups to cover the disc wells, one blue and one yellow cup were

used, for which the examiner randomly switches sides through the trials. The child does not observe the examiner hiding the reward. When the child reaches four consecutive correct responses the reward is moved to the cup of the other color. Four dependent measures can be scored: number of correct responses; number of trials until the first set was achieved; number of perseverative errors after the first correct set; and the number of consecutive trials in the longest perseverative run (Espy et al., 1999; Espy et al., 2001).

Throughout the literature that used the *Color Reversal* task, researchers have implemented several minor alterations to the scoring and administration systems. On an age group difference of performance on the *Color Reversal* task, there were no differences on the number of correct trials, number of trials until criterion achieved, and maximal number of consecutive perseverative errors, while the number of perseverative errors varied across age groups (Espy et al., 2001). Generally, the perseverative errors across age groups increased as the age groups increased (Espy et al., 2001). Unfortunately, after a review of the literature, the *Color Reversal* task has not been used with preschool-aged children with autism.

In general, the *Color Reversal* task appears to have limited reliability and validity across previous empirical research. More specifically, the *Color Reversal* task appears to have limited test-retest reliability, construct validity, and convergent and discriminant validity. One reason for this observation is the lack of standardized norms and variable administration and scoring systems. In addition, the *Color Reversal* task has not been used with preschool-aged children with autism and does not have significant age group differences in “normally developing” preschool children.

*Self-Control* (Lee, Vaughn, & Kopp, 1983). *Self-Control* is a measure of self-monitoring and inhibition. *Self-Control* has been used with preschool-aged children ranging in age from 23

to 66 months (Espy et al., 1999; and Espy et al., 2001). The child is shown a reward and the examiner uses an animated tone to comment of the reward's desirability (i.e., "Yum, these M & M's look good. I like the green ones, do you? Yum, yum."). The *Self-Control* task contains two trials. In Trial 1, the reward is hidden under a beige cup on the testing board after the desirable comment has been made. In Trial 2, the reward is gift wrapped that is placed under the testing table. The child is then instructed not to touch the reward while the examiner completes another task. "The examiner then backs away and partially turns from the testing table and reviews testing sheets while monitoring the child. The latency to touch the reward is measured in seconds until 150" (Espy et al., 2001; p 50).

In a study conducted by Espy et al. (2001), a group-age-difference comparison indicated that as children increased in age, they were able to better inhibit or self-monitor the behavior to reach for the desired reward compared to the younger age groups. For example, the 30-month age group had a mean time of 125 seconds before reaching for the reward, while all participants in the 60-month age group were able to totally inhibit responding to the reward. However, the *Self-Control* task has not been used with preschool-aged children with autism, so it is difficult to predict whether there would be age differences in that population.

The *Self-Control* task appears to be age-appropriate and provides a sufficient amount of reward to assess preschoolers' ability to self-monitor their own behaviors (i.e., impulsivity, managing directions/rules, and delaying gratification). On the other hand, the *Self-Control* task has limited usage with preschool-aged children with developmental disorders. In addition, the literature review only found two studies that used the *Self-Control* task (Espy et al., 1999; and Espy et al., 2001). More research needs to be conducted with this instrument to determine

whether it is appropriate to be used to assess self-monitoring and inhibition in preschool children with and without autism.

*Boxes* (Petrides, 1995; and Diamond, 1997). The *Boxes* task is designed to measure working memory and inhibition. The *Boxes* task was designed by Petrides in 1995 for use with monkeys and was later expanded by Diamond in 1997 self-ordered pointing task with adults (Griffith et al., 1999). More recently, the *Boxes* task has been used to assess executive functioning in preschool-aged children ranging in age from 40 to 61 months (Griffith et al., 1999).

Four box tasks are included: *3-Boxes Stationary*, *3-Boxes Scrambled*, *6-Boxes Stationary*, and *6-Boxes Scrambled*. Each box included in this task was decorated with a different colored abstract shape. While the child is watching, the desired object is placed inside each box and all lids are closed. A five-second delay was imposed on the 3-box trials, and a 10 second imposed on the 6 box trials with a screen to cover the boxes during the delay. After the delay the screen is lowered and the child is allowed to choose one box and retrieves the object. The lid to that box is closed and another delay is initiated. The child is then again allowed to open another box, which continues until all of the objects are retrieved or when five consecutive errors are made. In the scrambled conditions, the positions of the boxes are scrambled in a random sequence during the delay, in a way that a full box never cycled into the location to which the child just reached. This variation makes perseverating towards a particular location detrimental to performance, rather than a helpful strategy.

All conditions on the *Boxes* task are given an efficiency ratio score (i.e., number of rewards retrieved, number of reaches in the task); the rating scale is either 0 or 1 (Griffith et al., 1999). An error analysis is also conducted including the number of reaches prior to making the

first error, and the maximum consecutive reaches to the same box. In the scrambled condition, the only score recorded is the maximum consecutive reaches to the same location, because in this condition the boxes change locations.

This task requires the child to maintain a set over a delayed period of time paying attention to which boxes have been opened and updating this information each turn, while inhibiting a reach to a previously correct location. The *Boxes* task is similar to self-ordering pointing tasks, in which humans with frontal lesions are impaired (Griffith et al., 1999). Griffith et al. (1999) stated that it is possible to keep a simple maintenance of set during the stationary condition; however, the scrambled condition requires a higher level of maintenance because the information is more specific and visual appearance of the boxes have already been emptied. He continued to report that in the *Boxes* task monkeys with dorsolateral prefrontal cortex lesions have shown a decline in performance during the scrambled condition (Griffith et al., 1999).

In a study conducted by Griffith et al. (1999), the *Boxes* task was given to 18 children with autism compared to 17 children with developmental disorders other than autism, ranging in age from 40-61 months. Across all four conditions there were no significant differences between the children with autism and the children with developmental delays. However, on all four conditions the efficiency scores were slightly lower in the children with developmentally delays. The Griffith et al., (1999) study is the only study that used the *Boxes* task to examine executive functioning in children with autism.

Overall, the *Boxes* task has not been replicated across many studies investigating executive functioning in preschoolers. Additionally, in the limited research that has been conducted using the task, there have been only slight differences in performances between children with autism and children with developmentally delays. More research needs to be

conducted to determine age group differences, and compare performances of children with autism to children without developmental disorders. Furthermore, the *Boxes* task has not been administered to a large normative base, therefore lacking convergent and discriminant validity.

*Dimensional Card Change Test* (Zelazo, Reznick, & Pinon, 1995). The *Dimensional Card Change Test* (DCCS) is similar to the *Wisconsin Card Sorting Card* for adults, adolescents, and older children, in that it measures shifting set between multiple dimensions, and inhibition of a prominent stimulus. Zelazo et al. (1995) designed the *DCCS* to assess the extent that young children are able to hold two sets of rules “online” in their minds, apply them, and switch between them (Rennie, Bull, & Diamond, 2004). The *DCCS* was designed to assess preschool-aged children between the ages of 30 and 60 months.

The *DCCS* requires young children to sort picture cards according to shape or color, and then by the other criterion. The *DCCS* has three conditions (Condition A, Condition B, and Condition C). The following is a test description of the *DCCS* in a study conducted by Rennie et al. (2004).

“The test is presented by using 15-cm x 12-cm laminated test cards. All cards were sorted into 30-cm x 21-cm x 10-cm boxes, with the height of the boxes raised to 24-cm to accommodate the laminated target cards. All cards were presented at eye level to the eye level of the participants. On each of the cards used in the task, the picture was configured in the middle of the card with a white background behind the picture and a black border on the edge of the card, except for the single color cards presented in Condition B. The cards in Condition B were the same size, but the whole card was color required. In Condition A, the target cards were a blue star and a red truck, while the stimulus cards were a red star and a blue truck. The practice trial used blue and red grape cards, and yellow trucks and stars. In Condition B, the four target cards were just the outline drawings of a truck or star against a white background, and entirely blue or entirely red cards. The stimulus cards and training cards were the same as in Condition A (Rennie, Bull, & Diamond, 2004). In Condition C the stimulus cards were yellow trucks and green stars and red boats and blue birds. The training cards were red and blue grapes and colorless trucks and stars. Colorless rather than yellow training cards were used since the stimulus cards were colored yellow and introducing a new color into the task might have been confusing” (p. 431).

Condition A is the baseline condition. Condition B required reduced action-inhibition, where the correct response changed from pre to post-switch. Children were required to achieve five consecutively correct responses out of a total of six trials to pass both the pre and post-switch conditions. Condition C is the reduced attention and action-inhibition condition (Rennie et al., 2004). Each stimulus still had a color and a shape, the correct response only matched along one dimension (i.e., color or shape). Scoring rating was on a scale from 0 to 6 depending on the amount of correct responses in each condition.

Rennie et al. (2004) reported the 3-year olds have more problems successfully completing the task than their 4 and 5-year old counterparts. The 3-year olds have greater difficulty switching sorting criteria, regardless of which criterion was implemented first. Between the ages of 4 to 5-years of age, children can begin to successfully switch to sort by the second dimension (Rennie et al., 2004). An interesting phenomenon has been observed in the *DCCS*; children, who fail the post-switch phase of the test by sorting perseveratively, display an apparent dissociation between knowing the rules and using them (Rennie et al., 2004).

In the Rennie et al. (2004) study, 33 children between the ages of 30 to 46 months were given the *DCCS*. Twenty-one children were able to successfully complete the baseline condition (mean age = 37 months). All of these 21 children were given Condition B. “Although reducing demands on action inhibition (Condition B) did not significantly improve performance, when demands on both action and attentional inhibition were reduced (Condition C) almost all children (95%) successfully switched sets, even children only 2.5-years old” (p. 423). A review of the literature found no empirical research on the *DCCS* on children with autism or other developmental disorders.

The *DCCS* is constructed based on neuropsychological theory of executive functioning, more specifically, set shifting and working memory. In addition, the *DCCS* was adapted from a popular and highly validated instrument – the *Wisconsin Card Sorting Test* and can be used with children as young as 2 and a half years old. In contrast, the *DCCS* is a relatively new instrument (2004) and has been used differently across several studies. The *DCCS* also has limited empirically validated use without standardized norms; therefore, it lacks convergent and discriminant validity. Furthermore, the *DCCS* has not been used with preschool children with autism. Further research will indicate whether the *DCCS* is an appropriate measure of inhibition and set shifting.

*Noisy Book task* (Goldman-Fristoe-Woodcock, 1974). The *Noisy Book* task was adapted from the Goldman-Fristoe-Woodcock auditory memory battery (1974). More recently, the *Noisy Book* subtest has been used to assess working memory in preschool aged children (Dennis et al., 1991, Hughes, Dunn, & White, 1998, and Sonuga-Barke, Dalen, Daley, & Remington, 2002). Hughes, et al. (2002) slightly redesigned the task to make it more engaging for young children by using a “noisy book” (Red Riding Hood) that contained a 3 x 3 array of pictures that produced sound effects when pressed. Sonuga-Barke et al. (2002) explained three elements that support noisy book’s use as a working memory task: “performance depends on holding in mind: (a) the locations of different picture-noise pairings and, (b) the sequence of test items presented, while (c) in both cases resisting external distraction during the search for the location of the picture associated with each item” (p 262). In addition, Hughes et al. (1998) found that performance on this task was developmentally sensitive and could be dissociated from other executive functioning domains.

Each child was asked to press each button to identify what sounds each button made, allowing the experimenter to refer to the pictures in the same way as the child. If the child failed to name a picture, they were told its name and receptive identification was then checked. The instructions provided by Hughes et al. (1998) are as follows:

“For each picture, the experimenter said ‘can you press the --? See what noise it makes.’ Next, the experimenter introduced the task by saying ‘I’m going to cover up the pictures and say the names of two things. Do you think you can push the pictures I’ve said? Try and do it just the way I say.’

Children were given up to four practice trials before beginning the test. The test phase consisted of three 2-items lists, three 3-items lists, and three 4-items lists (Hughes et al., 2002). The trial lists had previously been tested to ensure that each involved the same delay period between items. All children received the same pictures in a fixed order. Each child attempted all three lists at a given level and scored at that level if he or she recalled the correct sequence on two of the three trials (Sonuga-Barke et al., 2002). Progress to the next level was dependent on the correct recall of items on all three trials of the previous level. Coding was 0 if one or fewer 2-items lists were recalled; 1 if at least two of three 2-item lists were recalled; 2 if at least two of three 3-item lists were recalled; and 3 if at least two of three 4-item lists were recalled (Sonuga-Barke et al., 2002).

The *Noisy Book* task has been constructed and adapted from the *Woodcock Auditory Memory* battery to assess working memory. It is developmentally sensitive, easy to administer, and has a child-friendly storybook format. In contrast, the *Noisy Book* task has little empirically validated use without standardized norms; therefore, it has limited convergent and discriminant validity. Furthermore, the *Noisy Book* task has not been used with preschool children with autism. Further research will indicate whether the *Noisy Book* task is an appropriate measure of working memory.

### *Ecologically Valid Measures*

In this section, the review and critique with focus on naturalistic or ecologically valid measures. Ecological validity is defined as the functional and predictive relation between the patient's behavior on a set of neuropsychological tests and the patient's behavior in a variety of real-world settings" (Isquith et al., 2005). The following review will include naturalistic instruments used to evaluate executive functioning in preschool-age children.

*BRIEF-P* (Gioia, Espy, & Isquith, 2002). The *BRIEF-Preschool Version (Behavioral Rating Scale of Executive Functions)* was developed to assess executive functions as observed in everyday behaviors of preschool-aged children. The *BRIEF-P* is a 63 item parent/teacher rating scale for children from 2 years 0 months to 5 years 11 months with items comprised of five executive functioning domains: *Inhibit* (16 items), *Shift* (10 items), *Emotional Control* (10 items), *Working Memory* (17 items), and *Plan/Organize* (10 items). The scale is summarized in three overlapping indexes: *Inhibitory Self-Control (Inhibit and Emotional Control)*, *Flexibility (Shift and Emotional Control)*, and *Emergent Metacognition (Working Memory and Plan/Organize)*. The instrument also captures levels of executive functions across common developmental and acquired disorders such as: ADHD, ASD, TBI, and reading disorders (Isquith et al. (2005).

The *BRIEF-P* is based on the theory that executive functions begin to develop in preschool-aged children beginning at 2 to 5 years of age. The examination of everyday behaviors further supports an ecological validity model, which complements performance based on controlled assessments of executive functions in preschool children.

The *BRIEF-P* requires that the rater have at least a fifth grade reading level and 10-15 minutes to complete. In addition, the rater should know the child well (i.e., at least 1 month).

Raters are asked to determine the level of each item as to whether it is never, sometimes, or often a problem for the child (never = 1, sometimes = 2, and often = 3). The scores are then compared with normative values in tables for two age groups (2-3 year olds and 4-5 year olds), separated by gender. Indices are calculated and referenced to normative data (*t* scores and percentiles) with 90 percent confidence intervals for scores and indexes. The *BRIEF-P* can be administered by technically trained individuals, but should be interpreted by appropriately trained professionals with experience in clinical assessment (Isquith et al., 2004; and Isquith et al., 2005).

Normative data were collected from a total of 460 parents and 302 teachers from children aged 2 to 5 years. Normative samples were obtained from both public and private school recruitment and pediatric well-child visits in urban, suburban, and rural areas. As a result, key demographic variables of the U.S. population were sampled.

Isquith et al. (2005) reported that the *BRIEF-P* exhibits appropriate internal consistency, temporal stability, and evidence based on convergence and divergence validity. Parents and teachers are viewed as valuable sources of data high in ecological validity. Internal consistency reliability estimates were high, with alpha coefficients ranging from .80 to .95 across scales, indexes, and the composite score for the parent sample. In the same vein, the internal consistency rating was slightly higher for the teacher rating scale with all scores falling at the .90 alpha level and above (Spies & Plake, 2005).

The inter-rater reliability across the scales was modest for both the teacher and parent raters, ranging from .06 to .28 with an overall mean correlation of .19. The variable correlation is not entirely unexpected because the expectations and opportunities for performance vary across home and school settings (Spies & Plake, 2005). For the parent sample, test-retest

correlations across the clinical scales ranged from .78 to .90. For the teacher sample, the test-retest correlations across clinical scales ranged from .65 to .94. Spies and Plake (2005) indicated that the authors of the *BRIEF-P* found that the *t* scores remained stable across the test-retest interval, supporting repeat administration of the *BRIEF-P* with no significant degree of variability expected to the instrument.

Item content was developed through clinical interviews with parents and teachers, empirical research, and the expertise of pediatric neuropsychologists who have significant experience in this age group and executive functioning. Spies and Plake (2005) reported that by using normative and clinically referenced samples, convergent and divergent validity was addressed through correlational studies between the *BRIEF-P* and three other well-known behavioral rating scales: *Attention Deficit Hyperactivity Disorder (ADHD) Rating Scale-IV Preschool version*, *Child Behavior Checklist*, and *Behavior Assessment System for Children*. In addition, the *BRIEF-P* captures profiles of executive functioning in preschool-aged children with pervasive developmental disorders, including autism (Gioia et al., 2002; and Spies & Plake, 2005).

The strengths of the *BRIEF-P* include easy administration and scoring, a user-friendly manual that is well organized visual information to explain technical information, a summary and profile forms that aid in interpretation and explanation of results, an adequate standardization sample, a sound theoretical basis of executive functioning, the usage with children diagnosed with childhood disorders, such as autism, and the observation of behavior in natural settings. Conversely, the weaknesses include the use of the subjective ratings that are largely influenced by how well the rater knows the child.

### Major Concerns of Current Executive Function Measurements

The above section contained a review and critique of the current executive function measurements in preschool-aged children. Executive functioning measurements and assessment techniques have made dramatic advancements within the past 10 to 15 years for use in the preschooler population. Nonetheless, many of the above instruments alone are limited in their ability to assess executive functions comprehensively in children. The following section will touch upon the critical components such as ecological validity, age appropriateness, population (autism) appropriateness, and construct validity. These key components need to be considered when assessing executive functions in preschoolers with and without autism.

#### *Ecological Validity*

The term ecological validity has been discussed briefly in Chapter One. The term is defined as the “functional and predictive relation between the patient’s behavior on a set of neuropsychological tests and the patient’s behavior in a variety of real-world settings” (Isquith et al., 2005). The challenge in evaluating executive functions in any age group is not just to identify appropriate performance-based measures, but also to evaluate functional, everyday-like behaviors. The question now becomes: how does one achieve ecological validity when assessing preschool-aged children with autism?

Isquith et al. (2005) stated that an ecologically valid assessment tool has characteristics similar to a naturally occurring human behavior and has value in predicting everyday behavior. Many of the current neuropsychological assessment tools that are constructed based on high internal validity have the potential only to test individuals in narrow, situationally constrained abilities. Therefore, many elicited tasks are unable to measure the fundamental principles of executive function processes which are often observed in real life or daily situations.

On the other hand, the high internal validity and construct validity of laboratory-based neuropsychological assessment tools offer a greater certainty of assessing executive functioning associated with brain-based activity, such as the frontal lobe regions, specifically the prefrontal cortex, and dorsolateral prefrontal cortex areas. Instead of viewing ecologically valid (i.e., rating scales, observational measures) and elicited instrumentation as separate, a comprehensive testing battery needs to include both types of assessments to ensure to greatest amount of accuracy in assessing executive functioning in preschool-aged children. Isquith et al. (2005) further supported this point: “traditional test-based measures of executive function are given to assess more specific components of executive function..., the rating scale (naturalistic) method measures the broader, molar level of function in the child’s everyday context” (p. 210). In sum, the combination of elicited and ecological measures (i.e., ecologically valid assessment) of executive functioning would provide a better understanding towards the impact of preschool children’s component-level (subdomain) deficits, in addition to their everyday functioning.

#### *Age-Appropriateness*

Careful developmental consideration must be taken when assessing executive functioning in preschool-aged children. Even though preschool assessment tools need to be adapted to meet the development needs of youngsters, it is not an impossible task. Isquith et al. (2004) stated, “executive functioning can be differentiated by using developmentally appropriate tasks, such as those adapted from developmental cognitive neuroscience” (p. 405). They go on to state executive functions, such as working memory, inhibition, shifting set abilities can be discriminated in preschool children (Isquith et al., 2004). In the same vein, group age differences can be observed in children between the ages of 3 and up, based on soundly constructed instrumentation (Espy, 1997; Espy et al., 2001; and Senn et al., 2004).

The executive functions mentioned above – working memory, inhibition, and set shifting – are thought to be more fundamental executive processes and, therefore, develop earlier in childhood. The more complex executive functioning, such as planning and systematic problem solving, have longer developmental courses. Regarding neurological development, each individual develops executive functioning skills at varying ages of onset: “rate of development, the level of proficiency at any given age, and the shape of the trajectory of skill acquisition” (Isquith et al., 2004; p. 405). Another important factor to consider is the development of non-executive functioning skills, such as motor and verbal skills that may impact the progression of executive functioning abilities. In particular, verbal skills often need to be accounted for across empirical research, as many of the executive functioning tests require a verbal component in order to achieve successful completion. Many researchers have recently begun to design executive functioning instruments (i.e., *DCCS*, *Day-Night*, and *BRIEF-P*; to name a few) for preschool children with the aim of minimizing the amount of verbal skills needed to identify specific components of executive functioning (Espy, 1997; Espy & Cwik, 2004; Isquith et al., 2004; and Isquith et al., 2005).

In a similar vein, the projected neurologic path of childhood disorders also may vary across age, especially compared to other typically developing same-aged children. Correspondingly, Isquith et al. (2004) reported growing evidence of neurological and behavioral disorders in preschool children result in unique patterns of executive functioning disturbance. Furthermore, in a literature review of preschoolers diagnosed with autism and other developmental disorders, there has been a wealth of research documenting executive functioning disturbances in children with autism when compared to their same-aged peers (Pennington & Ozonoff, 1996; Dawson et al., 1998; Griffith, et al., 1999; Ozonoff & Jensen, 1999; Coldren &

Halloran, 2003; and Ozonoff et al., 2004). It is important for measures of preschool executive functioning to have adequate floor effects when assessing children with developmental disorders including autism. An adequate floor effect on measures will increase the likelihood that these children will have the potential to complete the targeted task. Since children with diagnosed with these disorders are regarded as having unique executive functioning profiles, tasks to measure distinctive executive processes are essential.

### *Construct Validity*

The term construct validity is defined as “the ability of a test to measure the variable or construct it was designed to measure” (Pittenger, 2003; p. 53). The focus of construct validity in this section is to ensure that each executive functioning measure tests the intended components of executive functions it was designed to assess.

To increase the probability of construct validity, an instrument needs to demonstrate moderate test-retest reliability. One would expect a reliable instrument to produce similar results when used on similar subjects. However, good test-retest reliability is not enough. Executive function measures in preschoolers need to be based on sound neuropsychological and developmental theory. Sound theoretical instrumentation design focuses on item development based on previous research and current knowledge of brain-based functioning. In addition, preschool executive functioning measures need to consider developmental abilities and processes. Careful consideration needs to be taken of all of these factors when selecting an executive function assessment battery for preschool-aged children.

### Implications of the Literature

The study of executive functions is critically important in the understanding of overall neuropsychological functioning, especially for young children. Executive functioning plays a

fundamental role in a child's behavioral, cognitive, social, and emotional development beginning as early as birth. Young children use executive functioning skills to observe, interpret, and interact with their external world. To gain a better comprehension of executive functions would mean to have a clearer understanding of how young children begin to learn and interact with their environment.

The assessment of executive functions in preschoolers has presented a complex challenge because young children are continually learning and developing at a rapid rate. Developmental and ecological factors need to be considered when designing executive functioning tasks for preschoolers. The available measurements for preschool aged children are based, predominantly, on elicited, laboratory based tasks, which possesses little ecological validity. To assess executive functions at any age is not only to find appropriate performance-based measures, but also to evaluate the functional, real-world impact of executive functions expressed in everyday activities (Isquith et al., 2005).

It is of importance to focus on children with Pervasive Developmental Disorders, specifically, children with autism, because they have a greater risk of cognitive, emotional, and behavioral impairments compared to children with other developmental disorders. Preschool children with autism have been found to display more significant deficits in executive functioning in the areas of inhibition, shifting mental set, and self-monitoring of action when compared to same-aged children without autism (McEvoy, Pennington, & Rogers, 1993; Pennington & Ozonoff, 1996; Russell, 1996b, Ozonoff & Strayer, 1997; Griffith, Pennington, Wehner, & Rogers, 1999; Ozonoff & Jensen, 1999; Hughes & Graham, 2002; and Coldren & Holloran, 2003). Deficits in executive functioning are also typically observed to affect many

everyday behaviors in children with autism, such as perseverative responses, rigid and repetitive actions, and decreased impulse control.

Adequate identification of executive deficits in children with autism is of great concern. If executive functions can be assessed during the early stages of school entry, deficit profiles will be established to detect specific childhood disorders earlier. In turn, interventions can be provided earlier to treat and possibly reduce the symptoms of childhood disorders such as for children with Attention Deficit Hyperactivity Disorder (ADHD), Down syndrome, Tourette's syndrome, and Pervasive Developmental Disorder (PDD). Children with these disorders all present vulnerabilities in executive functioning.

## CHAPTER THREE

Chapter three provides a detailed description of the methods and instrumentation used in this investigation. More specifically, the settings, the sample population of preschool children, and selected measures and materials, procedures, research design and planned analyses are introduced.

*Setting*

The 59 participants were gathered from four schools. Three schools were located in the Christina School District in Northern Delaware. The investigator contacted the school district's Accountability and Assessment department and completed a Request to Conduct Research (Appendix G). Upon receiving the Research Approval (Appendix H) the three participating schools in the Christina School District were selected by the Accountability and Assessment Department. The fourth school, an institute in southern Massachusetts, granted the investigator verbal research approval with documented Institutional Review Board (IRB) approval from Northeastern University (Appendix B).

The participants without autism were gathered from two public elementary schools (Schools 1 and 2) in Northern Delaware in urban Mid-Atlantic communities. Schools 1 and 2 provided half-day instruction (AM and PM instruction) to the without autism group with no summer extension program. Classrooms consisted of a class size range of 10 to 30 students with a regular education teacher and at least one classroom aide.

School 3 is public alternative school in Northern Delaware located in an urban Mid-Atlantic community. School 3 offers comprehensive, research-validated services to children and adolescents with pervasive developmental disorders and other genetic developmental disorders. The institute has five preschool classrooms and two satellite locations for higher functioning

children diagnosed with ASD which is staffed by qualified special education teachers, therapists, and specialists. School 4 is a non-profit institute in Southern Massachusetts that is known for providing comprehensive, research-validated services to children and adults with autism, brain injury, mental retardation, pervasive developmental disorder (PDD), behavioral healthcare needs, and normally developing individuals. In addition, the institute has three preschool classrooms with several quiet rooms that are staffed by qualified special education teachers, therapists, and specialists. Schools 3 and 4 function on full day schedules with extended summer programs. The classrooms in schools 3 and 4 consisted of a maximum of six students with a special education instructor and at least one classroom aide.

### *Participants*

The sample consisted of 59 preschool-aged children, 29 children diagnosed with ASD (19 with PDD-NOS and 10 with Autistic Disorder) and 30 without ASD. The 29 children diagnosed with autism were recruited from schools 3 and 4. Records were obtained from the identified educational institutes to obtain diagnostic and demographic information to meet the inclusionary criteria (age and diagnosis).

Children in the autism group needed to be between the ages of four years, zero months to six years, eleven months and have a confirmed diagnosis of a pervasive developmental disorder without a primary medical or clinical condition. The participants in the without autism group were schools 1 and 2. The without autism group was defined as preschool age children between the ages of four years, zero months to six years, eleven months without any diagnosed medical or clinical conditions that would typically affect learning. Eligibility screening for the 29 participants in the autism group included a previous documented diagnosis of Autistic Disorder

or PDD-NOS by a licensed professional. All participants enrolled in the autism group had a documented diagnosis/disability to qualify for services.

Within the two groups (with and without autism) 3 subgroups were created to evaluate age-based performance on executive functioning measures across age. The autism group subgroups consisted of six 4-year olds, twelve 5-year olds, and eleven 6-year olds. The without autism group consisted of six 4-year olds, seven 5-year olds, and seventeen 6-year olds.

A sample size of 60 was chosen because: (1) based on the previous research of executive functions in preschoolers with autism (McEvoy et al., 1993; Dawson et al., 1998; and Griffith et al., 1999), relatively large effect sizes have been reported using small sample sizes of 20 participants per group, ranging from .82 to .88 mean effect size; (2) according to the Power Primer by Cohen (1992),  $n = 16$  is required if a large mean effect size ( $f = .40$ ) exists;  $n = 39$  for a medium mean effect size ( $f = .25$ ); and  $n = 240$  for a small mean effect size ( $f = .10$ ) using a one-way ANOVA with two groups ( $f =$  effect size,  $n =$  sample size).

Recruitment was notably difficult for the with autism group due to limited targeted sample. Two follow up letters were used for the autism group with success (11 additional consents returned during follow up period). However, in the end, the principal student investigator received a total 29 informed consents. It was determined that using one less participant would not negatively impact the effect size of the study.

### *Measures/Materials*

An outline and description of the available executive functions instruments used in this study can be found in Appendix B. The *Leiter-R*, a nonverbal test of intelligence is outlined. In addition, the five executive functioning instruments are outlined, which include: *Day-Night* test, *Dimension Card Change Sort* test (*DCCS*), *Noisy Book*, *Tower of Hanoi-Revised*, and *Self-*

*Control* task. A more detailed review of the executive functioning instruments can be found in chapter 2.

*Intelligence/Cognition: Leiter International Performance Scale-Revised* (Psychological Assessment Resources, Inc., 2005). The *Leiter International Performance Scale* is a nonverbal assessment of intelligence and cognitive abilities. The *Leiter-R* consists of two nationally standardized batteries: a revision of the original Visualization and Reasoning (VR) domains for measuring IQ; and the new Attention and Memory (AM) domains. Both batteries include unique growth scores that measure small, but important, improvement in children with significant cognitive disabilities (Psychological Assessment Resources, Inc., 2005). The *Leiter-R* has a high correlation with traditional intelligence tests such as *WISC-III* (.85). Normative information is standardized on 1,719 typical children and adolescents, and 692 atypical children (representing nine clinical groups, including autism) ages 2.0 to 20.11 years, using a national stratification plan based on the 1993 U.S. Census statistics (Psychological Assessment Resources, Inc., 2005). Reliability and validity have been tested across studies of internal consistency, test-retest and decision-consistency reliability, and construct and criterion validity are reported in the test Manual.

The *Leiter-R* is nonverbal measurement and was designed to assess children and adolescents who are cognitively delayed, disadvantaged, nonverbal or non-English speaking, ESL, speech, hearing or motor impaired, ADHD, autistic, and Traumatic Brain Injuries. Another benefit to using the *Leiter-R* is that it measures fluid intelligence, which does not change significantly in the adult years, and it can be used effectively with older subjects (Psychological Assessment Resources, Inc., 2005).

For the purposes of this study, the abbreviated scale of intelligence was used. The *Leiter-R* abbreviated battery consists of four subtests: *Figure Ground* (FG), *Form Completion* (FC), *Sequential Order* (SO), and *Repeated Patterns* (RP). An Intelligence Quotient and percentile can be gathered from the sum of the four scaled scores with a confidence interval of 95 percent.

*Working memory: Noisy Book task* (Goldman-Fristoe-Woodcock, 1974). The *Noisy Book* task was adapted from the *Goldman-Fristoe-Woodcock Auditory Memory* battery (1974). More recently, the *Noisy Book* test has been used to assess working memory in preschool aged children (Dennis et al., 1991, Hughes, Dunn, & White, 1998, and Sonuga-Barke, Dalen, Daley, & Remington, 2002). Hughes, et al. (2002) slightly redesigned the task to make it more engaging for young children by using a “noisy book” (Red Riding Hood) that contained a 3 x 3 array of pictures that produced sound effects when pressed. Sonuga-Barke et al. (2002) explains three elements that support noisy book’s use as a working memory task: “performance depends on holding in mind: (a) the locations of different picture-noise pairings and, (b) the sequence of test items presented, while (c) in both cases resisting external distraction during the search for the location of the picture associated with each item”, In addition, Hughes et al. (1998) found that performance on this task was developmentally sensitive and could be dissociated from other executive functioning domains.

In the present study, “Thomas the Train: Noisy Surprise” was used as the *Noisy Book*. The examiner named each button (Thomas, Sun, Rain, Wagon, Hook, Wheel, and Cat), and then asked the child to press each button to identify what sounds each button made. If the child failed to name a picture, they were told its name again and receptive identification was re-administered. The following administration was used:

“For each picture, the experimenter will say ‘can you press the --? You try... See what noise it makes.’ Next, the experimenter introduced the practice trial by

saying “On each go, I’ll show you a picture and then I’ll take it away while I count to 5. Then I’ll show you the book again. I want you to push the button with the same picture to make noise.”

Children were given up to four practice trials before beginning the test. The test phase consisted of three 2-item lists, three 3-item lists, three 4-item lists, and three 5-item lists. The trial lists had previously been tested to ensure that each involved the same delay period between items. All children received the same pictures in a fixed order. Each child attempted all four lists at a given level and scored at that level if he or she recalled the correct sequence on two of the three trials. Progress to the next level was dependent on the correct recall of items on all three trials of the previous level. Coding was 0 if one or fewer 2-items lists were recalled; 1 if at least two of three 2-item lists were recalled; 2 if at least two of three 3-item lists were recalled; and 3 if at least two of three 4-item lists were recalled.

*Shifting set: Dimensional Card Change Sort* (Zelazo, Reznick, & Pinon, 1995). The *Dimensional Card Change Test (DCCS)* is similar to the *Wisconsin Card Sorting Card* for adults, adolescents, and older children, in that it measures shifting set between multiple dimensions, and inhibition of a prominent stimulus. Zelazo et al. (1995) designed the *DCCS* to assess the extent that young children are able to hold two sets of rules “online” in their minds, apply them, and switch between them (Rennie, Bull, & Diamond, 2004). The *DCCS* was designed to assess preschool-aged children between the ages of 30 and 60 months.

The *DCCS* requires young children to sort picture cards according to shape or color, and then by the other criterion. The *DCCS* has three conditions (Condition A, Condition B, and Condition C). The test is presented by using 13 ½ -cm x 9-cm laminated test cards. All cards were sorted into 25-cm x 16-cm x 10-cm boxes. All cards were presented at eye level to the participants. On each of the cards used in the task, the picture was configured in the middle of

the card with a white background behind the picture and a black border on the edge of the card. In Condition A, the target cards were a blue star and a red truck, while the stimulus cards were a red star and a blue truck. The practice trail used blue and red grape cards, and yellow trucks and stars. Half of the participants were trained on shapes first, while the other half was initially trained on colors based on the assigned subject code (e.g., subject numbers ending in an odd number were administered colors were and vice versa). Training took place once the child was comfortable and settled, with the examiner giving the following instructions:

“Now we are going to play a card game. In this game we play the color (shape) or shape (color) game. In the color (shape) game all the blue ones (trucks) go in this tray (experimenter points), and all the red ones (stars) go in this tray (again, experimenter points).” Next the child was asked “Can you point and show me where the blue/red ones (trucks/stars) go?” If the child points correctly, the experimenter praises the child and restates the rules in incorrect. “Here’s a red one (star). Where does it go?”

These sentences were used again later in the session when the rules were restated between trials. To pass the training and continue with the game, the child had to correctly sort four cards (two for each dimension) and was only allowed a total of eight attempts during training. Test trials began immediately after the last training trial with the experimenter saying “Now we are going to keep playing the shape (color) game”, and is based on the dimension last sorted (e.g., if the last training card was a yellow truck, the first test dimension would be a shape. In the pre-switch phase, the experimenter presented each test card and said “Here is a truck (star, red one, blue one). Where does it go?” The experimenter always labeled the card along the current relevant dimension. Cards were always presented in predetermined pseudo-random order. The card dimension is switched after five out of six consecutive correct sorted cards or until the first six cards have been administered on the first dimension. Children who failed to pass the pre-switch trials continued to the post-switch. No feedback was given during the testing.

During the post-switch phase, the experimenter stated “Let’s not play the color ( shape) game anymore, ok? We’re not going to play that game anymore! Let’s play the shape (color) game now. Remember, in the shape (color) game, all the trucks (blue ones) go here, and all the stars (red ones) go here. The experimenter pointed to the appropriate boxes. “So stars (red ones) go in this box, and trucks (blue ones) go in this box. Can you show me where the trucks (blue ones) go in the shape (color game)?” Feedback was given based on the child’s response. The experimenter restated the rules and asked the knowledge question to make sure the child knew how to sort the cards correctly according to the new dimension. The knowledge question for the color game was “Point to where the red ones go. Point to where the blue ones go.” In the shape game the knowledge question was “Point to where the trucks go. Point to where the stars go.”

In Condition B, the four target cards were just the outline, colorless, drawings of a truck and star against a white background, and entirely blue and entirely red cards. The stimulus cards and training cards were the same as in Condition A and were the identical set of procedures from Rennie et al. (2004).

In Condition C the stimulus cards were green trucks, yellow stars, red boats, and blue birds. The training cards were red and blue grapes, and colorless trucks and stars. Colorless rather than yellow training cards were used because the stimulus cards were colored yellow and introducing a new color into the task might have been confusing. The procedures were the same as in Condition A except (a) the stimulus cards matched the target cards along only one dimension, and (b) the shape dimension was trained by using colorless trucks and stars and not trucks and stars in a neutral color.

Condition A is the baseline condition. Condition B required reduced action-inhibition, where the correct response changed from pre to post-switch. Children were required to achieve

five consecutively correct responses out of a total of six trials to pass both the pre and post-switch conditions. Condition C is the reduced attention and action-inhibition condition (Rennie et al., 2004). Each stimulus still had a color and a shape, the correct response only matched along one dimension (i.e., color or shape). Scoring was rated on a scale from 0 to 6 depending on the amount of correct responses in each condition.

Rennie et al. (2004) reported the 3-year olds have more problems successfully completing the task than their 4 and 5-year old counterparts. The 3-year olds have a greater difficulty switching sorting criteria, regardless of what criterion was implemented first. Between the ages of 4 to 5-years of age, children can begin to successfully switch to sort by the second dimension (Rennie et al., 2004). An interesting phenomenon has been observed in the *DCCS*; children who fail the post-switch phase of the test by sorting perseveratively display an apparent dissociation between knowing the rules and using them (Rennie et al., 2004).

In a study conducted by Rennie et al. (2004), 33 children between the ages of 30 to 46 months were given the *DCCS*. Twenty-one children were able to successfully complete the baseline condition (mean age = 37 months). All of these 21 children were given Condition B. “Although reducing demands on action inhibition (Condition B) did not significantly improve performance, when demands on both action and attentional inhibition were reduced (Condition C) almost all children (95%) successfully switched sets, even children only 2.5-years old” (p. 423).

*Inhibition: The Day-Night test* (Gerstadt, Hong, & Diamond, 1994). The *Day-Night test* is adapted from the adult *Stroop* test. It required the individual to inhibit an automatic, over-learned response. The *Day-Night test* was designed to assess inhibition without including a reading

component found in the *Stroop test*. The *Day-Night* test has been used with preschool-aged children ranging from 3.5 to 7-years of age.

The test is presented by using 13 and one half -cm x 9-cm laminated test cards. The testing cards were presented to each child facing flat on the testing table directly in front of the child. In the *Day-Night* task, the subject was required to say the word “day” when presented with a card showing a night sky (a moon with stars), and the word “night” when shown a picture of a sun. No control condition was used because response latency was not measured, differing from the Gerstadt et al. (1994) study. The administration was as followed:

“Now we are going to play a silly game.” Experimenter turned over a black card. “When you see this card, I want you to say day.” Experimenter then turned over a white card. “When you see this card, I want you to say night.”

Each child was given two practice trials (1 day card and 1 night card). During the experimental condition the subjects were presented with eight moon and eight sun stimuli in a pseudo-random order (white [w], black [b], b, w, b, w, w, b, b, w, b, w, w, b, w, and b) for a total of 16 test trials. The experimenter turned over a black card and stated “What do you say when I show you this card?” The experimenter asked this question throughout the 16 card experimental trial. The dependent measures were whether a response on a given trial was correct or not and the number of correct responses over a session. For children with limited or no verbal communication, two target cards were placed in front of the child. The child was required to point to the correct target card (day or night) when the examiner presented a new card.

In a study conducted by Gerstalt et al. (1994), 240 typically developing preschool-aged children between the ages of 3.5 and 7-years old were administered the *Day-Night* task. In addition, an age group differences comparison was conducted, comparing 3.5, 4, 4.5, 5, 5.5, 6, 6.5, and 7-year olds. In general children performed better on the control condition compared to

the experimental condition assessed by their response latency and ease at passing the pre-test. This result was true for each age group, 3.5 years:  $t(38) = 3.09, p < .01$ ; 4 years:  $t(38) = 4.22, p < .01$ ; 4.5 years:  $t(38) = 4.63, p < .01$ ; and 5 years:  $t(38) = 3.07, p < .01$ . A comparison on 3.5 to 5-year olds was conducted only because children between the ages of 5.5 and 7-years were not given the control condition. On the experimental condition, children under the age of 5-years had difficulties completing the task. One explanation is that the word-picture associations were not sufficiently automatized.

In a study conducted by Russell (1996), children between the ages of 5 and 8-years with and without autism were administered the *Day-Night* task and displayed similar performances. One explanation of similar performance may be a ceiling effect in older children. The children with autism were neither less accurate nor slower than the control groups. In the *Day-Night* task children are required to inhibit and switch simultaneously. In young children, it may be that these processes differ by age and contribute to executive functioning development (Espy, 1997).

*Planning: The Tower of Hanoi-Revised* (Welsh et al., 1991). The *Tower of Hanoi -R* (*TOH*) is a measure of problem solving planning ability, which can be used with young children approximately aging from 4 to 9 years old. The *Tower of Hanoi* requires higher order cognitive skills such as recognition and selection of goals and generation of plans (Sonuga-Barke et al., 2002). Senn, Espy, and Kaufmann (2004) stated that preschool children do not seem to possess overt planning skills. Therefore, *TOH* likely taps problem solving to a greater degree than planning in the preschooler age range.

The *TOH-R* used in this study contained three different colored plastic discs (red, orange, and yellow) that fit over three yellow plastic pegs taken from the Fisher Price ® Rock-n-Stack. The wooden testing board was 44cm x 17 one half cm x 3cm; each peg was spaced 10cm apart

from each other. Two identical testing boards were used (one for the child, the other for the examiner). The child was instructed to move his or her discs across the pegs according to certain rules to form a particular design that was formed on the examiner's testing board. A child-friendly story was given with the task. The instructions were as follows:

“There are three monkeys (rings) of different sizes (daddy, mommy, and baby) that may jump among the trees (pegs). Now in this game, I want you to make your monkeys look like my monkeys. The goal is to bring your monkeys home to sleep on their trees just like my monkeys.” The child is told three rules for the task; (1) Only 1 monkey can move at a time; (2) A bigger monkey cannot sit on a smaller monkey; (3) The monkeys have to stay on the pegs if they are not in your hand.”

The child is not told the minimum number of moves required for successful completion in each trial, and the trials are not timed. An individual problem was discontinued upon solution or when the child exhibited a maximum of 20 moves in the single problem. The test was discontinued after 2 consecutive failures, with failure occurring when the child refused to make any moves, or when he or she failed to make any legal moves for a given problem.

A child was given two points for correctly solving a two-move problem, and three points for solving the problems that require three moves, and so on. A total score was obtained by summing the total points across six problems. The dependent measure was the total number of problems solved in the minimal prescribed number of moves.

Bull et al. (2004) reported a test-retest reliability for *TOH-R* of .72 in 5-year-old children; however, the test-retest interval was only 25 minutes. Bull et al. (2004) also reported test-retest reliability of .53 over an interval of 30 to 40 days, in a sample of children aged 7-10 years from a study conducted by Bishop, Aamodt-Leaper, Creswell, McGurk, & Skuse, (2001). Currently, there are no published norms for the preschool version for the *Tower of Hanoi* test.

*Self-monitoring: Self-Control* (Lee et al., 1983). *Self-Control* is a measure of self-monitoring and inhibition in preschoolers ranging from 2.5 years to 6.5 years of age. It consisted of two trials. The child was shown a reward (i.e., sticker, pencil, or edible reinforcer) and the examiner used an animated tone to comment of the reward's desirability. In Trial A, the reward was hidden under a beige cup in a black testing box on the testing table after the desirable comment has been made, such as "boy that is really nice", or "wow what a cool looking –". In Trial B, the reward was gift wrapped and was placed under the testing table. The child was then instructed not to touch the reward while the examiner completes another task. The examiner then backed away and partially turns from the testing table and reviewed testing sheets while monitoring the child. The latency to touch the reward was measured in seconds until 150". Currently, there are neither standardized norms nor reliability or validity estimates for the *Self-Control* task.

In a study conducted by Espy et al. (2001), a group-age-difference comparison indicated that as children increased in age they were able to better inhibit or self-monitor the behavior to reach for the desired reward compared to the younger age groups. For example, the 30-month age group had a mean time of 125 seconds before reaching for the reward, while all participants in the 60-month age group were able to totally inhibit responding to the reward. However, the *Self-Control* task has not been used with preschool-aged children with autism, so it is difficult to predict whether there would be age differences in that population.

*BRIEF-P* (Gioia et al., 2002). The *BRIEF-Preschool Version (Behavioral Rating Inventory of Executive Functions for Preschoolers)* was developed to assess executive functions as observed in everyday behaviors of preschool-aged children. The *BRIEF-P* is a 63 item rating scale for children from 2 years 0 months to 5 years 11 months with items comprised of five

executive functioning domains: Inhibit (16 items), Shift (10 items), Emotional Control (10 items), Working Memory (17 items), and Plan/Organize (10 items). According to the *BRIEF-P* norms, maximum testing age is 5 years, 11 months. As a result, the *BRIEF-P* norms were adapted to assess 6 year-old children in the present study. The 5 year, 11 month norms were used to convert raw scores to *t* scores for this age group.

The *BRIEF-P* was designed for parents and teachers to administer. The scale is summarized in three overlapping indexes: Inhibitory Self-Control (Inhibit and Emotional Control), Flexibility (Shift and Emotional Control), and Emergent Metacognition (Working Memory and Plan/Organize). The instrument also captures levels of executive function across common developmental and acquired disorders such as: ADHD, ASD, TBI, and reading disorders (Isquith et al. (2005). For the purposes of the present study only the 5 executive functioning indexes and the Global Composite Scale were used. These scales were selected because the purpose of the study was to analysis global and domain specific executive functioning between preschool children with and without autism.

The *BRIEF-P* is based on the theory that executive functions begin to develop in preschool-aged children at 2 years of age to 5. Examination of everyday behaviors further support ecological validity model, which complements performance, based controlled assessments of executive functions in preschool children. It is important to observe a child's behavior and manifestations of executive functions in multiple venues (home, school/daycare).

The *BRIEF-P* requires from the rater at least a fifth grade reading level and 10-15 minutes to complete. In addition, the rater should know the child well (i.e., at least 1 month). Raters are asked to determine the level of each item as to whether it is never, sometimes, or often a problem for the child (never=1, sometimes=2, and often=3). The scores are then compared with

normative values in tables for two age groups (2-3 year olds and 4-5 year olds) separated by gender. Indexes are calculated and referenced to normative data ( $t$  scores and percentiles) with 90% confidence intervals for scores and indexes. The *BRIEF-P* can be administered by technically trained individuals, but should be interpreted by appropriately trained professionals with assessment experience (Isquith et al., 2004; and Isquith et al., 2005).

*Additional materials.* A pre-selected, non-gendered collection of preschool-age toys were available for each child to play with before the administration of any tests, which included a doll, a train with tracks, building blocks, and coloring books with crayons. Secondary rewards (i.e., stickers, pencils, and stamps) were also available to encourage maximum effort throughout testing. For the children in the autism group, edible reinforcers were used based on each child's behavioral modification plan. All testing material was made into a packet for easy administration, scoring, and record keeping.

### *Procedures*

All materials placed in an isolated testing room at the selected testing site prior to each testing session. Two doctoral students trained in assessment from Northeastern University were recruited to assist in the testing administration at School 4 located in Southern Massachusetts. The doctoral students were trained on the testing protocol by the student principal investigator. Training included an explanation of each test and two practice administrations. The principal student investigator administered all testing protocols at Schools 1, 2, and 3.

The examiner saw all children individually and administered all testing measures to the participants. Testing sessions were coordinated with the child's teacher, each session taking about one hour, up to an hour and a half. At the appointed time the examiner told the child "Hello \_\_\_\_\_, it is time to go to another room. We are going to play some games". Prior to the

administration of the testing battery, each child was allowed to play with pre-selected toys to facilitate a comfortable environment for testing. All measures were administered in a distraction-free, empty classroom or conference room at the selected testing site. The entire test battery of executive functioning measures required two 1 to 1 and ½ hour sessions, using breaks when necessary. Social and edible reinforcers (i.e., stickers, stamps, pencils, food, etc...) were given to all participants between tests to encourage cooperation and motivation. Edible reinforcers were used when testing the children in the autism group in accordance with the individual child's behavior modification plan.

The children without autism was tested at the end of the school hallway in School 1 due to the limited room space. A testing table and materials were set up in the hallway before each testing session. Participants were testing in a distraction free conference room at 2. Identical procedures and materials were implemented, with the exception of edible reinforcers.

#### *Human Subject Approval*

The study received approval from the human subjects review board (IRB) at Northeastern University and formal district approval for the sample collected in Northern Delaware (District Approval Letter: Appendix H) for schools 1, 2, and 3, and verbal approval for school 4 in Southeastern Massachusetts. In addition, cover letters and informed consents were sent home to parents for the children in the autism group (Appendices C & D) and to parents for the children in the without autism group (Appendices E & F). The signed informed consents from the participants' legal guardians were collected and stored in a locked cabinet at Northeastern University. The principal student investigator followed the set of procedures provided by the dissertation and IRB committees at Northeastern University.

### *Research Design*

A non-experimental, descriptive research study design was used to examine executive functions in children with and without autism based on the five components of executive functioning. Executive functioning was measured in children with and without autism using research validated executive functioning instrumentation.

Age-based groups were created to measure age-based executive functioning performance. The autism group consisted of six 4-year olds, twelve 5-year olds, and eleven 6-year olds. The without autism group consisted of six 4-year olds, seven 5-year olds, and seventeen 6-year olds.

### *Planned Analyses*

All raw scores of the six dependent variables were converted to descriptive statistics (i.e., means and standard deviations) and then converted to  $z$  scores and  $t$  scores. Standard scores were converted based on the entire sample mean scores across EF variables. Standard scores were used to standardize scores across measures.

*Hypothesis one (Ho1):* Preschool age-children with autism will have lower performance scores on global executive functions measures (i.e., initiation/shifting set, inhibition, planning/organization, self-monitoring, and working memory) compared to preschoolers without autism. Ho1 was analyzed using a discriminant function analysis between groups. A discriminant function analysis was used to determine whether a group differs from another with regards to mean of the variables and then used the variables to predict group membership (e.g., autism group and without autism group). Within the discriminant function analysis, a Wilks' Lambda ( $\lambda$ ) was used in an ANOVA ( $F$ ) test of the mean differences. The smaller the  $\lambda$  score for an independent variable, the more that variable contributed to the discriminant function.  $\lambda$  scores

vary from 0 to 1, with 0 implicating the mean differs (thus the more the variable differentiates the groups), and 1 meaning all group means are the same.

*Hypothesis two (Ho2):* Preschoolers with autism will display more executive function deficits in the specific areas of inhibition, self-monitoring, initiation/shifting set, and planning/organizing compared to children without autism. Ho2 was similarly analyzed using a discriminant function analysis of standardized canonical coefficients to determine the weight of each variable contributed to the global executive functioning profile. Separate discriminant function analyses were used for each variable within the five executive functioning domains. Standardized beta coefficients were given for each variable in each discriminant (canonical) function, and the larger the standardized coefficient, the greater the contribution of the respective variable of the discrimination between groups.

*Hypothesis three (Ho3):* Children in the autism group will exhibit lower EF performance over age compared to the children in the without autism group. Ho3 was analyzed using a univariate analysis of variance *F* statistic to determine age-based performance differences between the groups. A univariate analysis was conducted for each executive functioning variable. The executive measures were the dependent variables and groups and age were the fixed factors.

A post hoc univariate analysis of variance was used to determine executive functioning performance when controlling for intelligence (*Leiter-R* IQ) and to identify the significance each executive functioning variable contributed to the overall profile. Three IQ groups were created (i.e., <70 IQ autism group, >70 IQ autism group, and without autism group) based on the participant's performance on the *Leiter-R*. The univariate analysis was conducted for each executive functioning variable. The executive measures were the dependent variables and IQ

groups were the fixed factors. A post hoc one-way ANOVA was also used to control for IQ to determine executive functioning differences separate from intelligence.

*Hypothesis four (Ho4):* The measurement of executive functioning abilities will be the same for elicited and ecologically valid instruments for both groups of children. Ho4 was analyzed using a Pearson  $r$  between-measurement types correlation analysis to compare performances across the five executive functioning domains (elicited EF domains vs. ecologically valid EF domains). The purpose of this analysis was to identify correlations in performance on two different types of instruments that claim to assess the same domain of executive functioning.

## CHAPTER FOUR

In this chapter a review of results will be presented. First, the sample demographic information will be outlined and discussed. The demographic information includes the students' ages in (years and months), gender, race, Intelligence Quotient (IQ), and diagnosis. Second, raw scores, means, standard deviations of the assessments are summarized. The third section presents the assessment scores, which include *t* scores and percentiles for all executive functioning measures. The final section presents the statistical analyses to address the research questions. All aforementioned tables will be displayed in the appendix section.

*Demographic Sample Information*

The 59 participants consisted of 29 from the autism group and 30 from the without autism group whom were gathered from four schools. Three schools were located in the Christina School District in Northern Delaware. The investigator contacted the school district's Accountability and Assessment Department and completed a Request to Conduct Research (Appendix G). Upon receiving the Research Approval (see Appendix H), the Accountability and Assessment Department selected the three participating schools in the Christina School District. The fourth school, an institute in southern Massachusetts, granted the investigator verbal research approval with documented Institutional Review Board (IRB) approval from Northeastern University.

The participants in the without autism group (WG) were gathered from two public elementary schools in Northern Delaware in urban Mid-Atlantic communities. These schools (Schools 1 and 2) provided half-day instruction to the targeted age group without an extended summer program. The classrooms consisted of a class size ranging from 10 to 30 students with a regular education teacher and at least one classroom aide. Of the 30 participants in the without

autism group, 11 (37%) attended morning pre-k and kindergarten sessions, while 19 (63%) attended the afternoon pre-k and kindergarten sessions.

The third school in Northern Delaware (School 3) is a public alternative school located in an urban Mid-Atlantic community. It offers comprehensive, research-validated services to children and adolescents with pervasive developmental disorders and other genetic and neurologic disorders. The institute has five preschool classrooms and two satellite locations, for higher functioning children diagnosed with ASD, which is staffed by qualified special education teachers, therapists, and specialists.

The fourth school (School 4) is a non-profit institute in Southern Massachusetts that is known for providing comprehensive, research-validated services to children and adults with autism, brain injury, mental retardation, pervasive developmental disorder (PDD), behavioral healthcare needs, and typically developing individuals. In addition, the institute has three preschool classrooms with several quiet rooms that are staffed by qualified special education teachers, therapists, and specialists. Schools 3 and 4 function on full day schedules with extended summer programs. The third and fourth schools offered full day curriculum and extended summer programs to address students' significant delays in development and the need for a continuous supportive educational environment. Furthermore, the classrooms in schools 3 and 4 consisted of a maximum of six students with a special education instructor and at least one classroom aide.

The recruitment procedures began with asking the principals and educational diagnosticians from each school to develop a student list that met criteria for the present study. Once the participant list was created, cover letters and two copies of the informed consent were sent home with each student in his or her backpack. Parents were asked to keep one copy of the

informed consent for their records and sign and return the second copy with their children to school if they chose to participate in the study. Figure 1 describes the number of parental consents sent and response rates for each group.

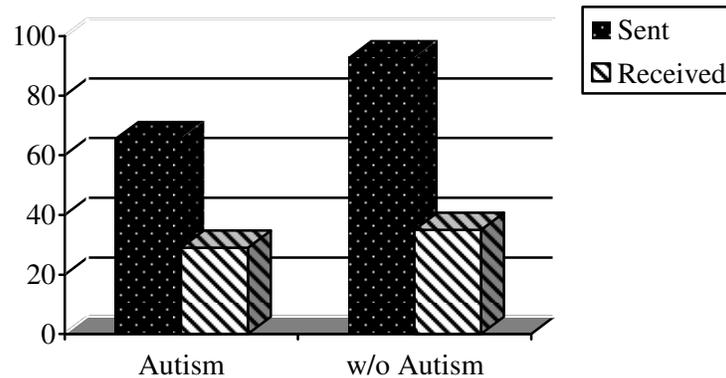


Figure 1. *Parental Consent Response Rate for Research*

The response rate was relatively similar across the two groups as noted in Figure 1. The autism group had a slightly higher response rate caused by two additional follow-up (see Appendix I) sent home to parents. Recruitment was more difficult for the autism group. For one, the population is significantly smaller compared to the without autism group. In addition, parents with children diagnosed with ASD may be more protective of their children and less likely to consent to their child's participation in a study that would remove the child from their structured school routine or increase their child's frustration in a testing environment. Twenty-nine participants in the autism group were eventually identified. The study targeted 30 participants from each group. Given the 35 responses, five eligible participants were excluded from the without autism group.

Demographic information regarding each group and the total sample including children's mean ages in years and months, gender, race, and diagnosis are presented in Table 1 (see

Appendix A). Of the total 59 participants, 41 (69%) were Caucasian, 8 (14%) were African American, 7 (12%) were Hispanic, 2 (3%) were Asian American and 1 (2%) was Pacific Island Indian.

Six participants were recruited in Southern Massachusetts. According to the 2000 United States Census information 75 percent of the population in this geographic area is Caucasian (United States Census Bureau, 2000). The remaining 23 participants were gathered from Northern Delaware: 35 (59%) Caucasian, 8 (14%) African American, 7 (12%) Hispanic, 2 (3%) Asian American, and 1 (2%) Pacific Islander. The United States Census Bureau information from 2000 indicated the general population in this geographic area was as follows: 87% Caucasian, 6% African American, 4% Asian American, 2.5% Hispanic, and 0% Pacific Islander (United States Census Bureau, 2000). As a result, the study sample appeared to be somewhat more representative of minority populations even though the majority of the sample was Caucasian.

In the total sample, a total of 36 (61%) boys and 23 (39%) girls ranging in age from 4 years, 0 months to 6 years, 11 months, with a mean age of 5 years, 9 months ( $SD = 9.34$ ). Age was evenly distributed across groups with a mean age in the autism group at 5 years, 8 months and a mean age in the without autism group of 5 years, 9 months.

The autism group included disproportionate amounts of boys 25 (86%) compared to girls 4 (14%). One would expect this uneven gender ratio in a group of individuals with ASD. According to the DSM-IV-TR, prevalence rates of Autistic Disorder and Pervasive Developmental Disorder – Not Otherwise Specified are four to five times higher in males than in females (American Psychiatric Association, 2000).

Of the total 29 participants in the autism group, 19 (66%) participants were diagnosed with Pervasive Developmental Disorder – Not Otherwise Specified (PDD-NOS) and 10 (34%) participants were diagnosed with Autistic Disorder. Three likely reasons why the majority of participants in the autism group carried a diagnosis of PDD-NOS at the preschool age are as follows: (1) professionals are in most cases just beginning to gather behavioral and diagnostic information on these children at this age and may be hesitant to assign a more socially stigmatizing condition such as Autistic Disorder or Asperger’s Disorder; (2) some preschool age children may not meet the diagnostic criteria for Autistic Disorder as some symptoms do not become clearly observable until later in the developmental lifespan; and (3) diagnosticians may not have enough clinical information to accurately diagnose Autistic Disorder.

The autism group included four participants who were completely non-verbal, but were able to use non-verbal communication by pointing, labeling, and identification. Eight autism group participants had limited verbal communication abilities, but these children generally had improved labeling, pointing, and identification skills. The *Leiter-R* IQ test did not require a verbal instructions or responses. The executive functioning tests included verbal instructions, but included non-verbal responses for the non-verbal participants.

#### *Summary of Data Collection for the Without Autism Group*

The without autism group data were collected from two public elementary schools (School 1 and School 2) in Northern Delaware. Seven participants were gathered from the School 1 from three different classrooms. The students were tested based on the order of returned informed consents. All testing administration and scoring for the without autism group was completed by the principal student investigator. The examiner administered all testing in either an isolated conference room or in an empty classroom to reduce distractions.

The remainder of the children from the without autism group sample (23 participants) were gathered at the second school and from three classrooms. All tests were administered at the end of a school hallway due to limited office and classroom space.

All children appeared to maintain focus and ignored mild distractions as evident by no breaks being needed during testing even when offered by the examiner. They were motivated by rewards such as pencils, stickers, stamps, and other small toys by responding positively towards the rewards (e.g., smiling, displaying excitement, and showing their rewards to their teachers and peers).

The *BRIEF-P*, an observational rating scale was distributed to each of the participant's primary teachers after the assessment protocol was administered to each participant. The *BRIEF-P* was collected by the examiner upon the teacher's completion usually one or two days after distributed. The examiner was responsible for following up with each teacher to collect the *BRIEF-P*.

#### *Summary of Data Collection for the Autism Group*

The autism group data were collected from two schools (Schools 3 and 4). Students were tested based on the order of returned informed consents. School 3, a public inclusive school located in Northern Delaware, included 23 participants. All participants were testing during the extended summer program. Participants were recruited from six classrooms and from two remote summer programs affiliated with the school. All testing was conducted by the principal student investigator and occurred in a distraction free office or conference room setting. Participants were escorted by the examiner to the testing area.

Six participants were gathered at School 4, a non-profit school located in Southeastern Massachusetts, and recruited from two classrooms. All testing sessions were conducted in a

testing room that consisted of a testing table, two chairs, and free-play toys. Participants were allowed to play with non-testing toys to adjust to the testing environment. Two doctoral students from Northeastern University administered the battery of tests to all participants in School 4, accounting for 20 percent of the autism group. They were recruited to assist in testing administration and were trained by the principal student investigator.

Generally, participants in the autism group required increasingly more redirection, adaptable motivational tools (i.e., implementation of individual reward systems in place in the classroom), and a greater number of testing breaks. The examiner would offer a break to a child who appeared to be unable to maintain his or her attention or when a child's behaviors would become unmanageable in the testing environment. Breaks included taking a walk around the school or playing with non-testing toys, which was effective in many cases. However, for those participants who continued to present difficulties in the testing environment after a small break, the examiner would escort the child back to the classroom and complete the testing at a later date. The *BRIEF-P* was distributed to each of the participant's primary teachers or classroom aides after the full administration of the testing battery. The *BRIEF-P* was collected by the examiner upon the teacher's completion of the inventory usually within one to two days of distribution.

#### *Summary of the Leiter-R Intelligence Quotient Data*

The brief IQ battery consists of four subtests ranging in total completion time from 30 to 45 minutes. Table 2 and 3 (see Appendix A) presents the autism group and without autism group participants' age in months, gender, *Leiter-R* subtest scaled scores, Intelligence Quotients, percentile scores, and the means and standard deviations by group. Figure 2 presents Brief Full Scale IQ scores from the *Leiter-R* by age and group.

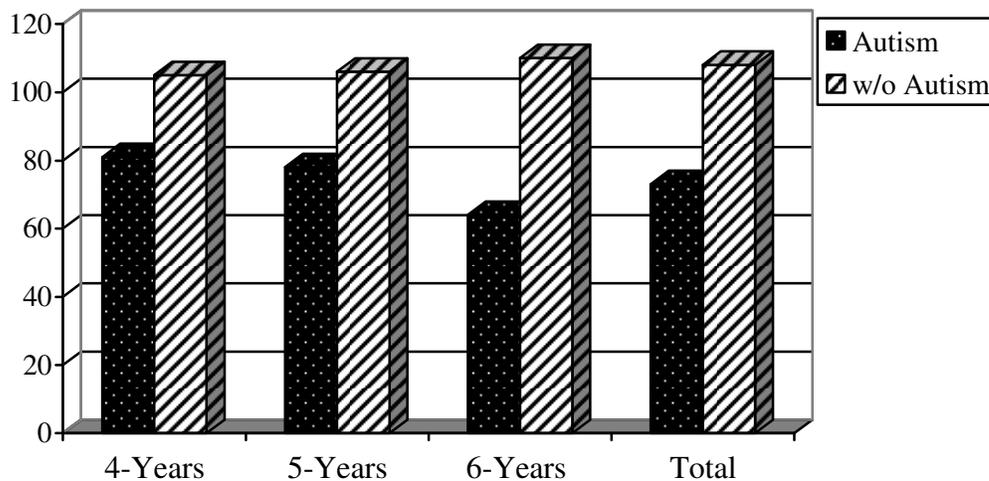


Figure 2. *Leiter-R Full Scale IQ by Age and Group.*

The mean score of the *Leiter-R* is 100 with a standard deviation of 10. As expected the participants in the autism group had lower IQ scores (IQ AG Mean = 73.4, SD = 21.1) compared to the same-aged participants without a diagnosis of autism or PDD-NOS (IQ WG Mean = 108, SD = 12.8). The autism group was over two and a half standard deviations below the standardized mean. The without autism group was almost one standard deviation above the standardized mean. An explanation for the difference in IQ scores is that children diagnosed with autism and PDD-NOS typically have lower mean IQ scores on standardized assessments compared to the general population. In addition, 3 out of 4 individuals diagnosed with PDD-NOS or Autistic Disorder are also dually diagnosed with Mental Retardation – individuals with an IQ score under 70 (American Psychiatric Association, 2000). The autism group in the present study consisted of 14 (48%) participants with an IQ score below 70, while 15 (52%) of the participants had IQ score above 70. The autism group represented a lower prevalence of mental retardation compared to the general population of individuals diagnosed with autism.

Across age, the participants in the autism group displayed lower scores on the *Leiter-R* (Figure 2) (i.e., 4-years olds:  $M = 81$ , 5-year olds:  $M = 78$ , and 6-year olds:  $M = 73$ ). In contrast, the children without autism exhibited stable IQ scores over age. There are two potential explanations for this phenomenon: (1) the selected sample of older children with autism had lower IQ than their younger counterparts, or (2) the children with autism in this sample had a regression in IQ scores over age. It is possible that young children with autism can display a regression in IQ over age due to their pervasive developmental delays compared to typically developing young children.

#### *Results of Executive Functioning*

All participants were administered an executive functioning battery of tests, which consisted of the *Dimensional Card Change Test (DCCS)*, *Day-Night* test, *Noisy Book*, *Tower of Hanoi-R*, and the *Self-Control* task. The executive functioning battery of tests ranged in total completion time from 30 to 45 minutes for both groups. All raw scores on the executive functioning measures were converted to  $z$  scores and then converted to  $t$  scores.  $t$  scores have a mean score of 50 with standard deviations of 10. Table 4 (see Appendix A) presents the values for the children in the autism group in terms of age in months, gender,  $t$  scores for the *Dimensional Card Change Test (DCCS)*, *Day-Night Test*, and the means and standard deviations by group. The *DCCS* consists of three conditions with a pre and post trial within each condition. Table 4 also presents  $t$  scores for each pre and post trial in each condition for the *DCCS*.

The autism group's mean scores and standard deviations on the *Day-Night* test and *DCCS* were as follows: *Day-Night* 46.4 (10.7); *DCCS Condition A Pre Switch* 45.1 (12.8); *DCCS Condition A Post Switch* 42.9 (9.0); *DCCS Condition B Pre Switch* 46.3 (12.3); *DCCS Condition B Post Switch* 42.7 (8.5); *DCCS Condition C Pre Switch* 47.1 (12.6); and *DCCS*

*Condition C Post Switch* 46.3 (10.9). The children in the autism group were generally below average on the *Day-Night* and on all conditions of the *DCCS*, which was similar to their overall below average IQ.

The without autism group's mean scores and standard deviations on the *Day-Night* test and *DCCS* were as follows: *Day-Night* 53.4 (8.7); *DCCS Condition A Pre Switch* 55.0 (0.0); *DCCS Condition A Post Switch* 56.5 (5.8); *DCCS Condition B Pre Switch* 53.7 (5.9); *DCCS Condition B Post Switch* 56.6 (5.0); *DCCS Condition C Pre Switch* 52.9 (4.7); and *Condition C Post Switch* 52.6 (6.8). The without autism group scores were above average (mean scores above 50) on the *Day-Night* test and on all conditions of the *DCCS*. Their scores were commensurate with the group's overall above average IQ on the *Leiter-R*.

Table 5 (see Appendix A) presents the without autism group age in months, gender, *t* scores for the Dimensional Card Change Test (*DCCS*), *Day-Night* test, and the means and standard deviations by age group. The *DCCS* consists of three conditions with a pre and post trial within each condition. Table 5 presents *t* scores for each pre and post trial in each condition.

The autism group's mean scores all fell below the mean and were significantly lower compared to the without autism group on all measures of inhibition (i.e., *Day-Night* test) and shifting set (*DCCS*). A comparison of group mean scores indicate that the without autism group were .5 standard deviations above the autism group on the *Day-Night* test, and on the *DCCS Condition B Pre-Switch*, *Condition C* both *Pre* and *Post-Switch* trials, 1 standard deviation above on the *DCCS Condition A Pre-Switch*, and 1.5 standard deviations above the mean on the *DCCS Condition A Post-Switch* and *Condition B Post-Switch* trials. The gap in mean scores indicate the autism group had more difficulty with tasks requiring inhibition and shifting cognitive set when compared to the without autism group.

Table 6 (see Appendix A) presents the autism group's age in months, gender, *t* scores for the *Noisy Book*, *Self-Control* task, the *Tower of Hanoi-R*, and the means and standard deviations. The *Noisy Book* assesses working memory and consists of a working memory span score and a total items correct score. The *Self-Control* task consists of two trials (A & B). Table 6 presents *t* scores for the *Noisy Book* span and total score and trials A and B on the *Self-Control* task.

The mean scores and standard deviations for the autism group on the *Noisy Book* test, *Self-Control* task, and the *Tower of Hanoi-Revised* are as follows: *Noisy Book Span* 43.6 (8.8); *Noisy Book Total* 43.3 (7.4); *Self-Control Trial A* 46.2 (11.9); *Self-Control Trial B* 40.1 (5.1); and the *Tower of Hanoi-Revised* 43.7 (3.0). With a mean score of 50, all of the autism group's overall scores on the measures included in Table 6 were below average.

Table 7 (see Appendix A) presents the without autism group's age in months, gender, *t* scores for the *Noisy Book*, *Self-Control* task, the *Tower of Hanoi-R*, and the means and standard deviations. The mean scores and standard deviations for the without autism group on the *Noisy Book* test, *Self-Control* task, and the *Tower of Hanoi-Revised* were as follows: *Noisy Book span* 54.9 (8.3); *Noisy Book total* 56.2 (7.8); *Self-Control Trial A* 55.6 (2.2); *Self-Control Trial B* 58.0 (3.9); and the *Tower of Hanoi-Revised* 56.7 (9.7). All of the without autism group's mean scores were above the mean were proportionate with their general intellectual abilities.

All the mean scores across measures for the without autism group were above the mean average ( $M = 50$ ). The autism group was below the mean on all measures and separated by at least one standard deviation when compared to the without autism group. A comparison of mean scores indicates the autism group had more difficulty with tasks of working memory, self-control, and planning/organization.

### *Results of BRIEF-P*

The *BRIEF-P* is a behavioral rating scale that assesses children's executive functioning. For the purposes of this study, the teacher rating form was used for all participants. A total of 20 teachers completed the *BRIEF-P*; 6 teachers for the without autism group and 14 for the autism group. All teachers participating in the study knew the participants for at least four months at the time of assessment, with the mean length of time as 10 months. The *BRIEF-P* protocols were delivered to the teachers by the examiner and were collected by the examiner usually within 1 to 2 days of distribution. The *BRIEF-P* is normed for children between the ages of two years to five years, eleven months. For the purposes of this study the norms have been adapted to assess participants between four years, zero months to six years, eleven months. The adapted norms were used only with the children that were six years old. For these children, the five year old norms were used. The limitations of attenuation are discussed in chapter five. Table 8 (see Appendix A) presents the results for the children in the autism group in terms of age in months, gender, and *t* scores for the *BRIEF-P* clinical scales: *Inhibit*; *Shift*; *Emotional Control*; *Working Memory*; *Plan/Organize*; and the *Global Executive Composite*. Table 9 (see Appendix A) also includes the autism group's mean scores and standard deviations of the *BRIEF-P* scales and composite scores. *BRIEF-P* *t* scores have a mean of 50 and a standard deviation of 10. For all *BRIEF-P* clinical scales and indexes, *t* scores equal to 65 to 69 are considered "Borderline Clinically Significant", while *t* scores equal to 70 or higher are considered "Clinical Significant" (Gioia, et. al., 2003).

The *BRIEF-P* mean scores and standard deviations for the autism group ( $n = 29$ ) are as follows: *Inhibit* 65.0 (10.0); *Shift* 64.8 (11.7); *Emotional Control* 63.2 (10.7); *Working Memory* 68.9 (12.4); *Plan/Organize* 69.3 (13.6); and *Global Executive Composite* 69.4 (10.2). All scores

for the autism group were in the clinically significant range indicating that the autism group had global difficulties with executive functioning compared to the population on which the BRIEF-P was normed.

The *BRIEF-P* mean scores for the without autism group (N=30) were as follows: *Inhibit* 44.7 (4.8); *Shift* 42.8 (3.9); *Emotional Control* 43.2 (4.1); *Working Memory* 45.6 (5.8); *Plan/Organize* 42.5 (3.0); *Global Executive Composite* 40.7 (3.9). Table 9 (refer to the appendix) presents the results for the children in the without autism group in terms of age in months, gender, and *t* scores for the *BRIEF-P* clinical scales: *Inhibit*; *Shift*; *Emotional Control*; *Working Memory*; *Plan/Organize*; and the *Global Executive Composite*. Table 10 also includes the without autism group's mean scores and standard deviations of the *BRIEF-P* scales and composite scores.

All scores across variables for the without autism group were more than two standard deviations below clinical significance for executive functioning deficits. In addition, the autism group had mean index scores and composite scores two standard deviations above the same-aged children in the without autism group scores, which indicated the teachers of the autism group reported a greater level of difficulty in executive functioning skills across domains compared to the reports from the teachers of the children in the without autism group. Of important note, the Global Composite mean score was five times higher in the autism group (89.3) compared to the without autism group (40.7).

#### *Testing the Hypotheses of the Study*

*Hypothesis one: Preschool age-children with autism will display lower performance scores in global executive functions measures (i.e., initiation/shifting set, inhibition,*

*planning/organization, self-monitoring, and working memory) compared to preschoolers without autism.*

To test Hypothesis one and evaluate the level of executive functioning in participants with autism compared to same-aged participants without autism, a discriminant function analysis was used. A discriminant function analysis is used to determine whether existing groups can be identified with a set of variables. Part of the analysis provides an assessment of the accuracy of predicting group membership (i.e., autism group or without autism group) using the set of executive functioning variables. The function analysis compared global executive functioning performances by including all executive functioning variables across groups (group with autism vs. group without autism). Table 10 presents the tests of equality of group means with Wilks' Lambda ( $\lambda$ ),  $F$ , and significance level.

All variables across executive functioning tests in comparing the two groups of children were found to be significant (i.e.,  $p < .05$ ). The autism group and the without autism group exhibited statistically significant differences between groups as evident by the mean of the variables' significance level. A  $\lambda$  analysis was used to determine global group independence.  $\lambda$  is used in an ANOVA ( $F$ ) test of mean differences in discriminant analysis, such that the smaller the  $\lambda$  for an independent variable, the more that variable contributes to the discriminant function.  $\lambda$  varies from 0 to 1, with 0 implicating that the group means differ, which suggests the more the variable differentiates the groups; a value of 1 means all group means are the same. Figure 3 presents the  $\lambda$  analysis for each executive functioning variable.

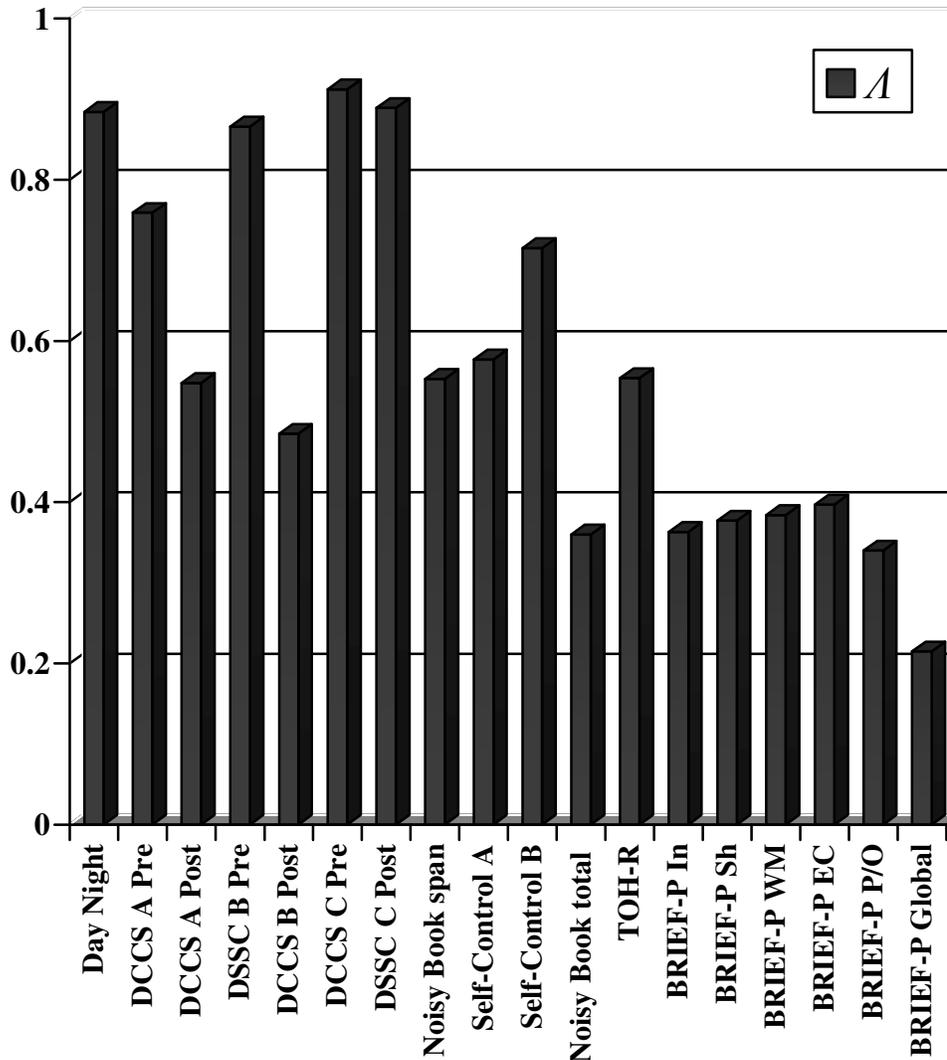


Figure 3. Wilk's Lambda ( $\lambda$ ) Analysis of Executive Functioning Variables

Figure 3 indicates statistical significance overall Wilk's Lambda ( $\lambda$ ) suggesting that the two groups were identified by the scores on executive functioning battery of variables. The group means are statistically significant, and accordingly, are a reliable predictor of group membership using the study sample. In other words, the autism group and without autism group are significantly independent from each other using all executive functioning variables. The

group independence is great enough to use the executive functioning battery of variables to assign group membership. The global  $\Lambda$  analysis produced a global  $\Lambda = .074$ , with a  $\chi^2 = 125.206$ , and the  $p$  was  $< .001$ .

*Hypothesis two: Preschoolers with autism will display lower executive function performance in the specific domains of inhibition, self-monitoring, initiation/shifting set, and planning/organizing compared to children without autism.*

To test Hypothesis two, five separate discriminant analyses were used for each of the executive functioning domains. The purpose of these five analyses was to group the executive variables by domains to establish an executive functioning profile for the autism group compared to the without autism group. Executive functioning variables were categorized and placed into one of the five discriminant analysis based on the domain to which it belonged. The variables for the analysis of inhibition were: *Day-Night* test and *the BRIEF-P: Inhibition*. The variables for the analysis of shifting were: *DCCS Condition A Pre-Switch*, *DCCS Condition A Post-Switch*, *DCCS Condition B Pre-Switch*, *DCCS Condition B Post-Switch*, *DCCS Condition C Pre-Switch*, *DCCS Condition C Post-Switch*, and *BRIEF-P: Shift*. The variables for the analysis of working memory were: *Noisy Book* span score, *Noisy Book* total score, and *BRIEF-P: Working Memory*. The variables for the analysis of self-monitoring analysis were: *Self-Control* Trial A, *Self-Control* Trial B, and *BRIEF-P: Emotional Control*. The variables for the analysis of planning/organization were: *Tower of Hanoi-Revised* and *BRIEF-P: Plan/Organize*.

Discriminant functions are interpreted by mean differences of the variables between groups. The closer the  $\Lambda$  score is to zero the greater statistical difference exists between the autism and without autism group. Figure 4 presents the five discriminant analyses  $\Lambda$  scores.

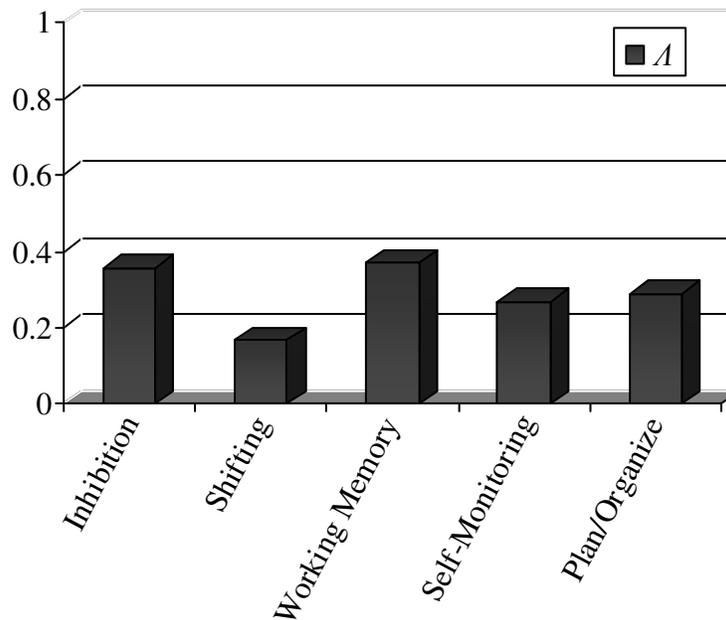


Figure 4. *Discriminant Function Analyses of Executive Functioning Domains*  
 Note: The ordinate axis represents  $\lambda$ .

In sum, all five discriminant analyses used to measure each executive functioning domain were found to demonstrate that the two groups were statistically different. The statistically significant difference between groups within each analysis indicates a reliable assignment of group membership across each executive functioning domain. An overview of the  $\lambda$  test of significance across executive functioning domains is presented in Table 11 (refer to the appendix section).

Of the five domains, shifting set had the lowest  $\lambda$  score followed by self-monitoring, planning/organization, inhibition, and working memory. One reason for the notably lower  $\lambda$  (meaning the largest difference between groups) score for Shifting Set is it had the largest number of variables (7) that contributed to its domain. However, all other executive functioning domains had low  $\lambda$  scores indicating group independence across domains.

*Hypothesis three: The interaction between measures and age will fit a different trend line for children with autism compared to children without autism.*

Hypothesis three was analyzed using a general linear model, univariate analysis of variance to determine age differences between the autism group and the without autism group. A univariate analysis was used to explore each variable in the data set, separately. It looked at the central tendency of the values and the range of the values. The executive functioning measure was the dependent variable, and group (e.g., autism group and without autism group) and age (e.g., 4 year-olds, 5 year-olds, and 6 year-olds) were the fixed factors. In addition, a post hoc univariate analysis of variance was used to determine the effect IQ scores had on executive functioning performance. Tables 12, 13 and 14 (see Appendix A) present the means and standard deviations for each executive functioning variable across age groups.

An overall age-based mean score comparison signified the 4 year olds with autism had a mean score of 43.9 on the *Noisy Book*, *Self-Control* and the *Tower of Hanoi-R* tests, while 4-years old without autism had a mean score of 51.2. On the same measures, the 5 year old age group with autism had a mean score of 43.3 and the without autism group had a mean score of 55.7. The mean score of the 6 year olds with autism was 43.5 and for the without autism was 58.8. The results from the *Noisy Book*, *Self-Control*, and the *Tower of Hanoi-R* age performance indicated the participants with autism did not exhibit performance improvement over age. On the other hand, the without autism group displayed steady improvement mean score over age. The age performance difference was most notable in the 5 and 6 year old age groups as the without autism group performed more than one standard deviation above their same-aged peers diagnosed with autism.

Table 14 (see Appendix A) presents the participants' *BRIEF-P* means *t* scores and standard deviations across age and between groups. The *t* scores are positively skewed in the *BRIEF-P*, which is different than the other executive functioning variables. The *BRIEF-P* has a mean of 50 and standard deviation of 10, which is the same as the other executive functioning variables. However, scores above the mean on the *BRIEF-P* are considered to indicate more executive functioning impairments. A *BRIEF-P t* score between 65 and 69 is considered "Borderline Clinically Significant", while *t* scores of 70 or higher are interpreted as "Clinically Significant". In Contrast, the elicited executive functioning *t* scores above 50 are considered above average in performance and *t* scores below 50 are considered below average.

An overall age-based mean score comparison signified the 4 year olds with autism had a mean score of 64.7 on the *BRIEF-P* index scores and global composite score while the without autism 4 year olds had a mean score of 45.1, which represents almost two standard deviations' of difference. On the same measures, the 5 year old age group with autism had a mean score of 65.6 and the without autism group had a mean score of 42.3, over two standard deviations difference. The mean score of the 6 year olds with autism was 69.2, and for the without autism group was 43, which represents over two and a half standard deviations separation between groups. The results from the *BRIEF-P* age performance indicated the participants with autism had increased difficulties with tasks of executive functioning over age. On the other hand, the without autism group had constant scores and remained in the non-clinically significant range. In sum, the age performance mean differences between groups increased over age.

In Tables 12, 13, and 14 (see Appendix A); there were striking differences when comparing mean scores between age and group on the majority of executive functioning variables. On 10 of the 18 executive functioning variables, the without autism group had

improved mean scores across age, while scores remained constant or varied slightly on 8 variables. On the other hand, the autism group did not display any score improvements on any variables over age, although they exhibited slightly varied scores across age subgroups on 14 of 18 variables. On 4 variables, the autism group's performance declined over age. In sum, the without autism group's mean performance across age generally improved while the autism group's mean performance across age generally remained static or declined.

Table 15 (see Appendix A) outlines the univariate analysis of variance by describing the tests of between subject effects for age and age + group. The between subject effects include the  $M^2$ ,  $F$  statistic, and the  $p$  level. Figure 5 presents the  $p$  level of the univariate analysis when using an age only analysis and an age + group analysis. An executive functioning variable is notable for statistical significance between groups when the  $p$  level is  $< .05$ .

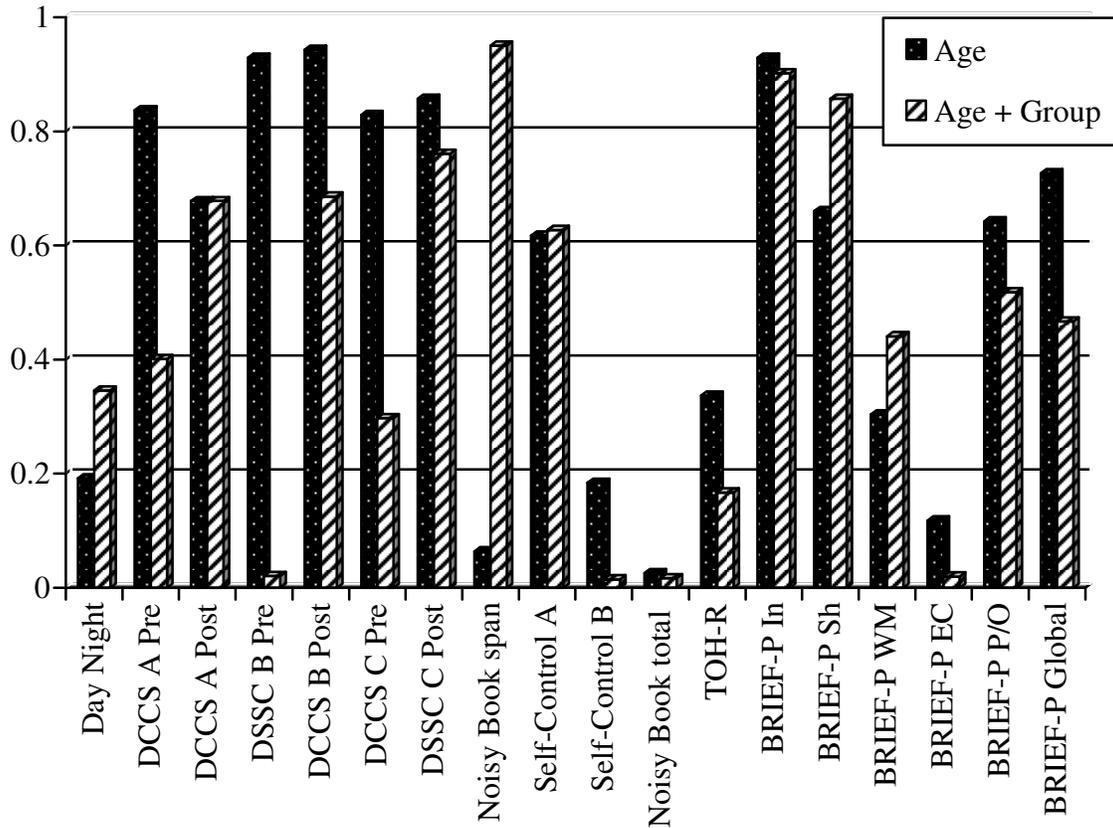


Figure 5. Univariate Age and Age + Group Analysis  $p$  levels for each Executive Functioning Variable.

Hypothesis three examined the relationship across age and between the groups at the same age (4 year-olds, 5 year-olds, and 6 year-olds) between groups (autism group and without autism group). The purpose of this between group analysis was to determine which executive functioning variables improved over age (i.e., did performances improve as age increased?) and was there a statistical significance between groups in each age categories (i.e., did 4 year-olds without autism perform better than 4 year-olds with autism?, and the same for 5 and 6 year-olds).

Age-based differences were observed only ( $p$  level  $< .05$ ) in the *Noisy Book* total score variable. On all other variables there were no significant age-based differences in performance.

The results indicated that the children improved globally over age on one elicited task (*Noisy Book* total score) of working memory. Furthermore, the participants improved their total score, not their working memory span score on the *Noisy Book*. The finding that only one variable demonstrated age-based difference was to be expected when analyzing age differences isolated from group differences. The children in the autism group had been diagnosed with significant developmental disorders, typically slowing or delaying their developmental progression compared to the children who have not been diagnosed with developmental disorders. Therefore, it was not expected for the participants in the autism group to exhibit significant age-based improvements compared to the participants in the without autism group.

Age + group differences were observed in four variables: *DSCT Condition A Post-Switch*, *Noisy Book* span score, *Noisy Book* total score, and *Tower of Hanoi-R*. The findings revealed statistically significant differences when factoring age-based scores between groups. In other words, the participants in the without autism group had better scores on the four measures across age compared to the participants with autism. However, for the majority of the variables including all of the *BRIEF-P* indexes, there were no significant differences across age and group. The univariate analysis of variance in Figure 5 did not identify statistically significant differences on all of the variables. The findings in Figure 5 were surprising because there was observed mean score differences were observed across age and group noted in Tables 12, 13, and 14 (see Appendix A). Furthermore, the mean score differences between groups consisted of several standard deviations of separation on several measures, which included the index scores and composite scores on the *BRIEF-P*. One explanation for this result is that the mean differences between groups reported in Figure 5 were so significantly different between the two groups on several of the executive functioning variables exclusive of considering age as a

variable. The between group differences on the *BRIEF-P* and *DCCS Post-Switch* trials A and B may have been so dramatic that an age effects was not found on these variables. Future studies will likely require a larger sample size to elicit a statistically significant effect of age-based differences between groups.

#### *Post Hoc Analysis*

A post hoc general linear model, univariate analysis of variance was used to determine differences in EF performance based on IQ scores. A IQ group variable was used to form three groups: subjects from the autism group with IQ scores under 70; subjects from the autism group with IQ above 70; and the without autism group. A univariate analysis was conducted for each executive functioning variable. The executive functioning measure was the dependent variable and IQ score represented the fixed factor. Table 16 (see Appendix A) includes mean scores and standard deviations for three groups. The mean IQ scores for the below 70 autism group was 55.8, the above 70 autism group was 87.8, and the without autism group was 108.3.

An increased mean score trend was noted from Table 16 (see Appendix A) in the executive functioning mean score comparisons across IQ groups. Participants with higher IQ scores generally displayed increased performance on executive functioning measures. The < 70 IQ autism group performed lowest on 11 of the 12 elicited executive functioning variables, with the exception of the *DCCS Condition A Post* variable. In the same vein, teachers rated higher levels of difficulties in tasks of executive functioning in the children with < 70 IQ autism group. However, the participants in the > 70 IQ autism group displayed lower performance on executive functioning measures and were rated higher for executive functioning difficulties by their teachers compared to the participants in the without autism group.

Table 17 (see Appendix A) presents the post hoc univariate analysis of variance by describing the tests of between subject effects for IQ groups (i.e., <70 IQ autism group, >70 IQ autism group, without autism group). The between subject effects include the  $M^2$ ,  $F$  statistic, and the  $p$  level. Figure 6 outlines the  $F$  statistic that indicated the level each executive functioning variable contributed to IQ group differences. The higher the  $F$  value the greater the variable contributed to IQ group differences. All variables had a  $p$  level < .02.

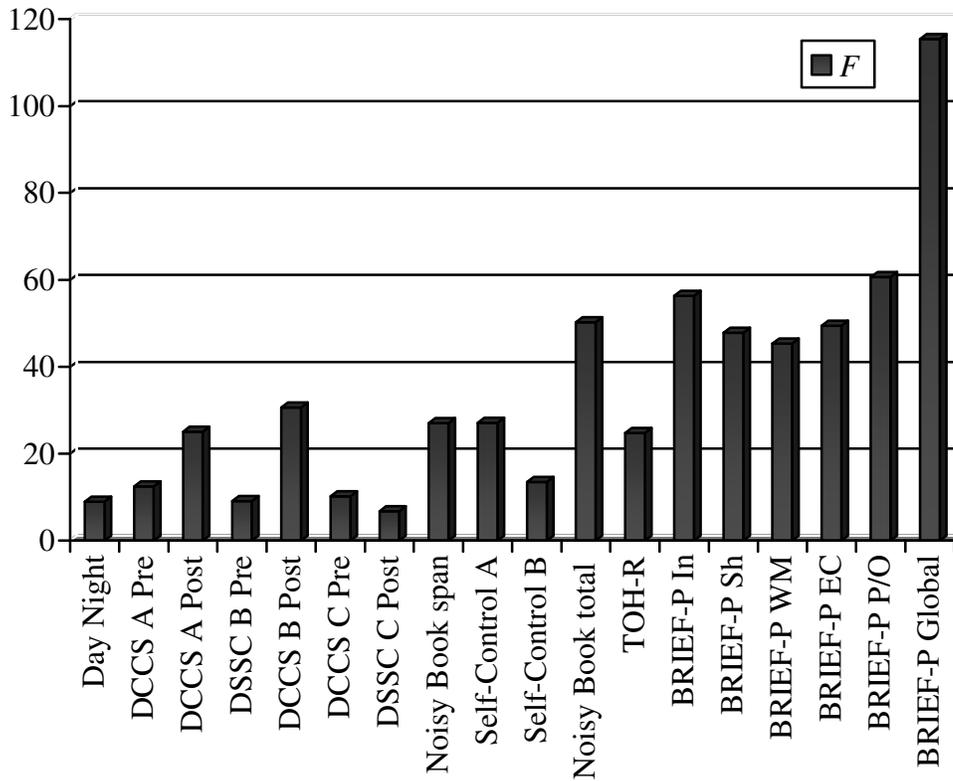


Figure 6. Univariate IQ Group Analysis F Statistic

The post hoc univariate IQ group analysis examined the relationship between IQ and executive functioning performance. The findings of the present study found that executive

functioning performance improved with higher intelligence scores on the *Leiter-R* and higher intelligence was a reliable indicator of improved executive functioning between the three IQ groups.

Additionally, a post hoc one-way ANOVA was used to control for intelligence by using the *Leiter-R* Full Scale IQ variable as a fixed factor with all executive functioning measures as the dependent variables. The purpose of this analysis was to determine which executive functioning variables were significantly affected by intelligence across the entire sample. Table 18 (refer to the appendix section) presents results from the one-way ANOVA including  $M^2$ ,  $F$ , and  $p$  level. Figure 7 presents the  $p$  level for the one-way ANOVA for all of the executive functioning variables. An executive functioning variable with a  $p$  level  $\leq .05$  indicated that intelligence (*Leiter-R* IQ variable) statistically impacted participants' performance across the sample.

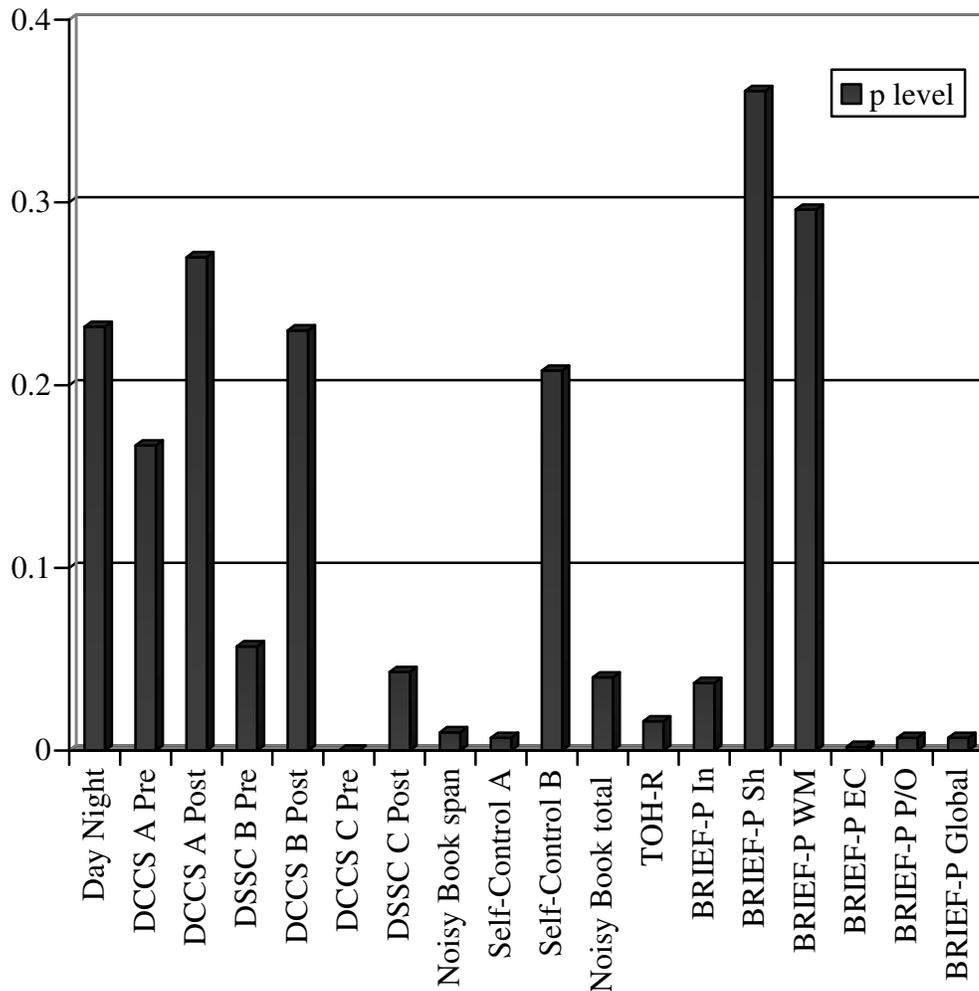


Figure 7. One-Way ANOVA of IQ and Executive Functioning Performance

The results of the post hoc one-way ANOVA found 11 out of the 18 executive functioning variables to be statistically significant when co-varied with intelligence. These variables were: *BRIEF-P Inhibition* (.037); *DCCS Condition B Post-Switch* (.023); *DCCS Condition C Pre-Switch* (.000); *DCCS Condition C Post-Switch* (.043); *Noisy Book span score* (.010); *Noisy Book total score* (.007); *Self-Control Trial B* (.040); *Tower of Hanoi-R* (.016); *BRIEF-P Working Memory* (.002); *BRIEF-P Plan/Organize* (.007); and *BRIEF-P Global Index*

(.007). Individuals with higher *Leiter-R* IQ scores displayed enhanced performance on these 11 executive functioning variables. In particular, the executive domains of working memory and planning/organization were significantly impacted by IQ across variables. The results suggested that individuals with higher IQ scores have an increased capacity to complete tasks of working memory and planning/organization successfully.

*Hypothesis four: The measurement of executive functioning abilities will be the same for elicited and ecologically valid instruments for both groups of children.*

Hypothesis four was analyzed using a between-group bivariate Pearson Correlation analysis to compare performances on elicited tests versus an ecologically valid test (i.e., *BRIEF-P*) across the five executive functioning domains. The purpose of this analysis was to identify correlations in performance on two different types of instruments that claim to assess the same domains of executive functioning. In the correlation analysis five comparisons were made according to the five domains of executive functioning. The test comparisons were as follows: *Day-Night* test vs. *BRIEF-P* Inhibition; *Dimensional Card Change Test* vs. *BRIEF-P* Shift; *Noisy Book* vs. *BRIEF-P* Working Memory; *Self-Control* task vs. *BRIEF-P* Emotional Control; and the *Tower of Hanoi-Revised* vs. *BRIEF-P* Plan/Organize. The Pearson's  $r$  ( $r^2$ ) statistic has a range between +1 and -1. Scores closer to +1 and -1 are considered to have stronger relationships while a score of 0 is considered to have no relationship. Table 19 (see Appendix A) summarizes the bivariate correlation analysis including the  $r^2$  score and the  $p$  level (2 tailed). A negative correlation was expected for all comparison because the *BRIEF-P*  $t$  scores have been positively skewed when normed compared to normally calculated  $t$  scores for all of the elicited instruments variables. Figure 8 presents the  $r^2$  analysis of executive functioning performance for the entire sample across domains. Figure 8 presents the  $r^2$  correlation analysis

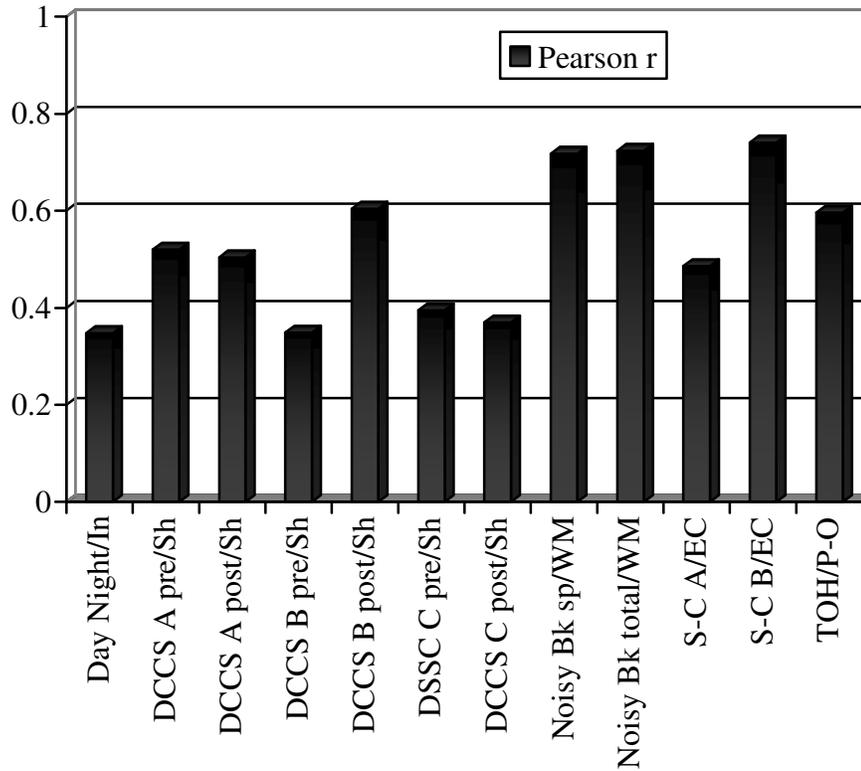


Figure 8. *Performance Pearson r Correlation Analysis across Executive Functioning Domains*

*Note: Day Night/In = Inhibition Domain; DCCS All Conditions/Sh = Shifting Domain, Noisy Book/WM = Working Memory Domain; S-C A & B/EC = Self-Monitoring Domain; and TOH/P-O = Plan/Organize Domain.*

The correlation analysis revealed a significance level less than .05 for all correlations between executive functioning domains indicating a statistically significant relationship between variables for each executive functioning domain. As a result, the hypothesis four can be accepted as there is a significant relationship between elicited tests and the subscales of the *BRIEF-P* across domains. Using the critical values of the Pearson Product-Moment correlation coefficient,  $r^2$  of +/- .273 or higher, was used to determine statistically significant relationships. The critical

value is determined by the degrees of freedom within the analysis, which in this study is 57 ( $df = n-2$ ) and the  $p$  level, which was set at .05. Using this formula, one can say with certainty that 95 out of 100 times the relationship that was found using the 59 participants in this study exists in the population from which they were drawn. If the correlation coefficient is above .273 hypothesis four can be accepted. In turn, we can accepting the alternative hypothesis that a statistical relationship exists between the two variables.

An examination of the  $r^2$  indicated statistically significant relationships between and among all variables examined. The strongest relationship between the *BRIEF-P* and elicited executive functioning variables was *Self-Control* trial B ( $r^2 = -.741$ ), followed by: *Noisy Book* total score ( $r^2 = -.724$ ); *Noisy Book* span score ( $r^2 = -.718$ ); *DCCS Condition B Post-Switch* ( $r^2 = -.604$ ); *Tower of Hanoi-R* ( $r^2 = -.596$ ); *DCCS Condition A Pre-Switch* ( $r = -.520$ ); *DCCS Condition A Post Switch* ( $r^2 = -.504$ ); *Self-Control* trial A ( $r^2 = -.486$ ); *DCCS Condition C Pre-Switch* ( $r^2 = -.395$ ); *DCCS Condition C Post-Switch* ( $r^2 = -.370$ ); *DCCS Condition B Pre-Switch* ( $r^2 = .349$ ); and the *Day-Night* test ( $r^2 = -.348$ ).

The results of the correlation analysis provided overwhelming evidence to accept Ho4. The results indicate that both types of measures reliably assessed each domain of executive functioning in the participants with autism and without autism. The findings support the use of both types of instruments (i.e., elicited tests and ecologically valid test) assessed effectively executive functioning profiles in preschool children with and without autism.

It was surprising to find strong relationships between the EF subscales of the *BRIEF-P* across each executive functioning domain. One explanation for the strong relationships across domains is the global ceiling performance effect that was noted on the *BRIEF-P* in the autism group, especially when compared to the children without autism. The autism group were noted to

have been rated by their teachers to exhibit a significant amount of executive dysregulation (over two standard deviations) compared to the children without autism. The findings should be interpreted with caution due to this ceiling effect. However, the findings reinforce the importance of using controlled/elicited measures and ecologically valid measures to understand and identify executive profiles in young children.

### *Summary of Findings*

In this section, a summary of findings for the four hypotheses will be presented. The summary will include the most important results that contribute to the current literature.

*Global profile of executive functioning.* Results of the discriminant function analysis revealed the following characteristics among the autism group and the without autism group. First, the two groups' performance on the battery of executive functioning instruments differed significantly. Second, the two groups' performance differed significantly on each executive functioning variable. Last, there was statistically significant independence between the two groups using all executive functioning variables. In other words, the global executive functioning battery was a reliable assessment to assign group membership to the autism group and the without autism group in this study based on the participants' performance. The results of the discriminant analysis supported hypothesis one: preschool children diagnosed with autism would exhibit decreased performance on all executive functioning measures compared to preschool aged children without a developmental diagnosis.

*Domain specific executive functioning profiles.* Results from the discriminant function analyses for each executive functioning domain was statistically significant. Five Wilks' Lambda ( $\Lambda$ ) tests of significance were used to assess the significance of each of the five executive functioning domains. The two analyses found the following. First, each variable used to assess

executive functioning tested significant for group independence, which means that each variable contributed to group membership. Second, when each of the executive functioning domains was analyzed independently, each domain was found to be significant and also contributed to autism group membership. Last, when using the identified test battery, the shifting set domain was found to be the most significant for autism group membership followed by self-monitoring, plan/organize, inhibition, and working memory.

*Age-based differences between preschoolers with and without autism.* Multiple univariate analyses of variance were used to analyze the role of age for the children in the two group. An age variable was used to predict age performance across the entire sample, while an age group (4, 5, and 6-years old) + group (autism and without autism group) variable was created to predict age-based performance between groups. The results found one executive functioning variable (*Noisy Book* total score) was noted to be statistically significant for age-based performance across the sample. Four executive functioning variables were noted for statistical significance using the age + group variable. The four variables included: *DCCS Condition A Post-Switch*, *Noisy Book* total score, *Noisy Book* span score, and *Tower of Hanoi-Revised*. When accounting for age + group more executive functioning variables were noted for statistical significance. Thus, the children without autism displayed improved scores on these four variables over age compared to the children in the autism group.

*Intelligence and executive functioning.* Two post hoc analyses were used to examine the effects of intelligence and executive functioning performance. Three IQ groups were created (i.e., <70 IQ autism, >70 IQ autism, and without autism) for the first univariate analysis. The univariate analysis examined the difference between the three IQ groups. The findings revealed a statistical difference between the three groups across all executive functioning variables.

However, the children without autism exhibited greater levels of executive functioning skills compared to the children with >70 IQ diagnosed with autism. It is important to note that the mean IQ difference was greater than two standard deviations between the >70 IQ autism group (IQ = 87.7) and the without autism group (IQ = 108.3), which suggested the children without autism had greater intellectual capacity compared to the “higher functioning” children with autism (IQ < 70).

Second, a one-way ANOVA was used to measure executive functioning while co-varying for intelligence (*Leiter-R* IQ) rather than assigning IQ groups. The one-way ANOVA was used to determine whether executive functioning weaknesses were present separate from intelligence across the entire sample. The results indicated that on 11 out of 18 executive functioning variables intelligence significantly impacted participants’ performance on elicited tests. In addition, these participants received elevated rating scores by teachers on the *BRIEF-P*. The participants’ performance on all working memory and planning/organization variables was significantly impacted by intelligence, suggesting that intelligence is a large contributor to exhibiting successfully these executive skills. However, participants’ performance on several shifting set and self-monitoring variables were significantly different even when controlling for intelligence, which implies that autism group membership existed using shifting set and self-monitoring even when accounting for intelligence.

*Comparison of the BRIEF-P and elicited executive functioning tests.* A correlational analysis was used to determine whether there was a relationship in performance of the *BRIEF-P*, an ecologically valid instrument, compared to the elicited instruments of executive functioning. Each correlation domain comparison instrument analysis was statistically significant with a correlation no less than +/- .273 across paired variables, which is needed to provide a strong

statistical relationship according to the Pearson  $r$  product moment coefficient table. The results support a strong relationship between the subscales of the *BRIEF-P* and the elicited tests across executive functioning domains.

## CHAPTER FIVE

## Discussion

The purpose of this study was to explore (1) global differences in executive functioning between preschool-aged children with autism and same-aged children without autism; (2) domain specific differences in executive functioning between preschool-aged children with autism and same-aged children without autism; (3) age-based differences in executive functioning within a group of preschoolers with autism and a group of preschoolers without autism; (4) the effect of intelligence in regard to executive functioning performance; and (5) the relationship between elicited and ecologically valid executive functioning instrumentation. Chapter five will discuss the present study's contribution and extension of the existing literature, review the limitations of the study, identify the educational implications, and provide direction for future research.

For approximately the past two decades, researchers have supported claims that adults and older children with autism have global weaknesses in executive functioning compared to the general population and other clinical populations. However, the potential to assess and measure executive functioning in preschool-aged children has been debatable. Early research on executive functioning suggested that executive functions were not present or observable under the age of twelve (Espy et. al., 2001). More recently, the emergence of executive functioning skills began to be conceptualized in young children. As a result of the recent emergence of executive functioning assessment in young children, preschool children with autism have been found to display significant deficits in some areas of executive functioning. However, few researchers have attempted to identify executive profiles in preschool-aged children with autism. Furthermore, much of the research that has assessed executive functioning in young children

with autism has presented mixed results, further complicating the profile of executive functioning in these children.

Four major results will be discussed in this section. First, the present study found that the children diagnosed with autism exhibited significant global and domain specific weaknesses in executive functioning when compared to children without any diagnosed developmental disabilities. Second, the children without autism improved their performance as their age increased. Third, the children with autism generally displayed static performance as age increased. This observation was most apparent in the areas of working memory, self-monitoring, and planning/organization domains of executive functioning. Last, a strong correlation in performance across groups existed between each subdomain on the *BRIEF-P* and on domain specific elicited tests.

#### *Global Profiles of Executive Functioning*

The present study found statistically significant differences in collective executive functioning performance between the children in the autism and without autism groups. Four known studies have examined executive functioning in preschool-aged children with autism. Three of these four studies commonly found weaknesses in shifting mental set, although none of the studies conducted an executive functioning profile examination across domains. A brief summary of these four studies are reviewed below.

McEvoy et al. (1993) found children with autism to have select vulnerabilities in the shifting set and self-monitoring domains when compared to same developmental-age children. Dawson et al. (1998) concluded that children with autism performed worse on a measure of shifting set compared to children with developmental disorders. Griffith et al. (1999) noted that the children without autism exhibited more perseverative responses. Griffith et al. (1999)

suggested that the children without autism had more difficulty shifting set and inhibiting responses compared to children with autism. Dawson et al. (2002) examined executive functioning in children with autism compared to children with other developmental disorders. Dawson et al. (2002) found children with autism had executive functioning vulnerabilities in tasks requiring shifting set, working memory, and inhibition. The results of three of the four studies found that children with autism had more difficulty shifting set. Shifting set is often observed in everyday behaviors as exhibiting perseverative or repetitive behaviors, difficulty transitioning from one task to another, and a rigid or concrete approach to problem solving. However, these studies did not present any clear executive functioning profiles in preschool-age children with autism. Moreover, these studies did not examine all domains of executive functioning in this population.

The results of the present study found the opposite to the results in the study conducted by Griffith et al. (1999). Griffith et al. (1999) found that children without autism displayed decreased performance on measures of executive functioning. A discriminant analysis encompassing all executive functioning variables used in the present study found that children without autism performed better compared to the children with autism on selected measure accessing each domain of executive functioning. Even though there were mixed results indicated from previous studies, in the present study expected to find global executive functioning vulnerabilities in children with autism. The reason these findings were expected is that autistic disorder is a pervasive developmental disability that impacts many aspects of an individual's life. The present study revealed pervasive global executive dysfunction in preschool-aged children with this disorder. The importance of this finding was to confirm significant executive functioning weaknesses in children with autism allowing for further analysis into specific

weaknesses. To understand specific executive functioning weaknesses, researchers can begin to develop specific profiles in preschool children with autism.

The global executive functioning results in preschool-aged children with autism in the present study lend support to evidence of frontal lobe impairments in this population. It has been documented that older children and adults with autism share a similar profile to individuals with frontal lobe brain injuries. Many neuro-anatomical studies have revealed that symptoms of autism are similar to individuals who experience frontal lobe brain injuries (Damasio & Maurer, 1978; Lewis & Baumeister, 1982; Jordan, et al., 2005; and Lopez et al., 2005). Considering the evidence presented on the connection between executive functioning to the frontal lobe, and the connection between frontal lobe functioning and autism in adults, similar vulnerabilities were predicted in young children with autism.

For the present study, substantial importance was placed on selecting multiple types of developmentally appropriate assessment tools and evaluating each domain of executive functioning to establish reliable executive functioning profiles in preschoolers with autism. The results provide further evidence that executive functioning can be reliably assessed in the preschool population in children as young as four years of age. The selection of appropriate measures expands our understanding of executive functioning assessment in young children. Furthermore, it provides further direction for researchers and developmental neuropsychologists to continue to construct and refine executive functioning measures to assess executive vulnerabilities more accurately at an earlier age in children with and without developmental disabilities.

*Domain Specific Executive Functioning Profiles*

To establish a reliable executive functioning profile, the present study examined each of the five domains of executive functioning separately using elicited and ecologically valid instruments. Previous studies have found specific weaknesses in the areas of shifting set, self-monitoring, and inhibition in young children with autism (McEvoy, et. al., 1993; Pennington & Ozonoff, 1996, Russell, 1996b, Ozonoff & Strayer, 1997, Griffith, et. al., 1999, Hughes & Graham, 2002; and Coldren & Holloran, 2003). These researchers have indicated executive functioning deficits in children with autism; however, less clear from their results is a specification of which areas are greater weaknesses or strengths for these children. Furthermore, these studies have not attempted to independently assess each area of executive function within one given study. One purpose of this study was to establish an executive functioning profile in children with autism to improved diagnostic markers of the disorder and to provide clinical and academic supports geared toward each child's strengths.

The *DCCS* and the teachers' evaluations of shifting set were found to be the most notable significant weakness of executive functioning in the preschool-aged children with autism. Difficulties with shifting set are often observed in everyday behaviors as problems with transitioning to new tasks or a new environment, perseverative or repetitive behaviors, rigid and concrete thinking, mental inflexibility, and the need for a strict daily routine. Many young children with ASD exhibit these atypical behaviors. Furthermore, these problems with shifting set are often so pervasive that children with ASD often struggle to find meaning in the world around them. As a result, these children often have notable social and interpersonal difficulties that contribute to their complex profile.

The present study found statistically significant differences between children with autism compared to children without autism across each area of executive functioning. More specifically, the children with autism displayed the greatest vulnerability to shift set, which is a similar finding in previous research. Shifting set is defined as the ability to mentally shift back and forth between multiple stimuli, operations, or mental sets. The second greatest area of weakness was self-monitoring followed by: planning/organization, inhibition, and working memory.

Self-monitoring also was an area of weakness for children with autism. Self-monitoring or self-awareness is a regulatory function that includes self-appraisal or self-control of one's own cognitive processes, including the regulation of impulses and motor actions. Problems with self-monitoring are often the most apparent in everyday dysfunctional behaviors such as impulsivity, difficulty with self-regulation, violating social norms, invading the personal space and boundaries of others, demanding behaviors, and the inability to delay gratification. A limited ability to self-monitor one's own behaviors often leads to severe inappropriate behaviors across many areas of functioning. In particular, children with deficits in self-monitoring often break social norms and rules. The violation of these rules can often be problematic for these children in school and in the community, and in building meaningful relationships. Children diagnosed with ASD are often noted to exhibit these types of problems and need additional support to help them manage the world around them.

On the other hand, working memory was a relative strength for children with autism compared to the other executive functioning domains. Working memory is a goal directed behavior that requires an individual to hold information in mind for a short time and mentally manipulate the information to accomplish a targeted goal. The findings in the present study lend

support to the theory that working memory may rely more heavily on vigilance and attentional processes rather than frontal lobe functioning (Jordan et al., 1995; Russell, et al., and Lopez, et al., 2005). This result was not unexpected as previous research has indicated individuals with autism do not exhibit as marked working memory weaknesses compared to other executive functioning domains, partly because working memory requires attentional processes (Jordan et al., 1995; Russell, et al., and Lopez, et al., 2005).

Working memory weaknesses are typical characteristics of individuals with attentional disorders, such as Attention Deficit Hyperactivity Disorder (Ozonoff & Jensen, 1999; Perner et al., 2002; Lezak et al., 2004; and Goldberg et al., 2005). Without proper attention to the information, an individual will be unable to manipulate the information to achieve the targeted goal. Individuals with attentional disorders often present with clear weaknesses in working memory skills. The results of this study suggest that individuals diagnosed with autism may have relatively intact working memory skills compared to the other domains of executive functioning. However, it is important to note that children without autism performed better compared to the children with autism in this study. Nonetheless, this study extended the literature by providing an initial performance rank order of executive functioning domains that can be easily replicated in future studies.

In sum, the young children within the autism group not only revealed significant global deficits, but also specific weaknesses in the areas of inhibition, shifting set, working memory, self-monitoring, and planning/organization when compared to children without autism. The weaknesses in these areas can become cyclical, meaning that these children with global and specific weaknesses in executive functioning will likely not be able to learn and process information at the same rate that children without these weaknesses would normally accomplish.

In turn, these weaknesses create a wider gap of learning and the processing of information over time and age. Thus, the results stress the importance of using executive functioning profiles to provide early detection and intervention in preschool-aged children with autism.

The executive functioning profiles in the autism group suggest serious implications their development. Executive functioning is key in the development of young children as these skills allow children to learn and make sense of the world around them. It allows them to respond to commands, gathering information, and make decisions. Without proper interventions to address executive functioning weaknesses, these children will fall further behind as they advance into later childhood, adolescence, and adulthood. Future studies need to continue to measure domain specific performances in young children with autism to further establish executive functioning profiles. These profiles will provide critical information to better serve these children.

#### *Age-Based Differences between Preschoolers with and without Autism*

The present study conducted an age-based analysis to identify age-based differences in children with autism compared with children who were not diagnosed with autism. An age-based analysis was considered to examine the developmental and longstanding implications that executive dysfunction can have on children with autism. In addition, only one known study has examined age-based performance in young children diagnosed with autism. Griffith et al. (1999) predicted children with autism would perform worse on a measure of shifting set (*Spatial Reversal*) over time. The measure was given to the participants at 40 months and again at 55 months. Griffith et al. (1999) found that the children with autism exhibited similar performance over time. These results were interpreted with caution because the study did not examine all domains of executive functioning using different modalities of instrumentation. The present study expanded the previous literature by evaluating children with autism across three different age

groups and using a battery of executive functioning tests that evaluated each domain of executive functioning in two settings.

Age-based differences between groups were noted in the present study on measures of working memory, self-monitoring, and planning/organization. First, there were four age + group differences scores among 4, 5 and 6 year-olds between the autism group and without autism group. The age + group differences were the *Noisy Book* total and span scores, *Tower of Hanoi-R*, and *DCCS Condition A Post-Switch*. It was predicted an age + group difference would be observed on the *Noisy Book* total score because there was an age-based difference mentioned in the above paragraph. The *Noisy Book* span score also had an age + group difference effect, meaning the autism group had decreased scores on this test across age groups compared to the without autism age groups. With a closer comparison of mean scores across age in Tables 12, 13, and 14 (see Appendix A), it could be seen that the participants in the autism group had decreased performance across age groups while the without autism group participants displayed an increase in performance across age groups.

These results indicated that the measures of working memory, self-monitoring, and planning/organization may have become increasingly consolidated over time in preschool-aged children without autism. Age appeared to have a significant impact on their performance, indicating that children's performance on the *Noisy Book*, *Self-Control*, and the *Tower of Hanoi* tests were sensitive to age. It still may be the case that preschool age children may not have completely learned or consolidated these executive functioning skills. These skills may become fully consolidated later in development in typically developing children.

Second, on tests of shifting set and inhibition, age was not an indication of improved performance and did not require consolidation over time. The findings suggest that typically

developing children begin to develop and learn these lower-order executive functioning skills, but the skills may not be fully consolidated until later in development. The results lend additional support the results of others that shifting set and inhibition skills are lower-order executive functioning processes that are automatized earlier in life, when compared to skills of self-monitoring, planning/organization, and working memory, which are thought to be higher-order processes. Higher-order executive functioning processes require the initial mastery of the lower-order processes (Zelazo, Craik, & Booth, 2004). Moreover, it is likely that if a child does not master lower-order executive functioning skills, he or she will likely exhibit increased difficulty with higher-order executive functioning processes.

Third, a similar effect was noted on the *Tower of Hanoi-R* and for the *DCCS Condition A Post-Switch*. This trend in scores was expected for the *Tower of Hanoi-R* test because the plan/organize domain of executive functioning has traditionally been viewed as a “higher-order” executive function requiring multiple “executive” processes such as attention, shifting, and inhibition in order to accomplish the targeted goal. Higher order executive functioning skills are thought to become increasingly consolidated over age (Diamond, 1990; Lezak, 2004). However, it was surprising to see an age + group difference on the *DCCS Condition A Post-Switch* and not observe the same effect in the *DCCS Condition B Post-Switch*, because both variables assess similar aspects of shifting set. The two post-switch variables did differ in some respects. The condition A required the participants to sort red star and blue truck cards, by color or shape depending on the post-switch condition, into two boxes (i.e., blue star box and red truck box), while condition B required the participants to sort the same cards into four boxes (i.e., red [no shape], blue [no shape], a colorless star, and a colorless truck). At first, one may think it may be more difficult to sort cards into a higher number of boxes; however, using all color and all shape

boxes suggests that it becomes a more concrete task compared to condition A. Condition A was a more abstract and fluid measure of shifting set as it required participants to go back and forth between two boxes. In contrast, on condition B, the participants were not required to use the same box between the pre and post switch trial. No effect was anticipated on the *DCCS Condition C* pre or post-switch since participants were only asked to sort cards on one dimension. Condition C was administered to determine whether participants were able to place the cards in the correct box more than 50 percent (chance) of the time.

The children diagnosed with autism did not exhibit this consolidation of skills in working memory, self-monitoring, and planning/organization compared to the children without autism. More specifically, the trend in age-based performance for the children with autism was generally decreased or stationary on all domains of executive functioning. Moreover, this trend became the most pronounced in the oldest age group (i.e., 6 year-olds), especially when compared to the children without autism. This trend was not statistically significant; however, it needs to be considered in further studies. Autism is a life-long pervasive disorder that can impact many areas of development including language, communication, socialization, learning, and daily living. Even though the age-based differences between groups were not statistically significant, the results suggest a potential trend. Likewise, as was seen in the present study, a widening gap of executive functioning performance was noted in the older age group. Preschool-aged children with autism may not exhibit statistically significant delays compared to children without autism; however over time it is likely that this trend will manifest and grow into more overt and pervasive weaknesses.

Last, from an observational point of view, it was revealing to compare age group mean performance scores between the autism group and the without autism group. On 55% of the

executive functioning variables, the without autism group's mean performance improved as age increased while their scores remained consistent on the remaining 45% of the variables.

Conversely, the autism group displayed static performance on 78% of the variables and showed a decline in performance on 22% of the variables. The autism group's IQ scores were also noted to decline over age, which may have contributed to the weaker executive functioning scores over age when compared to same-aged participants without autism. The autism group did not exhibit any performance increases across age. The age + group variable mean scores indicated that the participants in the autism group did not gain any substantial improvements in executive functioning skills over age based on their performance. On the other hand, the participants without developmental delays generally remained consistent in performance and at times displayed performance increases. Only four executive functioning variables indicated age + group differences, which may have been due to the general global statistical difference across variables between the autism and without group, regardless of age.

Future studies should explore this question with a larger sample size. The trends in mean age scores were expected as individuals with developmental delays such as pervasive developmental disorders learn and process information at a slower rate compared to the general population. Executive functioning skills allow us to learn, adapt, and interpret the world around us. Difficulties in learning and processing novel information over time can often become exacerbated for these children with core discrepancies in executive functioning. Finally, future studies should extend the examination of age-based differences over a larger age range. It is likely that children with autism will exhibit progressive age-based differences on executive functioning measures compared to children without autism. In the present study, age differences

were examined in 4, 5, and 6 year olds. Future studies may benefit from expanding this age range to establish a more clear profile of age-based discrepancies.

### *Intelligence and Executive Functioning Performance*

Two post hoc analyses were used to examine the effects of intelligence and executive functioning performance. It is important to assess the relationship between executive functioning and intelligence in children with autism because over 75 percent of individuals diagnosed with a autism spectrum disorders have a dual diagnosis of mental retardation which requires an intelligent quotient score under 70 (American Psychiatric Association, 2000).

Two interesting trends were found when intelligence was factored into the executive functioning statistics. First, a univariate analysis across IQ groups (i.e., <70 IQ autism, >70 IQ autism, and without autism) revealed improved executive functioning performance on elicited measures and decrease teacher EF ratings for children with higher IQ scores. The findings suggest that children with the higher IQ scores will perform better on executive functioning tasks and display less executive vulnerabilities in the classroom compared to children with lower IQ scores. Nevertheless, the children without autism exhibited higher levels of executive functioning performance compared to the children with >70 IQ diagnosed with autism. It is important to note that the mean IQ difference between the >70 IQ autism group (IQ = 87.7) and the without autism group (IQ = 108.3), was greater than two standard deviations which suggests these children without autism had greater intellectual capacity compared to the “higher functioning” children with autism.

Second, a one-way ANOVA was used to measure executive functioning while co-varying for intelligence (*Leiter-R* IQ) rather than assigning IQ groups. The ANOVA was used to determine whether executive functioning weaknesses were present separate from intelligence in

the preschoolers with autism. The results indicated that on 11 out of 18 executive functioning variables, intelligence significantly impacted participants' performance on elicited tests and these children received more clinically significant rating scores by teachers on the *BRIEF-P*. All working memory and planning/organization variables were found to be significantly impacted by intelligence, suggesting that intelligence is a large contributor to successfully exhibiting these executive skills. However, several shifting set and self-monitoring variables were significantly different even when controlling for intelligence, which implies that autism group membership existed using shifting set and self-monitoring even when accounting for intelligence.

Researchers and practitioners alike have debated the interaction between intelligence and executive functioning over the past decade. Lezak (2004) stated executive functioning can be measured separately from intelligence. She noted that individuals with cognitive impairments can live a successful independent life, while individuals with executive functioning impairments require life-long care. However, the converse of this argument claims that executive functioning allow us to problem-solve, manage several types of information at once, interact with the world around us, and plan for the future. With a decreased ability to perform these critical everyday functions (i.e., decreased performance in executive functioning), the question exists will that same individual demonstrate a lower level of IQ?

Research supports the executive dysfunction theory in older children and adolescents with high functioning autism when compared to same IQ and same age matched peers (Mikle, Ozonoff, & McMahon, 2007, Barnard, et al., 2008). However, no known studies have examined the relationship between executive functioning and intelligence in preschool-aged children diagnosed with autism. Historically, assessing intelligence and executive functioning in young

children has been difficult because assessment tools have demonstrated varied developmental validity and an unclear understanding of executive functioning development.

The present study addressed some of these questions by attempting to control for intelligence using a univariate analysis of variance across three IQ groups (i.e., <70 IQ autism group, >70 IQ autism group, and without autism group), which revealed statistically significant differences across IQ ( $p < .05$ ) for all executive functioning variables. All of the executive functioning variables contributed significantly to IQ group performance differences. It was expected that the higher autism IQ group would perform higher on EF tasks. However, it was interesting to find that the without autism group performed significantly higher compared to the higher IQ autism group. This finding suggested that “higher functioning” children with autism display significantly more executive dysfunction when compared to same-aged peers without autism, even when controlling for intelligence. The results from the present study provide supporting evidence that typically developing children will perform significantly better on elicited EF measures and their teachers report more clinically significant scores for executive functioning. The result was expected because children diagnosed with autism will likely display increased executive control difficulties due to the pervasive nature of the disorder.

The *Leiter-R* test of intelligence formulates an IQ score based on how well an individual can correctly problem-solve and mentally manipulate visual information. The *Leiter-R* assesses one’s ability to identify sequences and patterns, correctly match objects, and visually construct objects in a non-verbal format. It is likely that some degree of executive functioning is required to complete successfully the subtests on the *Leiter-R* as well as on other intelligence tests. The present study’s results suggested that intelligence plays a major role in an individual’s ability to successfully complete executive functioning tasks in a laboratory-based setting and display

increased executive control in the classroom. This effect was noticeable when assigning participants to groups based on IQ scores. Further analysis was needed, however, to determine which individual executive functioning variables were significantly affected by intelligence.

#### *Comparison of the BRIEF-P and Elicited Tests*

The present study examined the relationship between two types of executive functioning instrumentation -- elicited versus ecologically valid. No known studies have analyzed the correlation between elicited and ecologically valid measures in preschoolers diagnosed with autism. The assessment of executive functioning in young children with autism has presented a complex challenge because young children are learning and developing at a rapid rate. Diamond (1990) noted that similar to other cognitive skills such as language, executive functioning, although not fully developed at this developmental stage, can be measured at an early age. Early measurement can only be obtained by constructing age-appropriate tests that consider the developmental profiles of young children. Previous literature and current clinical tools do not contain a wealth of assessment tools for young children. Along with adapting developmental constructs, ecological validity (i.e., evaluates real-world functioning) is also a critical component when designing an executive functioning battery for preschool-aged children. Similarly, the available measurements for preschool-aged children are predominantly elicited, laboratory based tests that are not standardized. To assess executive functions in preschool-aged children is to find both appropriate performance-based measures and to evaluate the functional, real-world impact of executive functioning expressed in everyday activities. Using the selected battery of assessment tools, the present study extends the current research. The study selected a battery of tests to develop further an executive functioning assessment battery that captures age-based performance, ecological validity, and executive dysfunction in children with and without autism.

The results of the correlational analysis between the subscales of the *BRIEF-P* and domain specific measures of executive functioning found relationships between each paired variable across domains that were statistically significant. In the present study, the *BRIEF-P* and the selected elicited tests were used to assess executive functioning skills in both groups of children. The use of both types of instruments supports a comprehensive assessment of executive functioning. The high internal and construct validity of laboratory-based neuropsychological assessment tools offer a great deal of certainty to assess executive functions. Moreover, ecologically valid assessment tools contain characteristics similar to naturally occurring human behavior and has value in predicting everyday behaviors. The results of the present study lend support to a combination of elicited and ecological assessment tools to provide a thorough and comprehensive approach to evaluating executive functioning.

The analysis revealed statistically significant correlations for each paired relationship of instruments. First, the most notable was the relationship between the two instruments that measured working memory (*Noisy Book* and the *BRIEF-P Working Memory*). These results inferred that the *BRIEF-P Working Memory* index and the *Noisy Book* span and *Noisy Book* total score are parallel measures of working memory when compared to the *BRIEF-P: Working Memory* subscale in preschool-aged children in this study. Additionally, it supports the claim that the participants' teachers endorsed similar working memory abilities through the *BRIEF-P* as was found on an elicited task (*Noisy Book*). Second, a significant correlation existed between the *BRIEF-P Emotional Control* index and *Self-Control* trial B task. The *Self-Control* trial B task requires a high level of internal control and regulation of one's impulses as the participants have to resist touching a visually appealing gift-wrapped present. It is likely that children who have difficulties controlling their impulses or displaying sufficient self-monitoring will exhibit

impulsive behaviors and emotional dysregulation. Teachers in this study rated children's self-monitoring through the *BRIEF-P* similarly to the children's performance on the *Self-Control* trial B score. *Self-Control* trial A was a less visually stimulating task as the reward was a piece of candy hidden in a testing well. The results of the *Self-Control* task were not surprising because children diagnosed with autism are more likely to display more perseverative actions, problems with self-regulation, and problems with impulse control. These skills are needed to control one's actions towards more stimulating, attractive rewards (trial B) compared to a hidden, mundane reward (trial A).

In sum, the subscales of the *BRIEF-P*, and each elicited test variable matched for aspects of each domain of executive functioning, were found to be strongly correlated. This finding revealed that the young children in this study were observed to have similar executive functioning profiles in an individual testing session compared to their functioning in a classroom setting, as measured by their teachers. Generally, the without autism group participants performed above average on elicited measures and were observed by their teachers in their classrooms as exhibiting little to no executive vulnerabilities. In contrast, the children in the autism group generally performed below average on elicited measures and were observed similarly in their classrooms to exhibit increased weaknesses in executive functions. However, it is important to consider the ceiling performance effect that was exhibited by the autism group. The autism group performed dramatically different than their typically developing peers; a correlation may have existed regardless of their performance on elicited measures. Nonetheless, these results have clinical implications in the evaluation of executive functioning. They contribute to the additional information needed to diagnosing autism, more comprehensively, in young children. In the same vein, the results suggest that it is important for researchers and

clinicians to use an assessment battery that includes both elicited and ecologically valid measures to assess and diagnose young children. Researchers need to continue to study the relationship between types of executive functions measurements to advance the reliability of such a battery further.

Future studies should be geared towards the development of standardized preschool elicited executive functioning instruments. The instruments used in this study provide the groundwork for formulating developmentally appropriate assessment tools with construct validity similar to the standardized, ecologically valid *BRIEP-P*.

#### *Limitations to the Study and Directions for Future Research*

Research geared towards gaining an enhanced understanding of the learning and development of children with autism has great importance for the helping professions and for society as a whole. Understanding the autistic disorder and the neurological underpinnings of executive functioning for children with this disorder is a complex area of research, especially when studying young children. After several decades, researchers are just beginning to scratch the surface to improve diagnostic formulations and interventions for children with autism. In the same vein, researchers are beginning to understand executive functioning profiles and the role the profiles play in these children's learning, self-regulation, and quality of life. As a result of these complex issues, this study lends further understanding of autism and executive functioning profiles in young children. However, the study also has some limitations that are addressed in this section.

*Threats to internal validity.* In terms of internal validity, the sample was a sample of convenience. The sample was not randomly selected; it was based on parental response rate within a certain geographical area. Therefore, a causal effect cannot be declared between

executive functioning weaknesses and autism. Another limitation to internal validity is the possible confounding variable of Intelligence (IQ) that could have played a factor in the study. Three out of four individuals in the general population diagnosed with autism are dually diagnosed with mental retardation (IQ score 70 or below). The mean IQ score for the autism group was 73.4 with 12 of the 29 participants in the autism group with IQ scores under 70. Many of the participants' scores on the executive functioning measures may have been confounded by their generally decreased IQ scores while the without autism group was above average. The present study attempted to account for intelligence by using post hoc analyses to control for IQ. The children's performance on many of the executive functioning variables was significantly impacted by intelligence. The results of this study warrant further investigation into the connection between intelligence and executive functioning. It will be important to conduct studies in the future to examine executive functioning skills in preschool-aged children with IQ scores at 70 or higher in order to get a truer representation of executive functioning profiles in preschool-aged children with autism.

Another potential threat to internal validity was age-based differences that were examined in the third research question. Age-based statistical differences were noted between groups on several executive functioning variables. However, due to the time constraints of this study, these differences were analyzed by using different subjects across age (i.e., a cross sectional design). To fully understand executive functioning, age-based performance of young children with autism, future research should conduct a longitudinal study to follow the same participants over time to observe same-subject-age performance.

The last possible threat to internal validity was the confound variable of limited verbal language skills and communication observed in some of the participants with autism. Many

individuals diagnosed with ASD have pervasive delays in language and communication. Likewise, four participants in the autism group were completely non-verbal and eight participants in the autism group demonstrated limited verbal communication. Two assessment tools in the selected executive functioning battery (*Noisy Book* and *Day-Night* test) were adapted to include non-verbal responses for the participants with little or no verbal skills. The tests were adapted to allow the participants to use pointing to identify the correct stimuli rather than verbalizing their responses. Future studies focusing on the assessment of executive functioning in autism need to ensure the assessment protocol contains non-verbal responses to adequately measure the participants expressions of information.

*Threats to external validity.* A threat to external validity was the sample selection. As a result of limited resources and geographic constraints of the investigator, the sample was collected in two geographic locations: Southeastern Massachusetts and Northern Delaware. Although the sample was representative of the general population based on the United States 2000 Census in the two geographic areas, the findings cannot be generalized to the general population. However, the findings in this study further support and extend the scientific research suggesting preschool-aged children with autism have discrepancies in executive functioning skills compared to their same-aged peers without developmental disabilities (Ozonoff et al., 1991; McEvoy et al., 1993; Bennetto et al., 1996; Turner, 1996; Dawson et al., 1998; Ozonoff & Jensen, 1999; Coldren & Holloran, 2003; Hill, 2004; and Ozonoff et al., 2004).

Another threat to external validity was the comparison of performance between the elicited and ecologically valid instrumentation. Statistical significance in the relationship between the two kinds of measures was noted in all areas of executive functioning. However, because the two types of instruments were collected from different sources (investigator and

teachers), and gathered in different environments (testing room and classroom), caution must be used when interpreting these results or when replicating the study in the future. Several reasons for using caution are: (1) a potential rater bias could have existed, (2) the participants in the autism group could have exhibited an increase in executive dysregulation in a more unstructured classroom environment compared to an individual testing session, and (3) the two types of instruments were not sensitive to the targeted executive functioning skills. Of important note, the testing environment only captures a small portion of the participants' behaviors during one specific school day. In contrast, the teachers rate the participants based on the participants' behavior over the past six months. Results on the measures of elicited behaviors could be varied during a narrow time of testing depending on the participant's level of attention and arousal, fatigue, mood, or reaction to examiner.

*Measurement limitations.* A review regarding literature of the executive functioning in young children did not indicate a wealth of assessment instrumentation. Accordingly, several limitations regarding the measurements of executive functioning exist in the present study and are addressed in this section. First, the *Trails-P* and *School Shape* tests were originally selected to be used to assess shifting set and inhibition. Unfortunately, the two tests were currently under copyright review and were not available for use in the present study at the time of data collection. Second, a number of executive functioning instruments used in this study did not have standardized norms. These tests were: *Noisy Book*, *DCCS*, *Day-Night*, *Self-Control*, and the *Tower of Hanoi-R*. Furthermore, the assessments that have been used to assess executive functioning in the preschool population have only been used in research and have not been standardized using a large sample of the general population. Nevertheless, the executive functioning instruments were carefully selected based on previous research that indicated

construct validity and use with the targeted age and clinical population for this study (Dennis et al., 1991; McEvoy et al., 1993; Gerstalt, et al., 1994; Dawson et al., 1998; Hughes, et al., 1998; Espy, et al., 1999; Griffith et al., 1999; Espy et al., 2001; Dawson et al., 2002; Sonuga-Barke, et al., 2002; Bull et. al., 2004; and Rennie, et al., 2004).

The last measurement limitation was the issue of attunement when using the *BRIEF-P* with the six-year old children. The *BRIEF-P* has standardized norms used on an age population between two and five years, eleven months. In the present study, the *BRIEF-P* five year old norms were adapted and used for the six year old children in both groups. The risk of using younger norms is potentially creating a ceiling effect within the six-year olds. Young children have significantly difference developmental trajectories over age. Executive functioning in six year-old may not have been fully captured using younger norms. However, age-based difference (i.e., age-based t scores between groups) was noted as proportionate across age and group. Nonetheless, in future studies, researchers should consider using the *BRIEF (Behavioral Rating Inventory of Executive Functioning)* when assessing older children and adolescents. The *BRIEF* can be used with children and adolescents between the ages of five and eighteen.

Future research needs to focus on developing and using executive functioning assessments with a larger sample of young children. The development of these assessments will help establish standardized norms in order to use these tools in clinical settings. Researchers are beginning to take steps in this direction as evident by the future standardization of the *Trails-P* and the *School Shape* tests.

Last, the principal investigator was responsible for 90% of the administration of the testing and for 100% of the scoring due to limited resources. However, the investigator was able to oversee all assessment protocols and scoring procedures. The investigator attempted to limit

scoring error by double scoring 50% of the participant assessments and double entering all data into the data entry program (SPSS). To limit scoring and examiner bias, future studies should train research professionals who are blind to the study's purpose and to administer and score the executive functioning battery.

Although the results of the present study should be interpreted with caution, the results provide strong support to the importance for further research investigations. To gain a further understanding of executive functioning profiles in preschool-aged children with autism, several suggestions are made for future studies. Researchers and neuropsychologists should continue to construct and improve developmental instruments to assess executive functioning. First, the development of standardized instruments that are age-appropriate and have construct validity will allow researchers to generalize their findings with greater certainty. Studies should use large sample sizes to formulate standardized norms for pediatric executive functioning tests. Second, future investigations should assess preschoolers with and without autism who have an IQ equal to or above 80 to rule out IQ or mental retardation as a confounding variable. Third, it will be important for future researches to use non-verbal instrumentation when assessing children with ASD. Many individuals with ASD have difficulty with language and communication. Developing non-verbal instruments will assist researchers to parcel out language as a confounding variable and reliably assess information output in children with ASD.

Fourth, researchers may consider gathering *BRIEF-P* observational data from both the participants' teachers and their parents/caregivers. Researchers would be able to use these data to gather executive functioning profiles from multiple environments (i.e., home and school), therefore obtaining executive functioning data from multiple environments and informants. Fifth, a larger sample size should be considered to investigate age-based differences in young children

with autism. Age-based mean differences were noted on all variables between groups. A larger sample size will determine the extent of age-based differences between children with and without autism. Sixth, it would be ideal to conduct a larger longitudinal study to get a true measure of aged-based performances. Using a longitudinal research design would allow researchers to observe same-participant age performances over time. Last, it would be beneficial to gather and compare executive functioning profiles across diverse clinical, developmental, and neurological pediatric presentations such as: children with different forms of ASD, ADHD, mood disorders, and genetic-based disorders. Testing children from different clinical populations will allow researchers to isolate executive dysfunction in children with autism by comparing their profiles to children with other disorders. Furthermore, the development of executive functioning profiles across different pediatric disorders, health and educational providers will be able improve diagnostic formulations and appropriate interventions.

### *Summary of Findings*

Current research has emphasized the importance of executive functioning in young children in regards to learning, academic success, socialization, and daily living skills (Lezak, 2004). The present study lends support to executive dysfunction as a clinical indicator of autism in preschoolers. The autism group exhibited significant global weaknesses that were noted across all five domains of executive functioning compared to same-aged children without any diagnosed developmental disorders. The group differences were significant enough on the global executive functioning battery to assign group membership based on participants' scores. A closer examination revealed the executive functioning profile for these children indicated that they had the most difficulty in the area of shifting set, followed by self-monitoring, planning/organization, inhibition, and working memory.

The groups were also notable for age-based differences across groups on tasks requiring working memory, shifting set, and planning/organization. The age-based differences reveal a static or declining performance in these areas for the children with autism compared to a slight to moderate increase in performance for the children without autism. An examination of the measured executive profiles in young children using elicited and ecologically valid measures identified similarities in working memory and self-monitoring. The non-significant correlations between elicited and ecologically valid measures in the areas of shifting set, inhibition, and planning/organization underscore the importance of using both types of instrumentation to assess executive functioning profiles in young children. Developmental neuropsychologists will have a greater likelihood of establishing executive functioning profiles and diagnosing developmental disorders such as autism using both type of measures and gathering information from multiple informants.

#### *Clinical and Educational Implications*

The results of the present study continue to build on the evidence of executive dysfunction in younger children with autism (4-6 years of age) compared to children without developmental disabilities. It is critical to continue to investigate executive impairments in young children with autism given that the prevalence of the disorder has continually risen along with the cost of long-term care over the past decade (Yeargin-Allsopp et al., 2003; Newschaffer, et al., 2005; and Shattack, 2006). In the current study, the battery of tests displayed effective construct validity and reliably assessed executive functioning in the targeted age range. The results provide a framework to assess executive functioning in preschool-aged children and will assist researchers in the future to continue to create standardized assessment tools. Standardized instruments will provide improved assessment of executive functioning profiles to establish

diagnostic markers for developmental disorders such as ASD. In turn, executive functioning profiles will provide earlier detection and intervention aimed to reduce symptomatology found in children with autism.

Adequate identification of executive profiles in children with autism is of critical concern, because executive functions have been demonstrated to contribute to academic, behavioral, and social difficulties in children with autism, independent of their general intellectual abilities (Espy et al., 2001). The present study lends support that executive functions can be assessed during the early stages of school entry and executive functioning profiles can be established to detect specific executive dysfunctions. Age-based differences are also of great clinical and educational importance. In the present study, age-based differences were noted in several areas of executive functioning such as working memory, self-monitoring, and planning/organization. The performance of the children with autism did not exhibit age-based improvements in performance compared to the children without autism. These findings reinforce the importance of implementing appropriate early interventions to narrow the gap of performance observed in the children with autism.

Executive functioning profiles were reliably assessment using the *BRIEF-P* with elicited measures. Using different modalities of assessments captured executive functioning in multiple settings, in turn, yielding a greater amount of data for pediatric neuropsychologists to make appropriate diagnoses and recommendations. Clearer and more precise recommendations will advance the educational interventions to assist children with autism learn and improve their executive functioning skills. Detecting executive dysfunctions earlier in children will progress learning and general quality of life.

The present study is an important extension of the current literature. Furthermore, it refutes the notion that young children with autism cannot be assessed in the area of executive functioning. Previous research has identified language, communication, and social delays in young children with autism. Less studied has been executive functioning in these children. The study of executive functioning is equally important for these children because executive skills enable us to learn, interpret, and self-regulate our behaviors. Clearly, young children with autism display difficulties in executive functions and are more vulnerable to having an array of difficulties that will likely become exacerbated further throughout their lifespan without early detection and intervention. The present study demonstrated evidence for studying executive functioning throughout developmental stages. Age-based differences indicated that children with autism demonstrate expanding vulnerabilities in executive functioning evident in early childhood. Further development of an executive functioning battery for preschoolers is critical for preschoolers who begin to display symptoms of autism. The results within the present study contribute evidence for a movement to provide earlier clinical and educational services. Earlier services will reduce the severity of symptoms and potentially reduce the intensity of life-long services that individuals with autism and ASD require throughout their lives.

## Reference

- Ahmad, S. A. & Warriner, E. M. (2001). Review of the NEPSY: A developmental neuropsychological assessment. *The Clinical Neuropsychologist, 15*, 240-249.
- American Psychiatric Association (2000). *Diagnostic and Statistic Manual of Mental Disorders – Fourth Edition, Text Revision (DSM-IV-TR)*. Washington, DC: American Psychiatric Association.
- Baddeley, A. D. (1986). *Working Memory*. New York: Oxford University Press.
- Barkley, R. A. (2001). The executive functions and self-regulation: An evolutionary neuropsychological perspective. *Neuropsychology Review, 11*, 1-29.
- Barnard, L., Muldoon, K., Reem, H., O'Brien, H., & Stewart, M. (2008). Profiling executive dysfunction in adult with autism and comorbid learning disability. *Autism: The International Journal of Research and Practice, 12*, 125-141.
- Bennetto, L., Pennington, B. F., & Rogers, S. J. (1996). Intact and impaired memory functions in autism. *Child Development, 67*, 1816-1835.
- Bieberich, A. A. & Morgan, S. B. (2004). Self-regulation and affective expression during play in children with autism or down syndrome: A short-term longitudinal study. *Journal of Autism and Developmental Disorders, 34*, 439-448.
- Bildt, A., Sytema, S., Ketelaars, C., Kraijer, D., Mulder, E., Volkmar, F. & Minderaa, R. (2004). Interrelationship between autism diagnostic observation schedule-generic (ADOS-G), autism diagnostic interview-revised (ADI-R), and the diagnostic and statistical manual of mental disorders (DSM-IV-TR) classification in children and adolescents with mental retardation. (2004). *Journal of Autism Developmental Disorders, 34*, 129-137.
- Bishop, D. V. M., Aamodt-Leaper, G., Creswell, C., McGurk, R., & Skuse, D. H. (2001).

Individual differences in cognitive planning on the tower of Hanoi task:

Neuropsychological maturity or measurement error? *Journal of Child Psychology and Psychiatry*, 42, 551-556.

Blair, C., Zelazo, D. & Greenburg, M. T. (2005). The measurement of executive function in early childhood. *Developmental neuropsychology*, 28, 561-571.

Brambilla, P., Hardan, A. Y., Ucelli di Nemi, S., Caverzasi, E., Soares, J. C., Perez, J. & Barale, F. (2004). The functional neuroanatomy of autism. *Functional Neurology*, 19, 9-17.

Bull, R., Espy, K. A. & Senn, T. E. (2004). A comparison of performance on the towers of London and Hanoi in young children. *Journal of Child Psychology and Psychiatry*, 45, 743-754.

Coldren, J. T. & Halloran, C. (2003). Spatial reversal as a measure of executive functioning in children with autism. *Journal of Genetic Psychology*, 164, 1-11.

Cohen, J. (1992). A Power Primer. *In Psychological Bulletin*, 112, (p. 155-159). Washington, DC: American Psychological Association.

Chelune, G. J. & Baer, R. A. (1986) Developmental norms for the Wisconsin card sorting test. *Journal of Clinical Experimental Neuropsychology*, 8, 219-228.

Damasio, A., & Maurer, R. (1978). A neurological model for childhood autism. *Archives of Neurology*, 35, 777-786.

Dawson, G., Melzoff, A. N., Osterling, J., & Rinaldi, J. (1998). Neuropsychological correlates of early symptoms of autism. *Child Development*, 69, 1276-1285.

Dawson, G., Munson, J., Estes, A., Osterling, J., McPartland, J., Toth, K., Carver, L., & Abbott, R. (2002). Neurocognitive function and joint attention ability in young children with autism spectrum disorder versus developmental delay. *Child Development*, 73, 345-358.

- Dennis, M., Spiegler, B. J., Fitz, C. R., Hoffman, H. J., Hendrick, E. B., Humphreys, R. P., et al., (1991). Brain tumors in children and adolescents: I. Effects on working associative and serial order memory of IQ, age at tumour onset, and age of tumour. *Neuropsychologia*, 29, 807-828.
- Diamond, A. (1990). The development and neural bases of memory functions as indexed by AB and delayed response tasks in human infants and infant monkeys. *Annals of the New York Academy of Sciences*, 608, 267-317.
- Diamond, A. (1988). The abilities and neural mechanisms underlying the AB performance. *Child Development*, 59, 523-527.
- Diamond, A., Prevor, M. B., Callender, G., & Druin, D. P. (1997). Prefrontal cortex cognitive deficits in children treated early and continuously for PKU. *Monographs of the Society for Research in Child Development*, 62, 4.
- Dowsett, S. M. & Livesey, D. J. (2000). The development of inhibitory control in preschool children: Effects of executive skills training. *Developmental Psychobiology*, 36, 161-174.
- Espy, K. A. (2004). Using developmental, cognitive, and neuroscience approaches to understand executive control in young children. *Developmental Neuropsychology*, 26, 379-284.
- Espy, K. A. (1997). The shape school: Assessing executive function in preschool children. *Developmental Neuropsychology*, 13, 495-499.
- Espy, K. A. & Cwik, M. F. (2004). The development of a trail making test in young children: The Trails-P. *The Clinical Neuropsychologist*, 18, 411-422.
- Espy, K. A., Kaufmann, P. M., Glisky, M. L. & McDiarmid, M. D. (2001). New procedures to assess executive functions in preschool children. *The Clinical Neuropsychologist*, 15, 46-58.

- Espy, K. A., Kaufmann, P. M., McDiarmid, M. D., & Glisky, M. L. (1999). Executive functioning in preschool children: Performance on A-Not-B and other delayed response format tasks. *Brain and Cognition, 41*, 178-199.
- Fassbender, M. K., Foxe, J. J., Wylie, G. R., Javitt, D. C., Robertson, I. H., & Garavan, H. (2004). A topography of executive functions and their interactions revealed by functional magnetic resonance imaging. *Cognitive Brain Research, 20*, 132-143.
- Flavell, J. H. (1999). Cognitive development: Children's knowledge about the mind. *Annual Review of Psychology, 50*, 21-45.
- Frombonne, M. (2003). The prevalence of autism. *Journal of the American Medical Association, 289*, 87-89.
- Gerstadt, C. L., Hong, Y. J., & Diamond, A. (1994). The relationship between cognition and action: Performance of children 3 ½ - 7 years old on a stroop-like day-night test. *Cognition, 53*, 129-153.
- Gioia, G. A., Espy, K. A., & Isquith, P. K. (2003). *Behavioral Rating Inventory of Executive Function – Preschool Version (BRIEF-P)*. Lutz, FL: Psychological Assessment Resources, Inc.
- Goldberg, M. C., Mostofsky, S. H., Cutting, L. E., Mohone, E. M., Astor, B. C., Denckla, M. B. & Landa, R. J. (2005). Subtle executive impairment in children with autism and children with ADHD. *Journal of Autism and Developmental Disorders, 35*, 279-293.
- Goldman-Fristoe-Woodcock (1974). *Auditory Memory Tests*. Circle Pines, MN; American Guidance Services.
- Goldman, P. S., Rosvold, H. E., Vest, B., & Galkin, T. W. (1971). Analysis of the delayed-

alternation deficit produced by dorsolateral prefrontal lesions in the rhesus monkey.

*Journal of Comparative and Physiological Psychology*, 77, 212-220.

Griffith, E. M., Pennington, B. F., Wehner, E. A. & Rogers, S. J. (1999). Executive functions in young children with autism. *Child Development*, 70, 817-832.

Hale, C. M. & Tager-Flusberg, H. (2005). Brief report: The relationship between discourse deficits and autism symptomatology. *Journal of Autism and Developmental Disorders*, 35, 519-524.

Hill, E. L. (2004). Executive dysfunction in autism. *Trends in Cognitive Sciences*, 8, 26-32.

Hughes, C., Dunn, J., & White, A. (1998). Trick or treat?: Uneven understanding of mind and emotion and executive dysfunction in “hard to manage” preschoolers. *Journal of Child Psychology and Psychiatry*, 39, 981-994.

Hughes, C. & Graham, A. (2002). Measuring executive functions in childhood: Problems and solutions? *Child and Adolescent Mental Health*, 7, 131-142.

Hughes, C. & Russell, J. (1993). Autistic children’s difficulty with mental disengagement from an object: Implications for theories of autism. *Developmental Psychology*, 29, 498-510.

Isquith, P. K., Crawford, J. S., Espy, K. A. & Gioia, G. A. (2005). Assessment of executive function in preschool-aged children. *Mental Retardation and Developmental Disabilities Research Reviews*, 11, 209-215.

Isquith, P. K., Gioia, G. A. & Espy, K. A. (2004). Executive function in preschool children: Examination through everyday behavior. *Developmental Neuropsychology*, 26, 403-422.

Jordan, R., Libby, S. & Powell, S. (1995). Theories of autism: Why do they matter? *School Psychology International*, 16, 291-302.

Joseph, R. M., McGrath, L. M., & Tager-Flusberg, H. (2005). Executive dysfunction and its

- relation to language ability in verbal school-age children with autism. *Developmental Neuropsychology*, 27, 361-378.
- Kaufmann, P. M., Leckman, J. M., & Ort, S. I. (1989). Delayed response performance in males with fragile-X. *Journal of Clinical and Experimental Neuropsychology*, 12, 69.
- Kemp, S. L., Kirk, U., & Korkman, M. (2001). *Essentials of NEPSY Assessment*. Hoboken, New Jersey: Wiley Publishers.
- Kirkham, N. Z., Cruess, L., & Diamond, A. (2003). Helping children apply their knowledge to their behavior on a dimension-switching task. *Developmental Science*, 6, 449-476.
- Klahr, D. & Robinson, M. (1981). Formal assessment of problem-solving and planning processes in preschool children. *Cognitive Psychology*, 13, 113-148.
- Kleinhans, N., Akshoomoff, N., & Delis, D. C. (2005). Executive functions in autism and asperger's disorder: Flexibility, fluency, and inhibition. *Developmental Neuropsychology*, 27, 379-401.
- Korkman, M., Kirk, U., & Kemp, S. (1998). *NEPSY: A developmental neuropsychological assessment manual*. San Antonio, TX: Psychological Corporation.
- Lee, M., Vaughn, B. E., & Kopp, C. B. (1983). The role of self-control in young children's performance on a delayed response memory for location task. *Developmental Psychology*, 19, 40-44.
- Levin, H. S. & Hanten, G. (2005). Executive functions after traumatic brain injury in children. *Pediatric Neuropsychology*, 33, 79-93.
- Lezak, M. D., Howieson, D. B., & Loring, D. W. (2004). *Neuropsychological Assessment*. New York, NY: Oxford University Press.
- Lopez, B. R., Lincoln, A. J., Ozonoff, S., & Lai, Z. (2005). Examining the relationship between

- executive functions and restricted, repetitive symptoms of autistic disorder. *Journal of Autism and Developmental Disorders*, 35, 445-460.
- McDonough, L., Stahmer, A., Schreibman, L., & Thompson, S. J. (1997). Deficits, delays, and distractions: An evaluation of symbolic play and memory in children with autism. *Developmental and Psychopathology*, 9, 17-41.
- McEvoy, R. E., Rogers, S. J. & Pennington, B. F. (1993). Executive function and social communication deficits in young autistic children. *Journal of Child Psychiatry*, 34, 563-578.
- Mikle, S., Ozonoff, S., & McMahon, W. M. (2007). The relationship between executive functioning, central coherence, and repetitive behaviors in the high functioning autism spectrum. *Autism: The International Journal of Research and Practice*, 11, 437-451.
- Miles, C., Morgan, M. J., Milne, A. B., & Moris, E. D. M. (1996). Development and individual differences in verbal memory span. *Developmental Learning, Personality, Social*, 15, 53-67.
- Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex “frontal lobe” tasks: A latent variable analysis. *Cognitive Psychology*, 41, 49-100.
- Miyake, A., & Shah, P. (1999). Towards unified theories of working memory: Emerging general consensus, unresolved theoretical issues, and future research directions. In A. Miyake & P. Shah (Eds.), *Models of working memory: Mechanisms of active maintenance and executive control* (p. 442-481). New York: Cambridge University Press.
- Mullen, E. (1995). *Mullen Scales of Early Learning (AGS Edition)*. San Antonio, TX: Pearson Assessments.

- Muller, U., Dick, S. A., Gela, K., Overton, W. F., & Zelazo, P. D. (2003). The role of negative priming in preschoolers' flexible rule use on the dimensional change card sort task. *Child Development, 77*, 395-412.
- Nelson, C. A., Monk, C. S., Lin, J., Carver, L. J., Thomas, K. M., & Truwit, C. L. (2000). Functional neuroanatomy of spatial working memory in children. *Developmental Psychology, 36*, 109-116.
- Newborg, J., Stock, J., Wnek, L., Guidubaldi, J. & Svinicki, J. (1984). *Battelle Developmental Inventory*. Allen, TX: DLM Teaching Resources.
- Newschaffer, C. J., Falb, M. D. & Gurney, J. G. (2005). National autism prevalence trends from united states special education data. *Pediatrics, 115*, 277-282.
- Ozonoff, S. (1996). Components of executive function in autism and other disorders. In J. Russell (Ed.) *Autism as an Executive Disorder* (p. 179-214). New York, NY: Oxford University Press.
- Ozonoff, S. & Jensen, J. (1999). Brief report: Specific executive function profiles in three neurodevelopmental disorders. *Journal of Autism and Developmental Disorders, 29*, 171-177.
- Ozonoff, S., Pennington, B. F., & Rogers, S. J. (1991). Executive function deficits in high functioning autistic children: Relationship to theory of mind. *Journal of Child Psychology and Psychiatry, 31*, 1081-1105.
- Ozonoff, S. & Strayer, D. L. (1997). Inhibitory function in nonretarded children with autism. *Journal of Autism and Developmental Disorders, 27*, 59-77.
- Ozonoff, S., Cook, I., Coon, H., Dawson, G., Joseph, R. M., Klin, A., McMahon, W. M.,

- Minschew, N., Munson, J. A., Pennington, B. F., Rogers, S. J., Spence, M. A., Tager-Flusberg, H., Volkmar, F. R. & Wrathall, D. (2004). Performance on Cambridge neuropsychological test automated battery subtests sensitive to frontal lobe function in people with autistic disorder: Evidence from the collaborative programs of excellence in autism network. *Journal of Autism and Developmental Disorders*, *34*, 139-150.
- Pennington, B. F. & Ozonoff, S. (1996). Executive functions and developmental psychopathology. *Journal of Child Psychiatry*, *37*, 51-87.
- Perner, J., Kain, W. & Barchfeld, P. (2002). Executive control and higher-order theory of mind in children at risk of ADHD. *Infant and Child Development*, *11*, 141-158.
- Petrides, M. (1995). Impairments on nonspatial self-ordered and externally ordered working memory tasks after lesions of the mid-dorsal part of the lateral frontal cortex in the monkey. *Journal of Neuroscience*, *15*, 359-375.
- Pittenger, D. J. (2003). *Behavioral Research Design and Analysis*. Boston, MA: McGraw Hill Publishing.
- Posner, M. I. & Rothbart, M. K. (1998). Attention, self-regulation, and consciousness. *Philosophical Transactions: Biological Sciences*, *353*, 1915-1927.
- Prior, M. (2003). Is there an increase in the prevalence of autism spectrum disorders? *Journal of Pediatric Child Health*, *39*, 81-82.
- Prior, M. & Hoffman, W. (1990). Brief report: Neuropsychological testing of autistic children through an exploration with frontal lobe tests. *Journal of Autism and Developmental Disorders*, *20*, 581-590.
- Rennie, D. A. C., Bull, R., & Diamond, A. (2004). Executive functioning in preschoolers:

Reducing the inhibitory demands of the dimensional change card sort task.

*Developmental Neuropsychologist*, 26, 423-443.

Rogers, R. D., Sahakian, B. J., Hodges, J. R., Polkey, C. E., Kennard, C., & Robbins, T. W.

(1998). Dissociating executive mechanisms of task control following frontal lobe damage and parkinson's disease. *Brain: A Journal of Neurology*, 121, 815-842.

Rothbart, M. K., Ellis, L. K., Rueda, R. M. & Posner, M. I. (2003). Developing

mechanisms of temperamental effortful control. *Journal of Personality*, 71, 1113-1142.

Russell, J. (1996a). Introduction. In J. Russell (Ed.) *Autism as an Executive Disorder* (p. 1-20).

New York, NY: Oxford University Press.

Russell, J. (1996b). Executive disorder and an inadequate 'theory of mind'. In J. Russell (Ed.)

*Autism as an Executive Disorder* (p. 256-304). New York, NY: Oxford University Press.

Russell, J., Jarrold, C., & Hood, B. (1999). Two intact executive capacities in children with

autism: Implications for the core executive dysfunctions in the disorder. *Journal of Autism and Developmental Disorders*, 29, 103-112.

Rutter, M. (2000). Genetic studies of autism: from the 1970's into the millennium. *Journal of*

*Abnormal Child Psychology*, 28, 3-14.

Scheuffgen, K., Happe, F., Anderson, M., & Frith, U. (2000). High intelligence, low IQ? Speed

of processing and measured IQ in children with autism. *Developmental and Psychopathology*, 12, 83-90.

Senn, T. E., Espy, K. A. & Kaufmann, P. M. (2004). Using path analysis to understand

executive function organization in preschool children. *Developmental Neuropsychology*, 26, 445-464.

Shattack, P. T., (2006). The contribution of diagnostic substitution to the growing administrative

- prevalence of autism in US special education. *Pediatrics*, *117*, 1028-37
- Sonuga-Barke, E. J. S., Dalen, L., Daley, D., & Remington, B. (2002). Are planning, working memory and inhibition associated with individual differences in preschool ADHD symptoms? *Developmental Neuropsychology*, *21*, 255-272.
- South, M., Ozonoff, S., & McMahon, W. M. (2005). Repetitive behavior profiles in asperger syndrome and high-functioning autism. *Journal of Autism and Developmental Disorders*, *35*, 145-158.
- Spies, R. A. & Plake, B. S. (2005). *The sixteenth mental measurements yearbook*. Lincoln, Nebraska: The University of Nebraska Press.
- Stahl, L. & Pry, R. (2005). Attentional flexibility and perseveration: Developmental aspects in young children. *Child Neuropsychology*, *11*, 175-189.
- Stone, W. L., Coonrod, E. E., Turner, L. M. & Pozdol, S. L. (2004). Psychometric properties of the STAT for early autism screening. *Journal of Autism and Developmental Disorders*, *34*, 691-701.
- Taylor, B., Miller, E. & Farrington, C. P. (1999). Autism and measles, mumps and rebecca vaccine: no epidemiological evidence for a casual association. *Lancet*, *353*, 2026-2029.
- Tomblin, B. J., Hafeman, L., & O'Brien, M. (2003). Autism and autism risk in siblings with specific language impairments. *International Journal of Language and Communication Disorders*, *3*, 235-250.
- Turner, M. (1996). Executive dysfunction and repetitive behaviour. In J. Russell (Ed.) *Autism as an Executive Disorder* (p. 57-100). New York, NY: Oxford University Press.
- United States Census Bureau (2000). United States Census Information. Retrieved September 17, 2008, from [http://factfinder.census.gov/home/saff/main.html?\\_lang=en](http://factfinder.census.gov/home/saff/main.html?_lang=en)

- Welsh, M. C. (1991). Rule-guided behavior and self-monitoring on the tower of Hanoi disk transfer task. *Cognitive Development, 6*, 59-76.
- Welsh, M. C. & Pennington, B. F. (1988). Assessing frontal lobe functioning in children: Views from developmental psychology. *Developmental Neuropsychology, 4*, 199-230.
- Welsh, M. C., Pennington, B. F., & Grossier, D. B. (1991). A normative-developmental study of executive function: A window on prefrontal function in children. *Developmental Neuropsychology, 7*, 131-149.
- Yeargin-Allsopp, M., Rice, C., Karapurkar, T., Doernberg, N., Boyle, C. & Murphy, C. (2003). Prevalence of autism in a US metropolitan area. *The Journal of American Medical Association, 289*, 1-16.
- Zelazo, P. D., Reznick, S. J., & Pinon, D. E. (1995). Response control and executive the control of verbal rules. *Developmental Psychology, 31*, 508-517.
- Zelazo, P. D., Craik, F. M., & Booth, L. (2004). Executive functions across the lifespan. *Acta Psychologica, 115*, 167-183.

Table 1

*Total sample by group, mean age, gender, and race*

		<u>Race</u>						
	Girls <i>n</i> ( <i>M</i> age in years and months)	Boys <i>n</i> ( <i>M</i> age in years and months)	Caucasian	African- American	Hispanic	Asian American	Pacific Islander	Total <i>n</i> ( <i>M</i> age in years and months)
<u>AG</u>	4 (14%)	25 (86%)	18 (62%)	6 (21 %)	4 (14%)	1 (3%)	0 (0%)	29 (5.8)
<i>M</i>	( <i>M</i> =5.8)	( <i>M</i> =5.6)						
<u>WG</u>	19 (63%)	11 (37%)	23 (77%)	2 (7%)	3 (10%)	1 (3%)	1 (3%)	30 (5.9)
<i>M</i>	( <i>M</i> =5.11)	( <i>M</i> =5.7)						
<u>Total</u>	23 (39%)	36 (61%)	41 (69%)	8 (14%)	7 (12%)	2 (3%)	1 (2%)	59 (5.9)
<i>M</i>	( <i>M</i> =5.11)	( <i>M</i> =5.8)						

*Note: M = Mean; Groups: AG = Autism Group, WG = Without Autism Group*

Table 2

*Autism Group Participants' Age in Months, Gender, and Leiter-R Subtest scaled scores, IQ, and Percentile Ranks with Means (M) and Standard Deviations (SD by groups (N=29)*

<u>Student ID #</u>	<u>Age in Months</u>	<u>Gender</u>	<u>FG subtest</u>	<u>FC subtest</u>	<u>SO subtest</u>	<u>RP subtest</u>	<u>IQ score</u>	<u>Percentile</u>
21	51	M	8	9	13	13	105	63
24	56	M	12	11	10	16	117	87
28	56	M	6	9	10	13	97	42
5	59	M	3	3	7	8	68	2
10	59	M	1	1	1	7	48	<0.1
11	59	M	1	1	1	7	48	<0.1
19	60	M	6	11	6	7	82	12
26	60	M	6	11	7	8	85	16
29	62	M	4	5	2	6	62	1
20	63	M	7	10	7	4	79	8
25	63	F	16	12	11	14	124	95
6	64	M	2	3	8	6	65	1
12	64	M	10	10	6	4	82	12
1	65	M	1	6	5	4	60	0.4
3	68	M	5	7	4	8	73	4
13	70	M	6	7	5	5	71	3
18	70	F	7	8	13	10	97	42
22	71	M	1	2	6	6	58	0.3
2	74	F	3	7	4	5	65	1

Table 2 Continued

<u>Student ID #</u>	<u>Age in Months</u>	<u>Gender</u>	<u>FG subtest</u>	<u>FC subtest</u>	<u>SO subtest</u>	<u>RP subtest</u>	<u>IQ score</u>	<u>Percentile</u>
15	74	M	7	7	7	8	80	9
4	78	M	1	1	1	1	36	<0.1
9	78	M	6	9	7	6	79	8
17	79	M	4	11	9	6	82	12
7	80	F	1	6	4	5	60	0.4
14	81	M	1	5	4	2	52	0.1
8	82	M	1	1	1	2	38	<0.1
16	83	M	1	8	5	5	65	1
23	83	M	1	11	5	6	71	3
27	83	M	6	9	5	9	80	9
<i>M</i>	68	--	4.6	6.9	6.0	6.9	73.4	8.0
<i>SD</i>	9.7	--	3.8	3.5	3.3	3.6	21.1	6.4

*Note: Leiter-R subtests: FG = Figure Ground, FC = Form Completion, SO = Sequential Ordering, RP = Repeated Patterns.*

Table 3

*Without Autism Group Participants' Age in Months, Gender, and Leiter-R Subtest scaled scores, IQ, and Percentile Ranks with Means (M) and Standard Deviations (SD by groups (N=30)*

<u>Student ID #</u>	<u>Age in Months</u>	<u>Gender</u>	<u>FG subtest</u>	<u>FC subtest</u>	<u>SO subtest</u>	<u>RP subtest</u>	<u>IQ score</u>	<u>Percentile</u>
47	48	M	14	11	10	12	113	81
48	53	F	13	10	10	9	103	58
31	56	F	10	14	9	12	111	77
30	59	M	12	13	12	13	119	90
50	59	F	8	10	7	8	87	19
51	59	F	11	12	8	7	97	42
56	61	F	12	9	8	7	93	32
53	62	M	10	14	9	9	103	58
55	62	M	8	11	7	12	97	42
46	68	M	15	11	5	7	97	42
35	71	F	10	14	14	13	121	92
44	71	F	18	15	10	12	127	96
49	71	M	9	12	13	9	105	63
43	72	M	10	12	13	12	113	81
45	73	F	11	9	14	10	107	68
54	73	M	9	14	13	12	115	84
33	74	M	11	9	13	13	111	77
34	75	F	19	15	4	15	124	95
41	75	F	15	12	13	11	121	92

Table 3 Continued

<u>Student ID #</u>	<u>Age in Months</u>	<u>Gender</u>	<u>FG subtest</u>	<u>FC subtest</u>	<u>SO subtest</u>	<u>RP subtest</u>	<u>IQ score</u>	<u>Percentile</u>
37	76	F	14	15	13	11	124	95
52	76	F	6	7	12	9	89	23
57	76	F	12	11	11	12	111	77
40	77	F	9	11	12	9	102	55
36	78	F	15	14	12	13	126	92
39	78	M	12	13	12	12	117	87
38	79	F	10	11	9	5	91	27
59	79	F	18	15	13	11	131	98
32	80	M	12	13	12	10	113	81
42	80	F	6	11	7	11	91	27
58	80	F	9	7	11	8	91	27
<i>M</i>	70	--	11.6	11.8	10.5	10.5	108	66.1
<i>SD</i>	9	--	3.3	2.3	2.7	2.3	12.8	26.3

*Note: Leiter-R subtests: FG = Figure Ground, FC = Form Completion, SO = Sequential Ordering, RP = Repeated Patterns.*

Table 4

*Autism Group Participants' Age in Months, Gender, and t scores for the Day-Night test and the DCCS with Means (M) and Standard Deviations (SD by groups (N=29)*

<u>Student ID #</u>	<u>Age</u>	<u>Gender</u>	<u>Day-Night</u>	<u>Con. A Pre</u>	<u>Con. A Post</u>	<u>Con. B Pre</u>	<u>Con. B Post</u>	<u>Con. C Pre</u>	<u>Con. C Post</u>
21	51	M	60	55	35	49	37	54	54
24	56	M	56	55	35	55	58	54	54
28	56	M	60	55	35	55	37	54	17
5	59	M	33	38	50	44	44	46	42
10	59	M	33	44	50	23	37	29	36
11	59	M	37	44	35	44	37	46	42
19	60	M	58	44	58	55	44	54	48
26	60	M	42	55	35	55	37	54	54
29	62	M	33	22	50	49	40	54	36
20	63	M	35	55	35	55	37	54	54
25	63	F	60	55	35	55	37	54	54
6	64	M	33	38	47	34	44	29	36
12	64	M	45	55	35	55	37	54	54
1	65	M	47	44	47	49	53	54	54
3	68	M	60	55	58	23	58	54	54
13	70	M	53	22	43	23	55	29	48
18	70	F	37	22	58	55	58	54	54
22	71	M	43	44	50	34	37	29	36
2	74	F	35	55	35	55	37	54	54

Table 4 Continued

<u>Student</u> <u>ID #</u>	<u>Age</u>	<u>Gender</u>	<u>Day-Night</u>	<u>Con. A</u> <u>Pre</u>	<u>Con. A</u> <u>Post</u>	<u>Con. B</u> <u>Pre</u>	<u>Con.</u> <u>B. Post</u>	<u>Con.</u> <u>C. Pre</u>	<u>Con.</u> <u>C. Post</u>
15	74	M	60	55	35	55	37	54	54
4	78	M	42	49	50	44	37	46	36
9	78	M	60	55	35	55	37	54	36
17	79	M	50	27	54	55	37	54	54
7	80	F	47	55	35	55	37	54	54
14	81	M	53	22	47	23	58	29	48
8	82	M	33	22	35	23	37	4	17
16	83	M	60	55	58	55	40	54	54
23	83	M	47	55	35	55	37	54	54
27	83	M	33	55	35	55	58	54	54
<i>M</i>	68	--	46.4	45.1	42.9	46.3	42.7	47.1	46.3
<i>SD</i>	9.7	--	10.7	12.8	9	12.3	8.5	12.6	10.9

*Note: Day-Night test = Inhibition, DCCS = Shifting. DCCS: Con. A Pre = Condition A Pre-Switch, Con. A Post = Condition A Post Switch, Con. B Pre = Condition B Pre-Switch, Con. B Post = Condition B Post Switch, Con. C Pre = Condition C Pre-Switch, Con. C Post = Condition C Post Switch.*

Table 5

*Without Autism Group Participants' Age in Months, Gender, and t scores for the Day-Night test and the DCCS with Means (M) and Standard Deviations (SD by groups (N=30)*

<u>Student ID #</u>	<u>Age</u>	<u>Gender</u>	<u>Day-Night</u>	<u>Con. A Pre</u>	<u>Con. A Post</u>	<u>Con. B Pre</u>	<u>Con. B Post</u>	<u>Con. C Pre</u>	<u>Con. C Post</u>
47	48	M	53	55	58	49	58	54	54
48	53	F	35	55	58	55	58	54	54
31	56	F	56	55	58	55	58	54	54
30	59	M	60	55	58	55	58	54	54
50	59	F	37	55	58	55	40	29	17
51	59	F	33	55	58	55	58	54	48
56	61	F	45	55	35	55	37	54	54
53	62	M	47	55	58	55	58	54	54
55	62	M	37	55	35	55	58	46	54
46	68	M	58	55	58	55	58	54	54
35	71	F	60	55	58	55	58	54	54
44	71	F	60	55	58	55	58	54	54
49	71	M	56	55	58	55	58	54	54
43	72	M	50	55	58	55	58	54	54
45	73	F	58	55	58	55	58	54	54
54	73	M	58	55	58	55	58	54	54
33	74	M	60	55	58	55	58	54	54
34	75	F	60	55	58	55	58	54	54

Table 5 Continued

<u>Student ID #</u>	<u>Age</u>	<u>Gender</u>	<u>Day-Night</u>	<u>Con. A Pre</u>	<u>Con. A Post</u>	<u>Con. B Pre</u>	<u>Con. B. Post</u>	<u>Con. C. Pre</u>	<u>Con. C. Post</u>
41	75	F	60	55	58	55	58	54	54
37	76	F	58	55	58	55	58	54	54
52	76	F	60	55	58	55	58	54	54
57	76	F	60	55	58	55	58	54	54
40	77	F	56	55	58	55	58	54	54
36	78	F	56	55	58	55	58	54	54
39	78	M	60	55	58	55	58	54	54
38	79	F	55	55	58	55	58	54	54
59	79	F	60	55	58	55	58	54	54
32	80	M	60	55	58	55	58	54	54
42	80	F	53	55	58	55	58	54	54
58	80	F	40	55	58	23	58	54	54
<i>M</i>	70	--	53.4	55	56.5	53.7	56.6	52.9	52.6
<i>SD</i>	9	--	8.7	0	5.8	5.9	5	4.7	6.8

*Note: Day-Night test = Inhibition, DCCS = Shifting. DCCS: Con. A Pre = Condition A Pre-Switch, Con. A Post = Condition A Post Switch, Con. B Pre = Condition B Pre-Switch, Con. B Post = Condition B Post Switch, Con. C Pre = Condition C Pre-Switch, Con. C Post = Condition C Post Switch.*

Table 6

*Autism Group Participants' Age in Months, Gender, and t scores for the Noisy Book, Tower of Hanoi, and the Self-Control task with Means (M) and Standard Deviations (SD by groups (N=29)*

<u>Student ID #</u>	<u>Age</u>	<u>Gender</u>	<u>NB Span</u>	<u>NB Total</u>	<u>SC A</u>	<u>SC B</u>	<u>TOH</u>
21	51	M	47	47	56	39	47
24	56	M	78	63	56	41	47
28	56	M	47	47	56	38	47
5	59	M	40	36	30	37	41
10	59	M	33	34	30	38	41
11	59	M	40	42	46	38	41
19	60	M	47	44	56	38	47
26	60	M	40	42	46	39	47
29	62	M	40	24	43	57	41
20	63	M	40	42	37	38	47
25	63	F	40	42	31	39	47
6	64	M	40	39	56	38	41
12	64	M	40	42	30	38	47
1	65	M	40	36	56	59	41
3	68	M	40	36	56	37	41
13	70	M	40	42	56	40	41
18	70	F	60	60	56	40	47
22	71	M	40	39	30	40	41
2	74	F	40	42	56	38	41

Table 6 Continued

<u>Student ID #</u>	<u>Age</u>	<u>Gender</u>	<u>NB Span</u>	<u>NB Total</u>	<u>SC A</u>	<u>SC B</u>	<u>TOH</u>
15	74	M	53	57	30	37	41
4	78	M	40	39	32	38	41
9	78	M	40	53	56	42	47
17	79	M	47	44	56	39	41
7	80	F	40	39	30	38	47
14	81	M	40	39	56	39	41
8	82	M	40	39	29	37	41
16	83	M	47	47	56	39	41
23	83	M	33	34	56	41	41
27	83	M	53	52	56	41	47
<i>M</i>	68	--	43.6	43.3	46.2	40.1	43.7
<i>SD</i>	9.7	--	8.8	7.4	11.9	5.1	3

*Note: NB = Noisy Book (working memory); SC = Self-Control task (Self-Monitoring), SC A = Self-Control Trial A, SC B = Self-Control Trial B; TOH = Tower of Hanoi – Revised (Planning/Organization).*

Table 7

*Without Autism Group Participants' Age in Months, Gender, and t scores for the Noisy Book, Tower of Hanoi, and the Self-Control task with Means (M) and Standard Deviations (SD) by groups (N=30)*

<u>Student ID #</u>	<u>Age</u>	<u>Gender</u>	<u>NB Span</u>	<u>NB Total</u>	<u>SC A</u>	<u>SC B</u>	<u>TOH</u>
47	48	M	47	44	56	59	41
48	53	F	40	42	56	40	47
31	56	F	53	52	56	59	52
30	59	M	60	57	56	59	52
50	59	F	47	44	56	59	47
51	59	F	40	42	56	59	58
56	61	F	47	47	56	59	47
53	62	M	53	47	56	59	58
55	62	M	53	52	56	59	41
46	68	M	60	60	56	59	47
35	71	F	60	57	56	59	74
44	71	F	60	60	56	59	58
49	71	M	40	60	56	59	52
43	72	M	60	63	56	59	63
45	73	F	60	65	56	59	63
54	73	M	60	55	56	59	74
33	74	M	60	65	56	59	58
34	75	F	60	63	56	59	63
41	75	F	60	60	56	59	74

Table 7 Continued

<u>Student ID #</u>	<u>Age</u>	<u>Gender</u>	<u>NB Span</u>	<u>NB Total</u>	<u>SC A</u>	<u>SC B</u>	<u>TOH</u>
37	76	F	60	60	56	59	58
52	76	F	40	65	56	59	58
57	76	F	67	65	56	59	69
40	77	F	60	57	44	59	58
36	78	F	60	63	56	59	47
39	78	M	60	57	56	59	69
38	79	F	53	57	56	59	52
59	79	F	67	68	56	59	47
32	80	M	60	60	56	59	58
42	80	F	60	57	56	59	69
58	80	F	40	42	56	59	47
<i>M</i>	70	--	54.9	56.2	55.6	58	56.7
<i>SD</i>	9	--	8.3	7.8	2.2	3.9	9.7

*Note: NB = Noisy Book (working memory); SC = Self-Control task (Self-Monitoring), SC A = Self-Control Trial A, SC B = Self-Control Trial B; TOH = Tower of Hanoi – Revised (Planning/Organization).*

Table 8

*Autism Group Age in Months, Gender, BRIEF-P t scores, and Mean and Standard Deviations.*

<u>Student ID #</u>	<u>Age</u>	<u>Gender</u>	<u>Inhibit</u>	<u>Shift</u>	<u>EC</u>	<u>WM</u>	<u>P/O</u>	<u>GEC</u>
21	51	M	55	59	67	51	58	59
24	56	M	67	61	60	54	52	65
28	56	M	63	59	55	62	64	64
5	59	M	63	74	64	62	69	70
10	59	M	71	71	76	81	99	85
11	59	M	64	61	71	56	52	64
19	60	M	76	74	74	94	87	89
26	60	M	57	41	50	64	55	56
29	62	M	55	64	43	60	67	59
20	63	M	53	76	55	70	67	67
25	63	F	81	94	90	74	75	81
6	64	M	64	69	64	68	55	69
12	64	M	56	46	48	65	61	58
1	65	M	71	53	62	68	67	70
3	68	M	66	46	50	67	64	63
13	70	M	60	66	55	65	75	67
18	70	F	62	71	75	63	57	63
22	71	M	57	61	50	94	90	75
2	74	F	75	71	62	68	66	67

Table 8 Continued

<u>Student ID #</u>	<u>Age</u>	<u>Gender</u>	<u>Inhibit</u>	<u>Shift</u>	<u>EC</u>	<u>WM</u>	<u>P/O</u>	<u>GEC</u>
15	74	M	60	46	64	48	49	55
4	78	M	76	66	67	89	96	86
9	78	M	42	56	67	62	69	59
17	79	M	66	71	64	71	64	72
7	80	F	85	71	80	73	63	73
14	81	M	77	61	67	78	75	78
8	82	M	81	84	74	95	93	94
16	83	M	52	61	55	62	61	60
23	83	M	63	69	55	76	81	73
27	83	M	66	76	69	59	78	73
<i>M</i>	68	--	65	64.8	63.2	68.9	69.3	89.3
<i>SD</i>	9.7	--	10	11.7	10.7	12.4	13.6	10.6

*Note: Groups: BRIEF-P subscales: EC = Emotional Control; WM = Working Memory; P/O = Plan/Organize; and GEC = Global Executive Composite.*

Table 9

*Without Autism Group Age in Months, Gender, BRIEF-P t scores, and Mean and Standard Deviations.*

<u>Student ID #</u>	<u>Age</u>	<u>Gender</u>	<u>Inhibit</u>	<u>Shift</u>	<u>EC</u>	<u>WM</u>	<u>P/O</u>	<u>GEC</u>
47	48	M	59	53	41	51	49	52
48	53	F	46	50	62	46	48	46
31	56	F	43	41	45	46	42	40
30	59	M	41	41	41	43	40	39
50	59	F	43	50	42	49	42	41
51	59	F	43	41	42	44	42	38
56	61	F	43	41	42	44	42	38
53	62	M	45	41	41	42	40	40
55	62	M	48	41	45	45	43	44
46	68	M	44	41	41	42	40	40
35	71	F	56	41	47	44	42	43
44	71	F	43	41	42	44	42	38
49	71	M	39	41	41	42	40	38
43	72	M	44	41	41	46	40	41
45	73	F	43	41	42	44	42	38
54	73	M	41	41	41	42	40	39
33	74	M	39	41	41	45	43	40
34	75	F	43	44	47	44	42	40
41	75	F	43	41	42	44	42	38

Table 9 Continued

<u>Student ID #</u>	<u>Age</u>	<u>Gender</u>	<u>Inhibit</u>	<u>Shift</u>	<u>EC</u>	<u>WM</u>	<u>P/O</u>	<u>GEC</u>
37	76	F	54	41	42	44	42	41
52	76	F	43	50	42	44	42	40
57	76	F	43	41	42	44	42	38
40	77	F	43	41	42	44	42	38
36	78	F	43	41	42	44	42	38
39	78	M	41	41	41	49	43	42
38	79	F	43	41	42	44	42	38
59	79	F	43	41	42	44	42	38
32	80	M	44	41	48	42	40	41
42	80	F	43	41	45	49	42	40
58	80	F	54	53	42	74	54	54
<i>M</i>	70	--	44.7	42.8	43.2	45.6	42.5	40.7
<i>SD</i>	9	--	4.8	3.9	4.1	5.8	3	3.9

*Note: -P subscales: EC = Emotional Control; WM = Working Memory; P/O = Plan/Organize; and GEC = Global Executive Composite.*

Table 10

*Tests of Equality of Group Means of Executive Functioning*

<u>Tests</u>	<u><i>A</i></u>	<u><i>F</i></u>	<u><i>p</i></u>
Day Night Test	.884	7.51	.008*
DCCS Condition A Pre Switch	.759	18.07	.000*
DCCS Condition A Post Switch	.548	46.95	.000*
DCCS Condition B Pre Switch	.866	8.86	.004*
DCCS Condition B Post Switch	.485	60.49	.000*
DCCS Condition C Pre Switch	.912	5.47	.023*
DCCS Condition C Post Switch	.889	7.09	.010*
Noisy Book Span Score	.553	46.05	.000*
Noisy Book Total Correct	.577	41.74	.000*
Self-Control Trial A	.715	22.68	.000*
Self-Control Trial B	.360	101.40	.000*
Tower of Hanoi-R	.544	47.70	.000*
BRIEF-P Inhibition	.363	99.82	.000*
BRIEF-P Shift	.377	94.29	.000*
BRIEF-P Emotional Control	.384	91.38	.000*
BRIEF-P Working Memory	.397	86.72	.000*
BRIEF-P Plan/Organize	.340	110.86	.000*
BRIEF-P Global Score	.215	207.89	.000*

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\* *Indicates statistical significance*

Table 11

*Wilks' Lambda Test of Significance for each Executive Functioning Domain*

<u>EF Domain</u>	<u><math>\lambda</math></u>	<u><math>X^2</math></u>	<u><math>df</math></u>	<u><math>p</math></u>
Inhibition	.359	57.390	2	.000
Shifting Set	.167	95.826	7	.000
Working Memory	.370	55.178	3	.000
Self-Control	.269	72.892	3	.000
Planning/ Organization	.283	70.622	2	.000

*Note:  $df$  = degrees of freedom.*

Table 12

*Participants Means and Standard Deviations across Age Groups on the Day-Night test and the Dimension Card Sorting Test (DCCS)*

<u>Test</u>	<u>Age</u>	<u>Group</u>	<u>M</u>	<u>SD</u>	<u>n</u>
Day-Night	4	Autism	46.5	13.49	6
		Without Autism	45.67	11.96	6
	5	Autism	45.5	10.22	12
		Without Autism	51.86	8.93	7
	6	Autism	47.27	10.55	11
		Without Autism	56.59	5.2	17
DCCS Condition A Pre	4	Autism	48.5	7.45	6
		Without Autism	55	0	6
	5	Autism	42.58	14.45	12
		Without Autism	55	0	7
	6	Autism	45.91	12.8	11
		Without Autism	55	0	17
DCCS Condition A Post	4	Autism	40	7.75	6
		Without Autism	58	0	6
	5	Autism	46.25	8.98	12
		Without Autism	51.43	11.22	7
	6	Autism	41.27	9.09	11
		Without Autism	58	0	17
DCCS Condition B Pre	4	Autism	45	11.85	6

Table 12 Continued

<u>Test</u>	<u>Age</u>	<u>Group</u>	<u>M</u>	<u>SD</u>	<u>n</u>
		Without Autism	54	2.45	6
	5	Autism	45.17	12.94	12
		Without Autism	55	0	7
	6	Autism	48.18	12.88	11
		Without Autism	53.12	7.76	17
DCCS Condition B Post	4	Autism	41.67	8.48	6
		Without Autism	55	7.35	6
	5	Autism	44.75	8.78	12
		Without Autism	55	7.94	7
	6	Autism	41.09	8.41	11
		Without Autism	58	0	17
DCCS Condition C Pre	4	Autism	47.17	9.73	6
		Without Autism	49.83	10.21	6
	5	Autism	47.75	11.31	12
		Without Autism	52.86	3.02	7
	6	Autism	46.45	16.01	11
		Without Autism	54	0	17
DCCS Condition C Post	4	Autism	40.83	13.72	6
		Without Autism	46.83	14.81	6
	5	Autism	48.5	7.87	12
		Without Autism	54	0	7

Table 12 Continued

<u>Test</u>	<u>Age</u>	<u>Group</u>	<u>M</u>	<u>SD</u>	<u>n</u>
	6	Autism	46.82	12.19	11
		Without Autism	54	0	17

Table 13

*Participants Means and Standard Deviations across Age Groups on the Noisy Book test, Self-Control task, and the Tower of Hanoi-R*

<u>Test</u>	<u>Age</u>	<u>Group</u>	<u>M</u>	<u>SD</u>	<u>n</u>
Noisy Book span score	4	Autism	45.67	11.69	6
		Without Autism	47.83	7.73	6
	5	Autism	42.25	5.94	12
		Without Autism	56.14	5.21	7
	6	Autism	43	6.21	11
		Without Autism	59.24	5.79	17
Noisy Book total score	4	Autism	44.83	10.42	6
		Without Autism	46.83	6.21	6
	5	Autism	41.92	6.23	12
		Without Autism	54.71	5.99	7
	6	Autism	44.09	7.26	11
		Without Autism	60.12	6	17
Self-Control trial A	4	Autism	43.67	11.69	6
		Without Autism	56	0	6
	5	Autism	46.08	11.39	12
		Without Autism	56	0	7
	6	Autism	45.55	12.64	11
		Without Autism	55.29	2.91	17

Table 13 Continued

<u>Test</u>	<u>Age</u>	<u>Group</u>	<u>M</u>	<u>SD</u>	<u>n</u>
Self-Control trial B	4	Autism	41.5	8.6	6
		Without Autism	55.83	7.76	6
	5	Autism	41.92	7.56	12
		Without Autism	57.57	3.78	7
	6	Autism	42.27	8.38	11
		Without Autism	59	0	17
Tower of Hanoi-R	4	Autism	44	3.29	6
		Without Autism	49.5	5.82	6
	5	Autism	44.5	3.09	12
		Without Autism	53.86	10.82	7
	6	Autism	42.64	2.8	11
		Without Autism	60.41	8.84	17

Table 14

*Participants Means and Standard Deviations across Age Groups for the BRIEF-P*

<u>Test</u>	<u>Age</u>	<u>Group</u>	<u>M</u>	<u>SD</u>	<u>n</u>
BRIEF-P Inhibition	4	Autism	63.83	5.31	6
		Without Autism	45.83	6.65	6
	5	Autism	63.17	8.85	12
		Without Autism	45.43	5.38	7
	6	Autism	67.55	12.96	11
		Without Autism	43.94	3.98	17
BRIEF-P Shift	4	Autism	64.17	6.59	6
		Without Autism	46	5.59	6
	5	Autism	63.42	15.15	12
		Without Autism	41	0	7
	6	Autism	66.55	10.27	11
		Without Autism	42.41	3.54	17
BRIEF-P Working Memory	4	Autism	61	10.73	6
		Without Autism	46.5	3.02	6
	5	Autism	71	11.31	12
		Without Autism	43.29	1.25	7
	6	Autism	71	13.5	11
		Without Autism	46.29	7.39	17
BRIEF-P Emotional Control	4	Autism	65.5	7.56	6
		Without Autism	45.5	8.22	6

Table 14 Continued

<u>Test</u>	<u>Age</u>	<u>Group</u>	<u>M</u>	<u>SD</u>	<u>n</u>
	5	Autism	59.67	13.89	12
		Without Autism	42.71	2.36	7
	6	Autism	65.82	7.33	11
		Without Autism	42.59	2.06	17
BRIEF-P Plan/Organize	4	Autism	65.67	17.65	6
		Without Autism	43.83	3.71	6
	5	Autism	68.33	11.55	12
		Without Autism	41.29	1.25	7
	6	Autism	72.27	14.08	11
		Without Autism	42.47	3.11	17
BRIEF-P Global score	4	Autism	67.83	9.11	6
		Without Autism	42.67	5.35	6
	5	Autism	68.08	9.73	12
		Without Autism	40.14	2.48	7
	6	Autism	71.82	11.6	11
		Without Autism	40.24	3.8	17

Table 15

*Univariate Analysis of Variance by Age and Age + Group*

<u>EF Domain</u>	<u>Tests</u>	<u>Source</u>	<u>M<sup>2</sup></u>	<u>F</u>	<u>p</u>
Inhibition	Day-Night	Age	154.128	1.703	.192
		Group + Age	106.603	1.178	.316
	BRIEF-P Inhibition	Age	11.647	.185	.831
		Group + Age	58.379	.930	.401
Shifting Set	DCCS Condition A Pre-Switch	Age	32.816	.392	.678
		Group + Age	32.816	.392	.678
	DCCS Condition A Post-Switch	Age	3.860	.074	.929
		Group + Age	218.118	4.176	.021**
	DCCS Condition B Pre-Switch	Age	5.741	.059	.943
		Group + Age	37.177	.379	.686
	DCCS Condition B Post-Switch	Age	9.102	.180	.829
		Group + Age	1.241	1.241	.297
	DCCS Condition C Pre-Switch	Age	14.623	.154	.857
		Group + Age	25.938	.274	.761
	DCCS Condition C Post-Switch	Age	229.340	2.891	.064
		Group + Age	4.072	.051	.950
	BRIEF-P Shift	Age	38.177	.487	.617
		Group + Age	36.880	.471	.627

Table 15 Continued

<u>EF Domain</u>	<u>Tests</u>	<u>Source</u>	<u>M<sup>2</sup></u>	<u>F</u>	<u>p</u>
Working Memory	Noisy Book span score	Age	80.934	1.746	.184
		Group + Age	211.046	4.554	.015**
	Noisy Book total score	Age	183.475	3.920	.026*
		Group + Age	205.545	4.391	.017**
	BRIEF-P Working Memory	Age	99.289	1.111	.337
		Group + Age	165.612	1.854	.167
Self-Control	Self-Control trial A	Age	5.344	.074	.929
		Group + Age	7.523	.104	.902
	Self-Control trial B	Age	16.545	.419	.660
		Group + Age	6.098	.155	.857
	BRIEF-P Emotional Control	Age	77.735	1.217	.304
		Group + Age	53.043	.831	.441
Plan/Organize	Tower of Hanoi-R	Age	98.912	2.221	.118
		Group + Age	188.262	4.228	.020**
	BRIEF-P Plan/Organize	Age	47.034	.476	.642
		Group + Age	65.851	.666	.518
Global	BRIEF-P Global score	Age	19.484	.321	.727
		Group + Age	46.760	.771	.467

Note: \*  $p$  level  $\leq .05$ : Age-based differences. \*\*  $p$  level  $< .05$ : Group age-based differences.

Table 16

*Participants Means and Standard Deviations across low and high IQ autism groups and the without autism group on the Day-Night test and the Dimension Card Sorting Test (DCCS)*

<u>Test</u>	<u>Group</u>	<u>M</u>	<u>SD</u>	<u>n</u>
Day-Night	<70 IQ Autism	40.7	8.9	13
	>70 IQ Autism	51	9.9	16
	Without Autism	53.3	8.7	30
DCCS Condition A Pre	<70 IQ Autism	40.9	12.2	13
	>70 IQ Autism	48.4	12.6	16
	Without Autism	55	0	30
DCCS Condition A Post	<70 IQ Autism	45.3	7.7	13
	> 70 IQ Autism	41.3	9.7	16
	Without Autism	56.5	5.8	30
DCCS Condition B Pre	< 70 IQ Autism	40.9	12.3	13
	> 70 IQ Autism	50.6	10.9	16
	Without Autism	53.7	5.9	30
DCCS Condition B Post	< 70 IQ Autism	41.4	6.9	13
	> 70 IQ Autism	43.8	9.6	16
	Without Autism	56.7	5	30
DCCS Condition C Pre	< 70 IQ Autism	40.6	15.4	13
	> 70 IQ Autism	52.4	6.3	16
	Without Autism	52.9	4.7	30

Table 16 Continued

<u>Test</u>	<u>Group</u>	<u>M</u>	<u>SD</u>	<u>n</u>
DCCS Condition C Post	<70 IQ Autism	41.9	10.9	13
	>70 IQ Autism	49.8	9.9	16
	Without Autism	52.6	6.8	30
Noisy Book span	<70 IQ Autism	40	2.9	13
	>70 IQ Autism	45.9	8.8	16
	Without Autism	56.2	7.4	30
Noisy Book total	<70 IQ Autism	39.2	3.2	13
	> 70 IQ Autism	46.7	8.2	16
	Without Autism	56.2	7.8	30
Self-Control Trial A	< 70 IQ Autism	42.3	12.3	13
	> 70 IQ Autism	47.9	10.5	16
	Without Autism	55.6	2.2	30
Self-Control Trial B	< 70 IQ Autism	41.2	7.5	13
	> 70 IQ Autism	42.6	8.2	16
	Without Autism	58	3.9	30
Tower of Hanoi-R	< 70 IQ Autism	41.9	2.3	13
	> 70 IQ Autism	45.1	2.9	16
	Without Autism	56.7	9.7	30
BRIEF-P Inhibition	< 70 IQ Autism	68.5	10.3	13
	> 70 IQ Autism	62.1	9.1	16
	Without Autism	44.7	4.8	30

Table 16 Continued

<u>Test</u>	<u>Group</u>	<u>M</u>	<u>SD</u>	<u>n</u>
BRIEF-P Shift	<70 IQ Autism	66.7	7.8	13
	>70 IQ Autism	63.2	14.2	16
	Without Autism	42.8	3.9	30
BRIEF-P Emotion Control	<70 IQ Autism	64.2	10.4	13
	>70 IQ Autism	62.4	11.2	16
	Without Autism	43.2	4.1	30
BRIEF-P Working Mem.	<70 IQ Autism	73.4	13	13
	> 70 IQ Autism	65.3	11.2	16
	Without Autism	45.6	5.8	30
BRIEF-P Plan/Organize	< 70 IQ Autism	73.3	15.9	13
	> 70 IQ Autism	66	10.9	16
	Without Autism	42.5	3	30
BRIEF-P Global	< 70 IQ Autism	73.1	10.4	13
	> 70 IQ Autism	66.5	9.3	16
	Without Autism	40.7	3.9	30

Table 17

*Univariate IQ Analysis of Variance by IQ Group*

<u>EF Domain</u>	<u>Tests</u>	<u>M<sup>2</sup></u>	<u>F</u>	<u>p</u>
Inhibition	Day-Night	734.16	8.93	.000*
	BRIEF-P Inhibition	3188.345	56.345	.000*
Shifting Set	DCCS Condition A Pre-Switch	929.654	12.45	.000*
	DCCS Condition A Post-Switch	1382.467	25.01	.000*
	DCCS Condition B Pre-Switch	747.595	9.096	.000*
	DCCS Condition B Post-Switch	1461.245	30.627	.000*
	DCCS Condition C Pre-Switch	746.007	10.185	.000*
	DCCS Condition C Post-Switch	514.992	6.794	.002*
	BRIEF-P Shift	3599.115	47.874	.000*
Working Memory	Noisy Book span score	1368.255	27.045	.000*
	Noisy book total score	1417.812	27.112	.000*
	BRIEF-P Working Memory	4235.548	49.482	.000*
Self-Monitoring	Self-Control Trial A	881.344	13.523	.000*
	Self-Control Trial B	1909.852	50.278	.000*
	BRIEF-P Emotional Control	2963.537	45.383	.000*
Plan/Organize	Tower of Hanoi-R	1284.768	24.733	.000*
	BRIEF-P Plan/Organize	5490.654	60.691	.000*
Total	BRIEF-P Global	6248.541	115.438	.000*

\*  $p < .05 = statistically\ significant.$

Table 18

*IQ ANOVA including Mean Square, F, and Significance Level*

<u>Tests</u>	<u>M<sup>2</sup></u>	<u>F</u>	<u>p</u>
Day-Night	117.184	1.33	.232
BRIEF-P Inhibition	210.193	2.014	.037*
DCCS Condition A Pre-Switch	120.464	1.457	.167
DCCS Condition A Post-Switch	111.289	1.272	.270
DCCS Condition B Pre-Switch	131.169	1.854	.057
DCCS Condition B Post-Switch	126.036	2.196	.023*
DCCS Condition C Pre-Switch	141.481	3.824	.000*
DCCS Condition C Post-Switch	115.197	1.955	.043*
BRIEF-P Shift	208.567	1.152	.361
Noisy Book span score	129.711	2.515	.010*
Noisy book total score	135.930	2.658	.007*
BRIEF-P Working Memory	322.508	3.075	.002*
Self-Control Trial A	105.714	1.375	.208
Self-Control Trial B	130.467	1.987	.040*
BRIEF-P Emotional Control	179.926	1.234	.296
Tower of Hanoi-R	125.359	2.336	.016*
BRIEF-P Plan/Organize	377.673	3.075	.002*
BRIEF-P Global	365.909	2.649	.007*

\*  $p < .05 = \text{statistical significance.}$

Table 19

*Participants' Performance  $r^2$  Analysis across Executive Functioning Domains*

<u>Tests</u>	<u>BRIEF-P Inhibition</u>	<u>BRIEF-P Shift</u>	<u>BRIEF-P Working Memory</u>	<u>BRIEF-P Emotional Control</u>	<u>BRIEF-P Plan/Organize</u>
Day-Night	-.348*				
	.007				
DCCS Con. A Pre-Switch		-.520*			
		.000			
DCCS Con. A Post-Switch		-.504*			
		.000			
DCCS Con. B Pre-Switch		-.349*			
		.007			
DCCS Con. B Post-Switch		-.604*			
		.000			
DCCS Con. C Pre-Switch		-.395*			
		.002			
DCCS Con. C Post-Switch		-.370*			
		.004			
Noisy Book span score			-.718*		
			.000		
Noisy Book total score			-.724*		
			.000		

Table 19 Continued

<u>Tests</u>	<u>BRIEF-P Inhibition</u>	<u>BRIEF-P Shift</u>	<u>BRIEF-P Working Memory</u>	<u>BRIEF-P Emotional Control</u>	<u>BRIEF-P Plan/Organize</u>
Self-Control trial A				-.486*	
				.000	
Self-Control trial B				-.741*	
				.000	
TOH-R					-.596*
					.000

*Note: Top statistic =  $r^2$ . Bottom statistic =  $p$  level (2 tailed).*

*\* Statistical Significant Correlation*

Appendix B  
*Summary of Preschool Executive Functioning Instruments*

<u>Instrument Name</u>	<u>Age Group</u>	<u>Form</u>	<u>Aval.</u> <u>Norms</u>	<u>Valid</u> <u>Norms</u>	<u>Used w/</u> <u>autism</u>	<u>W.M.</u>	<u>Inhibit</u>	<u>Shift/Ini</u> <u>t</u>	<u>Self-</u> <u>Monitor</u>	<u>Plan/Or</u> <u>g</u>	<u>®</u>
NEPSY-2	3-12 yrs	Elicited	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Trails-P	3-6 yrs	Elicited	No	No	No	No	No	Yes	No	No	In review
School Shape	3-5 yrs	Elicited	No	No	No	No	Yes	Yes	No	No	In review
Day-Night Task	3.5-7 yrs	Elicited	No	No	Yes	No	Yes	Yes	No	No	No
Tower of Hanoi-R	2.5-9 yrs	Elicited	No	No	Yes	Yes	Yes	Yes	No	Yes	No
A-not-B	3-7 yrs	Elicited	No	No	Yes	Yes	Yes	No	No	No	No
Delayed Alternation	3-7 yrs	Elicited	No	No	Yes	Yes	No	Yes	No	No	No
Spatial Reversal	2.5-7 yrs	Elicited	No	No	Yes	No	No	Yes	No	No	No
Color Reversal	2-7 yrs	Elicited	No	No	Yes	No	No	Yes	No	No	No
Self Control	2-6.5 yrs	Elicited	No	No	No	No	Yes	No	Yes	No	No
Boxes	3.5-5 yrs	Elicited	No	No	Yes	Yes	Yes	No	No	No	No
DCCS	2.5-6 yrs	Elicited	No	No	No	Yes	Yes	Yes	No	No	No
Noisy Book Task	2.0-5.5 yrs	Elicited	No	No	No	Yes	No	No	No	No	No
BRIEF-P	2.0-5.11 yrs	Rating scale	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

*Note: W.W. = Working memory, ® = existing copyright*

Appendix C

Date: \_\_\_\_\_

Title: Executive Functioning Profiles in Preschool Children with Autism

Principle Investigator: Karin Lifter Ph.D., Professor

Student Investigator: Jeff Drayer MS Ed., 4<sup>th</sup> year Doctoral Student in Counseling Psychology

Dear Parent(s) of \_\_\_\_\_,

My name is Jeff Drayer, a fourth year doctoral student in counseling psychology at Northeastern University. My academic advisor and I would like to include your child in my dissertation study investigating the learning patterns of preschool-aged children with autism. More specifically, I am studying how preschool children with autism organize information, store and manipulate short-term information, initiate in goal oriented tasks, inhibit automatic over-learned responses, and self-monitor their own behaviors (otherwise known as executive functioning) compared to preschool children without autism. It is our expectation that the results of this study will extend our understanding of how children with autism learn to provide improved educational services to these children.

Enclosed are two copies of the informed consent form that describes the research study in further detail. Upon your agreement to allow your child to participate in the study, please be signed and returned to school the official copy with your child to school. The other copy is for you to keep for your records.

On a more personal note, I graduated from Concordia College with a Bachelor's degree in Behavioral Science in 1999 and with a Master's degree from Johns Hopkins University in Clinical Community Counseling in 2003. Over the past eight years, I have been committed to working with children, adolescents, and adults in hospital settings, in the community, and in the educational system. In addition, I have three years of experience in cognitive and learning assessment. Currently, I am working as a doctoral psychology intern at Terry Children's Psychiatric Center in New Castle, Delaware. Over the course of my professional experience, I have become increasingly interested in executive functioning. These characteristics of learning play a fundamental role in a child's behavioral, cognitive, social, and emotional development beginning as early as birth. Young children use executive functioning skills to observe, interpret, and interact with their external world. To gain a better comprehension of these characteristics would mean to have a clearer understanding of how young children with autism begin to learn and interact with their environment. It is my hope that this research study will contribute to the

field of psychology by providing important information about how young children with autism learn.

Your and your child's participation in this study is completely voluntary. Your choice to participate will not impact any services you or your child is currently receiving. Your participation will also be completely confidential. Only Jeff Drayer will receive the identified data. These data will only be de-identified and coded by Jeff Drayer to protect the identity of the participants. Once the information is coded and de-identified it will be stored in a locked file cabinet at Northeastern University.

If you have any questions or concerns throughout the research study, please feel free to contact my dissertation chair (Dr. Karin Lifter) or Jeff Drayer by mail, email or phone.

Sincerely,

Jeffrey Drayer MS Ed.  
4<sup>th</sup> year Doctoral Student  
Northeastern University  
(617) 373-5916  
drayer.j@neu.edu

Karin Lifter Ph.D.  
Professor and Dissertation Chairperson  
Northeastern University  
(617) 373-5916  
k.lifter@neu.edu

If you have any questions about your rights as a research participant please contact the Division of Research Integrity at (617) 373-7570.

## Appendix D

## INFORMED CONSENT

Mr. Jeff Drayer, a fourth year doctoral student in the counseling psychology program at Northeastern University is conducting a research dissertation study to investigate the learning patterns of preschool children between the ages of 4 and 6 years, who have been diagnosed with autism. Mr. Drayer will be under direct supervision of Dr. Karin Lifter, a Northeastern University professor and a member of the May Institute Advisory Board. As the guardian, you are asked for permission to allow your child to participate in this study.

As part of the study, your child will be asked to complete specific paper and pencil tasks in a child friendly, storybook format. These tasks measure an area of learning called executive functions. More specifically, executive functioning is known as the ability to plan and organize information, to inhibit automatic responses, to initiate in goal directed behavior, to hold information in short-term memory, and to self-monitor one's own behavior.

Research has shown that older children and adults diagnosed with autism display decreased amounts of executive functioning skills when compared to same-aged individuals without autism. Less is known, however, about the performance on tests designed to measure executive functioning skills in preschool-aged children, especially preschool children with autism.

Procedures

Mr. Drayer and another Northeastern doctoral student in school psychology will be conducting the testing. Prior to the administration of the test battery, both students will serve as classroom aides for two weeks to become familiar with each child participating in the study. Testing sessions will be coordinated with the child's teacher, each session taking about one hour, up to an hour and a half. At the appointed time the investigator will tell the child "Hello \_\_\_\_\_, it is time to go to another room. We are going to play some games". Prior to the administration of the testing battery, each child will be allowed to play with pre-selected toys to facilitate a comfortable environment for testing. All measures will be administered in a distraction-free, empty classroom at the selected testing site. The research battery of tests will include six paper and pencil tests designed in a child friendly format, taking approximately 1 to 2 hours to complete.

Teachers will also be asked to complete an observational rating scale test with a time of completion of approximately 10 to 15 minutes. The rating scale test will incorporate teacher behavior observations of executive functioning in your child's nature everyday environment.

Potential Risks

Participating in this study poses no medical risk to your child. As a result of the testing however, your child will be absent from his or her class for approximately 1 to 2 hours. In addition, your child may experience some level of frustration from the test procedures. Some examples of possible frustration may be: difficulty identifying the correct answers, delaying

positive reinforcements, multitasking different information at the same time, and remaining focused on a particular test over a period of several minutes.

Benefits

In the event that your child experiences any level of frustration during testing, he/she will be allowed to play with toys, take a break, have the opportunity to win rewards (i.e., stickers, stamps, or pencils), or return to his/her classroom. If you chose, your results can be shared with your child's service providers. With this information, your child's service providers will gain a better understanding into your child's learning patterns and hopefully be able to develop more effective cognitive, behavioral, and academic strategies to improve his or her success in the future. This research will also provide vital information to improve our knowledge of autism and further improve treatment for future generations of children diagnosed with autism.

Your participation will be completely confidential. Your and your child's participation in this study is completely voluntary. Your choice to participate will not impact any services you or your child is currently receiving. Only Jeff Drayer will receive the identified data. These data will only be de-identified and coded by Jeff Drayer to protect the identity of the participants. Once the information is coded and de-identified it will be stored in a locked file cabinet at Northeastern University. No information about your child will be released to anyone other than yourself, if you request it. The publication or presentation of the study data would in no way identify you or your child as a participant. In addition, all confidential information will be destroyed at the end of the study.

Your and your child's participation in this study is completely voluntary. If you want to withdraw your child from the study, at any time, you may do so without penalty. Any information collected from your child to this point would be destroyed.

Once the study is completed, you may receive the results of the study. If you would like these results, or if you have any questions or concerns in the meantime, please contact:

Jeffrey Drayer or Dr. Karin Lifter  
230 Lake Hall  
Northeastern University  
360 Huntington Avenue  
Boston, MA 02115  
(617) 373-5916  
drayer.j@neu.edu or k.lifter@neu.edu

If you have any complaints about your treatment as a participant in this study, believe that you have been harmed in some way by your participation or just have general concerns, please call or write:

Northeastern University  
Division of Research Integrity  
413 Lake Hall  
Boston, MA 02115-5000  
(617) 373-7570  
[www.research.neu.edu/research\\_integrity/](http://www.research.neu.edu/research_integrity/)

I have received a complete explanation of the study and I agree to participate.

---

Print Name of Child Participating

---

Legal Guardian Signature

Appendix E

Date: \_\_\_\_\_

Title: Executive Functioning Profiles in Preschool Children with Autism

Principle Investigator: Karin Lifter Ph.D., Professor

Student Investigator: Jeff Drayer MS Ed., 4<sup>th</sup> year Doctoral Student in Counseling Psychology

Dear Parent(s) of \_\_\_\_\_,

My name is Jeff Drayer, a fourth year doctoral student in counseling psychology at Northeastern University. My academic advisor and I would like to include your child in my dissertation study investigating the learning patterns of preschool-aged children with autism compared to same-aged peers without autism. More specifically, I am studying how preschool children with autism organize information, store and manipulate short-term information, initiate in goal oriented tasks, inhibit automatic over-learned responses, and self-monitor their own behaviors (otherwise known as executive functioning) compared to preschool children without autism. It is our expectation that the results of this study will extend our understanding of how children with autism learn to provide improved educational services to these children. In understanding how children with autism learn, it is important to be able to compare their learning patterns to the learning patterns of children who are developing without any delays or disabilities.

Enclosed are two copies of the informed consent form that describes the research study in further detail. Upon your agreement to allow your child to participate in the study, please be signed and returned to school the official copy with your child to school. The other copy is for you to keep for your records.

On a more personal note, I graduated from Concordia College with a Bachelor's degree in Behavioral Science in 1999 and with a Master's degree from Johns Hopkins University in Clinical Community Counseling in 2003. Over the past eight years, I have been committed to working with children, adolescents, and adults in hospital settings, in the community, and in the educational system. Furthermore, I have three years of experience in cognitive and learning assessment. Currently, I am working as a doctoral psychology intern at Terry Children's Psychiatric Center in New Castle, Delaware. Over the course of my professional experience, I have become increasingly interested in executive functioning. These characteristics of learning play a fundamental role in a child's behavioral, cognitive, social, and emotional development beginning as early as birth. Young children use executive functioning skills to observe, interpret, and interact with their external world. To gain a better comprehension of these characteristics

would mean to have a clearer understanding of how young children begin to learn and interact with their environment. It is my hope that this research study will contribute to the field of psychology by providing important information about how young children with autism learn.

Your and your child's participation in this study is completely voluntary. Your choice to participate will not impact any services you or your child is currently receiving. Your participation will also be completely confidential. Only Jeff Drayer will receive the identified data. These data will only be de-identified and coded by Jeff Drayer to protect the identity of the participants. Once the information is coded and de-identified it will be stored in a locked file cabinet at Northeastern University.

If you have any questions or concerns throughout the research study, please feel free to contact my dissertation chair (Dr. Karin Lifter) or me by mail, email or phone.

Sincerely,

Jeffrey Drayer MS Ed.  
4<sup>th</sup> year Doctoral Student  
Northeastern University  
(617) 373-5916  
drayer.j@neu.edu

Karin Lifter Ph.D.  
Professor and Dissertation Chairperson  
Northeastern University  
(617) 373-5916  
k.lifter@neu.edu

If you have any questions about your rights as a research participant please contact the Division of Research Integrity at (617) 373-7570.

## Appendix F

## INFORMED CONSENT

Mr. Jeff Drayer, a fourth year doctoral student in the counseling psychology program at Northeastern University is conducting a research dissertation study to investigate the learning patterns of preschool children between the ages of 4 and 6 years with and without autism. Mr. Drayer will be under direct supervision of Dr. Karin Lifter, a Northeastern University professor and a member of the May Institute Advisory Board. As the guardian, you are asked for permission to allow your child to participate in this study.

As part of the study, your child will be asked to complete specific paper and pencil tasks in a child friendly, storybook format. These tasks measure an area of learning called executive functioning. More specifically, executive functioning is known as the ability to plan and organize information, to inhibit automatic responses, to initiate in goal directed behavior, to hold information in short-term memory, and to self-monitor one's own behavior.

Research has shown that older children and adults diagnosed with autism display decreased amounts of executive functioning skills when compared to same-aged individuals without autism. Less is known, however, about the performance on tests designed to measure executive functioning skills in preschool-aged children, especially preschool children with autism. In this same vein, this research study will examine executive functioning performance of preschool-aged children (4-6 year olds) and compare their performance to same-aged children without autism. By examining these skills in younger children we hope to develop a clearer understanding of autism.

Procedures

With your permission, your child will be enrolled in the group of children without autism. Mr. Drayer and another Northeastern doctoral student in school psychology will be conducting the testing. Testing sessions will be coordinated with the child's teacher, each session taking about one hour, up to an hour and a half. At the appointed time the investigator will tell the child "Hello \_\_\_\_\_, it is time to go to another room. We are going to play some games". Prior to the administration of the testing battery, each child will be allowed to play with pre-selected toys to facilitate a comfortable environment for testing. All measures will be administered in a distraction-free, empty classroom at the selected testing site. The research battery of tests will include six paper and pencil tests designed in a child friendly format, taking approximately 1 to 2 hours to complete.

Teachers will also be asked to complete an observational rating scale test with a time of completion of approximately 10 to 15 minutes. The rating scale test will incorporate teacher behavior observations of executive functioning in your child's nature everyday environment.

Potential Risks

Participating in this study poses no medical risk to your child. As a result of the testing however, your child will be absent from his or her class for approximately 1 to 2 hours. In addition, your child may experience some level of frustration from the test procedures. Some

examples of possible frustration may be: difficulty identifying the correct answers, delaying positive reinforcements, multitasking different information at the same time, and remaining focused on a particular test over a period of several minutes.

Benefits

In the event that your child experiences any level of frustration during testing, he/she will be allowed to play with toys, take a break, have the opportunity to win rewards (i.e., stickers, stamps, or pencils), or return to his/her classroom. If you chose, your results can be shared with your child's service providers. With this information, your child's service providers will gain a better understanding into your child's learning patterns and hopefully be able to develop more effective cognitive, behavioral, and academic strategies to improve his or her success in the future. This research will also provide vital information to improve our knowledge of autism and further improve treatment for future generations of children diagnosed with autism.

Your participation will be completely confidential. Your and your child's participation in this study is completely voluntary. Your choice to participate will not impact any services you or your child is currently receiving. Only Jeff Drayer will receive the identified data. These data will only be de-identified and coded by Jeff Drayer to protect the identity of the participants. Once the information is coded and de-identified it will be stored in a locked file cabinet at Northeastern University. No information about your child will be released to anyone other than yourself, if you request it. The publication or presentation of the study data would in no way identify you or your child as a participant. In addition, all confidential information will be destroyed at the end of the study.

Your and your child's participation in this study is completely voluntary. If you want to withdraw your child from the study, at any time, you may do so without penalty. Any information collected from your child to this point would be destroyed.

Once the study is completed, you may receive the results of the study. If you would like these results, or if you have any questions or concerns in the meantime, please contact:

Jeffrey Drayer or Dr. Karin Lifter  
230 Lake Hall  
Northeastern University  
360 Huntington Avenue  
Boston, MA 02115  
(617) 373-5916  
drayer.j@neu.edu or k.lifter@neu.edu

If you have any complaints about your treatment as a participant in this study, believe that you have been harmed in some way by your participation or just have general concerns, please call or write:

Northeastern University  
Division of Research Integrity  
413 Lake Hall

Boston, MA 02115-5000

(617) 373-7570

[www.research.neu.edu/research\\_integrity/](http://www.research.neu.edu/research_integrity/)

I have received a complete explanation of the study and I agree to participate.

---

Print Name of Child Participating

---

Parent/Legal Guardian Signature

Appendix G  
Request to Conduct Research

**Part I: Personal Information**

Name: \_\_\_\_\_

Work Location: \_\_\_\_\_

Work Address: \_\_\_\_\_

Work Telephone: \_\_\_\_\_

Email address: \_\_\_\_\_

Name of Approver:  
(CSD employees  
only) \_\_\_\_\_

**Part II: Introduction to the Project**

Title of the Project: \_\_\_\_\_

Why are you  
conducting the  
study?

Masters Thesis/Paper

Independent Research

Dissertation Research/Project

Federal/State/Foundation Grant

University  
Affiliation: \_\_\_\_\_

Faculty Advisor:  
(graduate students  
only) \_\_\_\_\_

Has this study been reviewed and approved by an Institutional Review Board (IRB)?

Yes, it has been reviewed and approved. Attach IRB approval notification.

No, review is pending. Evidence of IRB approval may be submitted at a later date, but must be received prior to initiating study.

No, this study is exempt from IRB approval as indicated in federal guidelines.

Rationale for exemption: \_\_\_\_\_

Expected Date of Project Completion: \_\_\_\_\_

**Part IV: Required Attachments**

- Research Description (including the purpose, research design and methodology, detailed protocol for data collection, plan for analyzing the data, and expected benefit to the school district)
- Copy of informed consent/assent forms, all data collection instruments (e.g. surveys, tests, observation protocols) and the informational letter that will be sent to the participants describing the study

**Please read each of the following statements and place a check mark in the box indicating your have read and agree to abide by each of the following statements.**

- I will comply with all statutes, rules, and regulations applicable to conducting research including the *Federal Family Rights and Privacy Act*. I will abide by all of the policies and regulations of the Christina School District and will conduct this research with the stipulations accompanying any letter of approval.
- I will request approval for any changes or additions made to data collection instruments that are not formatting or editing related after receiving approval. The research and use of data will be consistent with the approved research design. No further uses of this data will be permitted without additional written permission from the Office of Research and Assessment.
- I acknowledge that participation in research by students, parents, and school staff is voluntary. I will preserve the anonymity of all participants in all reporting of this study. I will not reveal the identity or include identifiable characteristics of schools or the school district unless authorized by the Senior Administrator of Research and Assessment.
- I will notify the Office of Research and Assessment immediately if my status as principal investigator changes.
- At the completion of the study, I will provide the Office of Research and Assessment in the Christina School District with a copy of the results.

_____ / _____
Signature of Researcher/Principal Investigator / Date
_____ / _____
Signature of Approver (CSD employees only) / Date
_____ / _____
Signature of Advisor (graduate students only) / Date

**Please mail or fax requested material to:**

Appendix H

Dear Mr. Drayer:

Thank you for submitting your proposal *Executive Functioning Profiles of Preschooler with Autism* for consideration by the Christina School District (CSD). Staff has reviewed your research proposal, and approval has been granted.

This approval means that we have found your proposed research methods to be compatible with a public school setting and your research questions of interest to the school district. Based on the information you have supplied, your approval to conduct research will expire on **March 25, 2008**. If you are unable to complete your research by the date indicated, you must contact the Accountability and Assessment office in writing and request an extension.

Implementing your research, however, is a decision to be reached by the affected principals on a strictly voluntary basis. To assist principals in their decision, please submit via e-mail ([paxtond@christina.k12.de.us](mailto:paxtond@christina.k12.de.us)) a one-page summary outlining the operational steps to be performed by staff at their schools. Upon receipt of the summary, I will forward the summary to the principal of Brennen School, Dr. John Dewey, along with the *Approval Memorandum* indicating this research has been approved by the district.

Per your proposal, the anticipated date for submitting an electronic copy of the research findings is **May 25, 2008**. If additional assistance is needed from our staff, please contact me at (302) 552-2702.

Thank you for your request.

Sincerely,

Pamela B. Stazesky

Pamela B. Stazesky, Ph.D.  
Supervisor  
Accountability and Assessment

Appendix I

Dear Parent(s),

My name is Jeff Drayer, a fourth year doctoral student in counseling psychology at Northeastern University. I would like to follow up on a letter that you received a few weeks ago regarding your child's participation in my dissertation study investigating the learning patterns of preschool-aged children with autism compared to same-aged peers without autism. More specifically, I am studying the learning patterns in a childlike, storybook format in preschool children with autism (otherwise known as executive functioning) compared to preschool children without autism. It is our expectation that the results of this study will extend our understanding of how children with autism learn to provide improved educational services to these children. In understanding how children with autism learn, it is important to be able to compare their learning patterns to the learning patterns of children who are developing without any delays or disabilities.

Enclosed is another copy of the informed consent form that describes the research study in further detail. If you agree to allow your child to participate in the study, please sign and returned the informed consent to school with your child.

Your and your child's participation in this study is completely voluntary. Your choice to participate will not impact any services you or your child is currently receiving. Your participation will also be completely confidential. Only Jeff Drayer will receive the identified data. These data will only be de-identified and coded by Jeff Drayer to protect the identity of the participants. Once the information is coded and de-identified it will be stored in a locked file cabinet at Northeastern University. Jeff Drayer is a Delaware state employ at the Terry Children's Psychiatric Center and has received a criminal background check. In addition, this dissertation research project has been approved by the Christina School District and Northeastern University.

If you have any questions or concerns throughout the research study, please feel free to contact my dissertation chair (Dr. Karin Lifter) or me by mail, email or phone. If you have any questions about your rights as a research participant please contact the Division of Research Integrity at (617) 373-7570.

Sincerely,

Jeffrey Drayer MS Ed.  
4<sup>th</sup> year Doctoral Student  
Northeastern University  
(617) 373-5916  
drayer.j@neu.edu

Karin Lifter Ph.D.  
Professor and Dissertation Chairperson  
Northeastern University  
(617) 373-5916  
k.lifter@neu.edu