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Profiling Executive Dysfunction in Adolescents with Autism

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PROFILING EXECUTIVE DYSFUNCTION IN ADOLESCENTS WITH AUTISM

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Dissertation Approval

This is to certify that the thesis presented to us by Nicole Rogers on the 24th day of June, 2010, in partial fulfillment of the requirements for the degree of Doctor of Psychology, has been examined and is acceptable in both scholarship and literary quality.

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Dedication and Acknowledgements

This dissertation represents not only the completion of my formal educational training, but is also a testament to the power of personal strength, resilience, love, perseverance, and hope. Although this is a culmination of years of study and learning, my hope is that I will always continue to be a lifelong learner.

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Abstract

Executive Functions (EF) have been assigned a causative role in a number of disorders, including schizophrenia, Tourette syndrome, autism, obsessive compulsive disorder, violent and criminal behavior, and nearly all learning disabilities. While the term *executive functions* in the professional literature easily yields more than 150 references, empirical research in which executive functions are studied and linked with specific disorders, such as autism, continues to help answer long-held questions about the disorder and adds to the literature base in order to better understand and treat the disorder. The purpose of this study was to review archival data collected using the Behavior Rating Inventory of Executive Functions (BRIEF) for the purpose of profiling executive dysfunction for adolescents with autism. The sample was comprised of 76 male and female public middle and high school students with autism spectrum disorder. All participants were assessed using the BRIEF Teacher Form. This study revealed that teachers' ratings with the BRIEF reflected a high level of executive function deficiency in the behaviors of adolescents with autism. Overall, results of the analyses revealed that most domains of the BRIEF yielded clinically significant results. Students with autism who were educated in inclusion settings appeared to exhibit fewer problem behaviors and therefore appear to be making greater use of executive functions capacities than students who were educated in self-contained settings. The executive function deficits demonstrated by students with autism necessitate involvement in educational programs that address these students' needs for greater external prompting. This study is limited by the relatively small sample size, narrow age range of the participants, and the highly specialized nature of the programming in a single state.

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Chapter 1

Introduction

Statement of the problem.

Cherkes-Julkowski (2005) reported that over the past two decades, executive functions and their designated brain location in the frontal cortex have received increasing attention. Executive functions (EF) have been assigned a causative role in a number of disorders, including schizophrenia (Weickert, Goldberg, Gold, Bigelow, Egan, & Weinberger, 2000), Tourette syndrome (Landon & Oggel, 2002), autism (Pennington & Ozonoff, 1996; Tanguay, 2000), obsessive compulsive disorder (Rauch & Grabiel, 2000), violent and criminal behavior (Goldberg 2001; Price, Daffner, Stowe, & Mesulam, 1990), and nearly all learning disabilities (Denckla, 1996). The role executive functions play in attention deficit hyperactivity disorder, with and without hyperactivity has also been extensively researched. While the term *executive functions* in the professional literature easily yields more than 150 references (McCloskey et al., 2009), additional empirical research on the nature of the relationship between executive functions and autism is needed to help answer long-held questions about the disorder and add to the literature base in order to better understand and treat the disorder. Executive functions' involvement in autism traditionally has been examined using tests such as the Wisconsin Card Sorting Task, the Tower of Hanoi/London, and a variety of verbal fluency tests such as the Controlled Oral Word Association Test (Rinehart, Bradshaw, Moss, Brereton, & Tongue, 2006). Due to the increase in the research on executive functions, McCloskey, Perkins, and Van Divner (2009) list and review many of the recent instruments developed, including the Delis-Kaplan Executive Function System (D-KEFS;

Delis, Kaplan, & Kramer, 2001), the NEPSY: A Developmental Neuropsychological Assessment (Korkman, Kirk, & Kemp, 1998), the Behavioral Assessment of the Dysexecutive Syndrome (BADS) (Wilson, Alderman, Burgess, Emslie, & Evans, 1996), the Behavior Rating Inventory of Executive Function (BRIEF, BRIEF–2, BRIEF–SR) (Gioia, Isquith, Guy, & Kenworthy, 2000), and the Frontal Systems Behavior scale (FrSBE) (Grace & Malloy, 2001). Work in the area of executive function deficits and autism is only in the preliminary stages. Currently, there is no specific pattern of executive skill weaknesses identified with autism or evidence that the disorder can be distinguished on the basis of particular executive skill patterns (Dawson & Guare, 2004). "The findings of Mackinlay and colleagues (2006) in a study of autism indicating correlations between some subdomains of the BRIEF, but not others, with a laboratory measure of multi-tasking, is consistent with Burgess and colleagues' (1998) argument. At this point, however, data on the veridicality of specific tasks in any population, not to mention autism, are so sparse that conclusions are premature" (Kenworthy, Yerys, Anthony, & Wallace, 2008, p. 332). The present study was conducted to add to the literature on executive functions and their relationship with autism. This study also examined the profile of Behavior Rating Inventory of Executive Functions (BRIEF) scores, based on teacher ratings of children with autism.

Purpose of the study.

The purpose of this study was to review archival data obtained with the Behavior Rating Inventory of Executive Functions (BRIEF) for the purpose of profiling executive dysfunction for adolescents with autism.

Chapter 2

Review of the Literature

Overview of autism.

Despite the extensive literature available, the nature of autism remains perplexing (Kabot, 2003). Autism has been described and researched since Leo Kanner first identified the disorder in 1943, when he described children who exhibited a number of peculiar behaviors, at first thought to be childhood schizophrenia, but all of whom exhibited a lack of interest in people around them. Autism is extensively researched, possibly due to the fact that it encompasses so many areas, such as cognition, language, behavior, development, and psychopathology. Major psychopathology is now widely recognized to have a neurobiological basis that is distinct to each disorder and underlies its behavioral characteristics, its etiology, and its response to treatment (O'Hearn, Asato, Oradaz, & Luna, 2008). Autism is a neurodevelopmental syndrome characterized by impaired social function, communication, and complex reasoning (Luna, Doll, Hegedus, Minshew, & Sweeney, 2007; Minshew, Meyer, & Dunn, 2003; Volkmar, Chawarska, & Klin, 2005). According to the American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev, 2000) *(DSM–IV–TR)*, autism is a neurodevelopmental condition characterized by deficits in language development and social interaction, as well as restricted and stereotyped patterns of behavior, interests, and activity. The essential features of autistic disorder are the presence of markedly abnormal or impaired development in social interaction and communication, including the use of and understanding language, and a markedly restricted repertoire of activity and interests. There may be a lack of or delay in speech and language skills, a stereotyped and/or repetitive use of language, and poor language comprehension. Individuals with autistic disorder often avoid eye contact, poorly regulate social interactions, lack spontaneous enjoyment with others, and lack awareness of others. Lastly, the patterns of interests are abnormal either in intensity or focus. Often these children are preoccupied with a narrow interest, and are inflexible when it comes to specific routines. For a *DSM–IV* diagnosis of autism to be made, a child needs at least two of the social impairment symptoms, but only one each of the communication impairment and restricted behavior and interests symptoms (Ingram, 2007). Since the first epidemiological study of autism in 1956 (Eisenberg and Kanner), the prevalence of autism has increased dramatically and at an alarming rate. The Autism Society estimates that autism now occurs in approximately 1 in every 110 births (Autism Society, 2010), using the current diagnostic criteria set forth in the *DSM–IV–TR* (American Psychiatric Association, 2000).

Executive dysfunction hypothesis and autism.

The cause of autism spectrum disorder (ASD) is not well understood; however, much research has focused on impoverished social functioning, leading to the speculation that specific sociocognitive deficits lie at the heart of behaviors observed across the autism spectrum (Barnard, Muldoon, Hasan, O'Brian, & Stewart, 2008). While social and language impairments have long been established and well researched in ASD, more recent evidence suggests that deficient executive functions are fundamental to the cognitive deficits in ASD (Chan, Cheung, Han, Sze, Leung, Man, & To, 2009). One of the most consistently replicated cognitive deficits in individuals with autism is executive dysfunction. Currently, one of the primary phenotypes in autism is executive dysfunction (Dawson & Guare, 2008; O'Hearn et al., 2008). One early and influential speculation was that dysfunction of the frontal lobe might underlie some of the characteristic behavioral abnormalities in autism (Damasio & Maurer, 1978). It has been proposed that deficient executive functions, such as flexibility, set maintenance, organization, planning, and working memory, may be primary cognitive deficits of autism (Hughes, Russell, & Robbins, 1994; Ozonoff & Jensen, 1999; Ozonoff, Pennington, & Rogers, 1991). Executive dysfunction in autism including impairments in tasks requiring response inhibition, working memory, planning, and attention has been found in both childhood and adulthood (Bennetto, Pennington, & Rogers, 1996; Hughes et al., 1994; Luna, Doll, Hegedus, Minshew, & Sweeney, 2007; Minshew, Luna, & Sweeney, 1999; Ozonoff et al., 2004; Reed, 2002; Turner 1999; Zelazo, Jacques, Burack, & Frye, 2002; van der Geest, Kemner, Camfferman, Verbaten, & van Engeland, 2001).

Conceptualization of executive functions.

Executive function has been conceptualized as involving several overlapping but potentially dissociable mental operations, such as planning, working memory, maintenance and shifting of mental set, and inhibition of prepotent responses (Joseph, 1999). Executive function should not be thought of as some unitary cognitive process or construct. These functions can be thought of as multiple processing modules collected together to direct cognitive activity, including mental functions associated with the ability to engage in purposeful, organized, strategic self-regulated, goal-oriented behavior (McCloskey et al., 2009).

Development of executive functions.

Infants do not have executive skills that are developed or available for use. Instead, these skills lie dormant in the brain as future skills. Assuming there is no insult to the brain, executive functions develop over time (Dawson & Guare, 2004). The areas of the brain that control attention and executive function are quite immature in preschoolers, and maturation is not complete until adolescence or early adulthood (Hale & Fiorello, 2004). Young children resemble adults with frontal-lobe damage; both have a very poor sense of time, a brief attention span, and a pronounced lack of self-control or behavioral inhibition, and they are generally less self-conscious than normal adults and older children. The frontal lobes lag behind all other areas of the brain from the very start of their development (Eliot, 1999). The frontal lobe region of the brain begins to develop during early childhood and continue to mature into adolescence, which parallels the emergence and continued development of executive functions (Levin et al., 1991; Welsch, Pennington, & Groisser, 1991). Executive abilities are evident early in development, but continue to improve throughout childhood and into adolescence (Demetriou, Christou, Spanoudis, & Platsidou, 2002; Luciana, Conklin, Hooper, & Yarger, 2005; Luna et al., 2007; O'Hearn et al., 2008). O'Hearn and colleagues (2008) report that despite some developmental gains, mature executive functioning is limited in autism, reflecting abnormalities in widespread brain networks that may lead to impaired processing of complex information across all domains.

Neurological aspects of executive functions.

Like the CEO of a large corporation, the prefrontal cortex, or frontal lobe region, tracks information from all over the brain, including the senses, the limbic systems mediating memory and emotion, and the subcortical systems that control mood, arousal, and basic drives. It then weighs this input, makes a decision, and then executes it through speech, movement, or another action by route of the frontal lobe (Eliot, 1999).

Over three decades ago, the noted Russian neuropsychologist A.R. Luria developed a conceptual understanding of how the posterior-anterior and left-right axes work together to produce complex behavior. Luria (1973) first described the frontal lobes region of the brain as the "superstructure" or the seat of all volitional goal-directed activity and responsible for governing the entire brain (Hale & Fiorello, 2004). The frontal lobes, with their connections to other parts of the brain, play a major role in executive cognitive processes, emotions, and self-awareness. Luria reported, "The frontal lobes constitute the cortical apparatus regulating the state of activity and that they thus play a decisive role in the maintenance of one of the most important conditions of human conscious activity – the maintenance of the required cortical tone and modification of the state of waking in accordance with the subject's immediate tasks" (1973, p. 197). Luria further stated that "maintenance of the optimal cortical tone is absolutely essential for the basic condition of all forms of conscious activity, mainly, the formation of plans and intentions that are stable enough to become dominate and to withstand any distracting or irrelevant stimulus" (p. 198).

Executive functions are thought to be driven by the prefrontal cortex. The prefrontal cortex, or the foremost area of the frontal lobe region, plays an important role in coordinating thought and actions in accordance with internally motivated intentions or goals (Lezak, 1995; Miller, 2001). Executive functions are housed in the dorsolateral prefrontal cortex and regulate functions such as inhibiting, managing conflict, goal setting, planning, persisting on task, monitoring, attending and self-regulating, and supervising working memory (Berninger & Richards, 2002). The frontal lobes are also important for integrating information over time, both past and future. People with frontal lobe lesions have difficulty remembering events and have poor planning and working toward a goal (Eliot, 1999). The frontal lobes are thought to be the "brain-manager" (Hale & Fiorello, 2001) and responsible for governing almost every aspect of cortical functioning (Hale & Fiorello, 2004). As Tranel, Anderson, and Benton (1995, p. 125) describe:

> It is virtually impossible to find a discussion of prefrontal lobe functions that does not make reference to disturbances of executive functions and, in parallel fashion, there is rarely a discussion of executive functions that does not make reference to dysfunction of prefrontal brain regions…it must be acknowledged that the capacities subsumed by executive functions have been linked to the prefrontal region throughout the entire history of neuroscience, and to some extent, the psychology and the anatomy are inseparable.

Denckla, however, (1999) reports that the term *executive function* should not be confounded with the term *prefrontal*, except on a hypothesis-generating level.

There is a growing body of evidence of frontal involvement in autism from functional imaging and neuropathology investigations (Casanova, 2002). Results from neurobiological studies on individuals with autism have revealed abnormal neurobiological processes in the frontal lobes that underlie the executive function deficits (Chan et al., 2009; Mundy, 2003; Schmitz et al., 2006;). Functional imaging studies also provide evidence for neocortical involvement in autism, demonstrating a delayed maturation of the frontal lobes (Levitt et al., 2003; Zilbovicius et al., 1995).

Approaches of executive function.

Neuropsychological approach.

Martha Denckla describes the neuropsychological perspective of executive functions as behaviors that have a specific brain basis. Denckla states that executive functions are best considered as an umbrella construct of central control processes (Denckla, 1999). Denckla includes under this umbrella concept of executive functions processes such as inhibition and delay of responding, planning, organization, maintenance of anticipatory set, preparedness to act, and integration of cognitive and output processes (Denckla, 1999). Stuss and Benson (1986) formulated a comprehensive behavioral/anatomical model of frontal lobe functioning whereby the prefrontal cortex is the biological base for executive functions.

Behavioral approach.

Barkley (2001) defines executive functions in terms of self-regulation and inhibition, with self-control as the main focus. Self-control requires one to act in opposition to one's own immediate impulses and self-interest in order to achieve a future goal. When an intention of a future goal is effectively regulated by executive functions, a temporal delay occurs, during which the consequences of alternative responses are weighed in terms of risk/benefit ratios.

Information processing approach.

Sternberg (1985, 1987) has argued that metacomponents (processes similar to executive functions) differentiate general giftedness from more restricted or specific forms of giftedness and distinguish students who are gifted from students with normal achievement, who are in turn differentiated from students with learning delays. Superior metacomponents result in high performance on IQ and school tasks, and likewise, immature metacomponents results in poor performance (Borkowski & Burke, 1996). The information processing model indicates that there are three essential components of executive functioning. The three essential components are task analysis, strategy control, and strategy monitoring. Borkowski and Muthukrishna (1992) have outlined a set of behaviors that might be common to sophisticated learners. A person who is a good information processor would possess the certain skills, most of which are related to executive functioning and which help to situate a concept from a metacognitive perspective.

Borkowski and Muthukrishna (1992) describe the development of executive functioning from the learning of lower-level cognitive skills. Outlined below are the steps in helping children to develop adequate executive functioning: First, the child is taught a specific learning strategy and uses this strategy with repetition. Next, the child learns other learning strategies and again uses these with repetition in a variety of contexts. Third, the child learns to select appropriate strategies for a given context, and then refines these strategies and develops a sense of self-efficacy. Fifth, domain-specific knowledge is acquired and accumulated, and finally, visions of the future help the child form “hoped-for” and “feared” selves. When these steps are not fulfilled or achieved, an immature developmental connection between the emerging self and executive systems likely prolongs or exacerbates academic difficulties for students who have learning impairments (Borkowski & Burke, 1996).

Hierarchial/integral approach.

Despite the increasing research on many executive function capacities, few attempts have been made to organize the research, resulting in no single theory of executive control. McCloskey, Perkins, and Van Divner (2009) have developed a holarchical, developmental model of executive function organization to help conceptualize the interplay of the multiple executive function capacities that involve frontal lobe neural functions. According to this model, executive functions comprise many capacities, including self-activation, self-regulation, self-realization and self-determination, self-generation, and trans-self-integration.

Self-activation.

The self-activation capacity involves how our executive function capacity wakes up from sleep. "Research has documented that most persons are lacking in executive control for at least a short period of time when roused from a deep sleep: (Balkin et al., 2002; McCloskey et al. 2009, pp. 39). McCloskey et al. describe a gradual "ramping up" of, or gradual increase in, executive functions during the first 5 to 20 minutes of awakening. The role of executive capacities during this period can be characterized as a nonconsciously mediated process of "turning on" the various neural circuits needed to enable greater self-control to a higher tier of executive capacity (McCloskey et al., 2009).

Self-regulation.

The greatest number of executive functions (23) comprise the self-regulation tier. The self-regulation executive functions are responsible for cueing and directing functioning within the domains of sensation and perception, emotion, cognition, and action. These executive functions are involved in all that we do on a daily basis. The 23 capacities involved in the self-regulation tier are: perceive, initiate, modulate/effort, gauge, focus/select, sustain, stop/interrupt, inhibit, flexible/shift, hold, manipulate, organize, forsee/plan, generate, associate, balance, store, retrieve, pace, time, execute, monitor, and correct.

Self-realization.

The third tier of executive capacity, self-realization, moves beyond the basic processes of awakening and self-regulation. While self-realization does not require a conscious awareness, it does engage neural circuits in the frontal lobe that are necessary for a person to become aware of their sensations, emotions, thoughts, and actions. Activation of these neural circuits produces a deeper realization of self that initiates the emergence of self-awareness, and the more organized and sustained use of these neural pathways allows for a deeper sense of self (McCloskey et al., 2009). A greater sense of self therefore results in a greater sense of self-analysis. Self-analysis involves sustained and enhanced reflection on perceptions, emotions, thoughts, and actions in a manner that yields judgments about one's functioning in these domains (McCloskey et al., 2009.

Self-determination.

In order to act in a self-determined manner requires the use of specific neural circuits involving portions of the frontal lobes that enable goal setting and long-term planning is required(Luria, 1980; McCloskey et al., 2009). Engagement of this neural circuit enables a person to develop foresight and formulate plans that extend into a long-term plan. Executive capacity of self-determination also involves achieving long-term self-selected goals or carrying out self-selected plans. The self-determination executive capacities that generate, maintain, monitor and revise long-term goals and plans are often in competition with urges that are on a shorter time frame. The better developed a person's self-determination capacity is, the better one he or she able to suppress those short-term urges to achieve their long-term goals (McCloskey et al., 2009).

Self-generation.

When effectively engaged, the self-generation executive capacity makes inquiries into the nature of existence, the purpose of life and the ultimate sources of what is experienced as reality, contemplation of concepts such as spirit and soul, the nature of the relationship of mind to body, and speculation that considers the possibility of existence of a God or a form of consciousness beyond the physical (McCloskey et al., 2009). Questions one may encounter in this executive capacity include "Who am I?", "Why am I here?", or "What is my life's purpose?". Consistent with the functioning and development of the other tiers of executive capacity, the tier of self-generation can emerge independently of other executive functions and can vary in its effectiveness in one's life.

Trans-self integration.

Research in the neurosciences has indicated that the ability to experience the phenomenological state of egolessness or unity consciousness is directly linked to neural circuits dependent on areas of the frontal lobes (Benson, Malhotra, Goldman, Jacobs, & Hopkins, 1990; Herzog et al., 1990; McCloskey et al., 2009; Newberg, Alavi, Blaine, Mozley, & D'Aquili, 1997; Newberg & D'Aquili, 2001). Individuals with this highest level of executive capacity seek the "ultimate truth" and are often determined to see past the illusion of self to get a glimpse of what may lie beyond our physical state. The likelihood that a child or adolescent has developed their executive functioning capacity to the level of Trans-Self Integration is unlikely.

Arenas of involvement for executive functions.

McCloskey's concept of arenas of involvement offers an additional dimension for greater understanding of the full range of variability of engagement of self-regulation capacities. Executive control can greatly vary, depending on whether the person is attempting to control his or her own internal states (intrapersonal arena), interact with others (interpersonal arena), interact with the environment (environmental arena), or engage in the culturally derived symbol system used to process and share information (symbol system arena) (McCloskey et al., 2009).

The intrapersonal arena.

According to McCloskey et al. (2009), this arena refers to a person's perceptions, feelings, thoughts, and actions in relation to his or her own self. In terms of executive functions, this arena is where control processes are turned inward to cue and regulate self-referencing. This in turn controls one's own self-control and self-discipline.

The interpersonal arena.

McCloskey (2009) suggests that this arena is where executive capacities are turned outward to cue and regulate a person's perceptions, feelings, thoughts, and actions in relation to the perceptions, feelings, thoughts, and actions of others. The result would be successful interactions with others, the ability to appreciate the perspectives of others, the ability to generate a theory of mind that enables a person to understand the motivations, needs, and desires of others, and the ability to find a balance with the person's own needs and the needs of the community (pp. 58).

The environment arena.

In this arena, executive capacities are directed outward to cue and direct thoughts, feelings, perceptions, and actions to the surrounding world. The result of engagement of executive functions in relation to environmental surroundings is the ability to carry out daily living in a manner that utilizes natural and man-made resources appropriately, resulting in a desired outcome. This enables a person to avoid "accidents" by anticipating the impact and consequences of his or her own actions in and on the physical environment (McCloskey et al., 2009).

The symbol system arena.

The symbol system arena includes the use of language, mathematics, systems of logic, and media sources such as words, figures, or diagrams. Executive functions cue and regulate a person's thoughts, feelings, perceptions, and actions relating to the processing of this symbol information. The result is the ability to effectively direct self-expression through reading, writing, and speaking, to direct work with the concept of mathematics or science, and to direct the use of symbols systems such as a computer (McCloskey, 2004).

Assessment of executive functions.

Children with autism are difficult to assess, largely because behavioral interference with performance on standardized tests may limit the utility of these measures and necessitates the use of behavioral observation and interviews to formulate diagnostic impressions (Hale & Fiorello, 2004). Because executive functions are directive processes that interact with emotional, cognitive, and motor domain abilities while performing skills, assessment of executive functions must be assessed in tandem with abilities and skills (McCloskey, 2004). There are many standardized assessment tools available to assess executive functions, including neuropsychological tools, cognitive assessments, and behavior rating scales.

Standardized neuropsychological assessment instruments.

Neuropsychological assessment of children is a complex process by which historical information, behavioral observations, and standardized psychological tests are used to make inferences about brain impairment and its implications for adaptive functioning in a developmental context (Yeates & Donders, 2005; Yeates & Taylor, 2001). Neuropsychological tests are used to assess brain dysfunction and executive function deficits (Royall et al., 2002). Neuropsychological tests used to assess executive functioning include the Wisconsin Card Sorting Task (WCST), the Stroop Color-Word Test, the Rey-Osterrieth Test, the Delis-Kaplan Executive Function System (D-KEPS), the Tower of Hanoi Test (TOH), and several others that will be described below.

Wisconsin Card Sorting Test

The Wisconsin Card Sorting Test WCST (Grant & Berg, 1948): was designed to primarily test flexibility. This test requires individuals to shift cognitive set up to six times during the task. The primary index of executive dysfunction for individuals was the number of perseverative responses, in which the individual continued to sort by a previously correct category despite feedback that was incorrect (Heaton, Chelune, Talley, Kay, & Curtiss, 1993; Ozonoff, 1999).

Stroop Color-Word Test

Individuals with frontal-lobe damage exhibit poor response inhibition, as evidenced by the Stroop test (Eliot, 1999). The Stroop test assesses difficulties in shifting perceptual set in response to cues and rapid automated naming(Stroop, 1935): An individual is shown the name of a color written in ink of a different color. Individuals are required to inhibit the urge to read the word instead of naming the color of ink (Ozonoff, 1999). Individuals with frontal-lobe damage lack the inhibition that is primarily a function of the orbital zone of the prefrontal cortex, which also plays a role in social and emotional regulation (Eliot, 1999).

Delis-Kaplan Executive Function System

The Delis-Kaplan Executive Function System (D-KEFS) is a standardized test designed to measure executive functions in both children and adults. The nine subtests can be administered independently or as a comprehensive evaluation of overall executive functioning. The nine subtests are trail making, verbal fluency, design fluency, color-word interference, sorting, twenty questions, word context, tower test, and proverbs.

Tower of Hanoi/London Test

The Tower of Hanoi/London Test (TOH) measures planning ability and working memory (Borys, Spitz, & Dorans, 1982). Following specific rules, individuals are required to move disks from a prearranged sequence on three different pegs to match a goal state determined by the examiner in as few moves as possible. Success on these tasks requires that participants be able to hold in mind previous configurations to work towards new potential configurations (Hala, Rasmussen, & Henderson, 2005). Every study using the TOH has found highly deficient performance in autistic samples relative to controls (Ozonoff, 1999).

Cambridge Neuropsychological Test Automated Battery

The Cambridge Neuropsychological Test Automated Battery (CANTAB) is a computer-administered, nonverbal (visually presented) set of tasks developed to examine specific components of cognition, particularly those associated with frontal and medial temporal regions of the brain (Ozonoff, 1999). A study conducted by Ozonoff et al. in 2004 using the CANTAB concluded that deficits in planning and flexibility were present in individuals with autism. This study went to further say that not all types of attention shifting were impaired; however, the results contributed to the accumulating evidence of frontal lobe impairment in autism.

Rey Complex Figure Test

The Rey Complex Figure Test (RCFT) is a test of visual perception and long-term memory and attempts to understand the organization and planning processes of executive functions (Bobik, 2008).

Verbal Fluency Test

This task is timed, and the executive function which is measured is the participant's ability to initiate a response. The participant is required to generate as many words as possible that begin with specific letters or categories.

Comprehensive Trail-Making Test

The Comprehensive Trail-Making Test (CTMT) is a neuropsychological test of basic trail making that assesses frontal-lobe impairments, cognitive flexibility (set-shifting), attention, psychomotor speed, and visual search and sequencing difficulties.

Neuropsychological Assessment

The Neuropsychological Assessment (NEPSY, Korkman, Kirk, & Kemp, 1998) is an individually administered battery that includes subtests designed to assess executive skills in children. The executive skills assessed are planning, cognitive flexibility, impulsivity, vigilance, auditory selective attention, monitoring, self-regulation, and problem-solving (Dawson & Guare, 2004).

Wide Range Assessment of Memory and Learning-Second Edition

The Wide Range Assessment of Memory and Learning-Second Edition (WRAML–2) assesses memory functioning across development from ages 5 to 90. The battery consists of a core battery to assess basic memory functions, as well as a verbal working memory scale, a symbolic memory scale, and a delayed memory scale to further expand assessment of memory functions. The test also includes an attention-concentration index, verbal memory index, and visual memory index.

Intelligence scales and neuropsychological assessment.

Although intelligence tests were originally developed primarily to predict academic achievement, as opposed to brain function, they have long been used to assess cognitive dysfunction in individuals with brain injury and disease (Groth-Marnat, Gallagher, Hale, & Kaplan, 2000; Yeates & Donders, 2005).

Wechsler Intelligence Scale for Children–Fourth Edition–Integrated

The Wechsler Intelligence Scale for Children–Fourth Edition–Integrated (WISC–IV–Integrated) incorporates the core and supplemental subtests from the WISC–IV along with 12 additional Process Approach Subtests and multiple process approach procedures for enhancing the collection of clinically relevant information from the performance of selected subtests (McCloskey & Maerlender, 2005 pp. 101). The WISC–IV–Integrated includes a multiple choice version of the similarities and comprehension subtest, a revision of the information, vocabulary, and picture vocabulary subtests, a multiple choice version of the block design subtest, a revision of the letter span subtest; an addition of a visual digit span and letter-number sequencing subtest, a revision of the arithmetic subtest, a revision of the mazes subtest, a deletion of the sentence arrangement subtest, and the addition of several process scores.

Donders (1997) and Tremont et al. (1999) conducted studies to investigate the validity of the WISC–IV and the D-KEFS compared to other neuropsychological tests. The study sample consisted of 36 students with a traumatic brain injury (TBI). Results revealed that the word reasoning and letter-number sequencing subtests on the WISC–IV showed a strong correlation with tasks that assess executive functions of concept formation and planning, the picture concepts subtest showed a clear association with the executive function of perceptual fluency and conception formation, and the cancellation subtest showed covariance with the executive functions of speed of performance, with and without motor speed (Yeates & Donders, 2005).

Stanford Binet Intelligence Scales–Fifth Edition

The Stanford Binet is an individually administered assessment of cognitive abilities that includes high-end items to measure gifted performance as well as low-end items for better measurement of low-functioning older children or adults with mental retardation. The nonverbal IQ can be used for assessing individuals with communication disorders, hearing impairments, autism, specific learning disabilities, traumatic brain injury, or other conditions where linguistic ability is limited (Roid, 2003).

Comprehensive Test of Nonverbal Intelligence

The Comprehensive Test of Nonverbal Intelligence (CTONI) is an individually administered test of intelligence that contains six subtests designed to measure problem-solving, reasoning, and abstract thinking abilities (Sattler, 2001). The instructions can be pantomimed and the examinee may point to the answer from an array of five choices.

Wechsler Nonverbal Scale of Ability

The Wechsler Nonverbal Scale of Ability (WNV) measures general cognitive ability using a multi-subtest, comprehensive format that eliminates or minimizes verbal content. Pictorial directions were developed to communicate the demands of the subtests with little or no verbal instructions. The characteristics of the WNV allow administration to a diverse population, including individuals with language impairments, or hearing deficits and linguistically diverse populations (Wechsler & Naglieri, 2006).

Universal Nonverbal Intelligence Test

The Universal Nonverbal Intelligence Test (UNIT) is a useful instrument to provide a fair assessment of intelligence for children and adolescents who have speech, language, or hearing impairments, are from different cultural or language backgrounds, or are verbally uncommunicative. The administration allows for completely nonverbal instructions. The UNIT measures memory and reasoning abilities, including symbolic processes, recall, pattern processing, problem-solving, understanding of relationships, and planning abilities (Bracken & McCallum, 1998).

Behavior rating scales.

Behavior Rating Scales are also an important method to assess executive functions. Gioia, Isquith, and Guy (2000) developed the Behavior Rating Inventory of

Executive Function (BRIEF), which assesses executive functions in both children and adolescents. The BRIEF is a questionnaire for parents and teachers of school-age children that enables professionals to assess executive function behaviors in the home and school environments (Gioia et al., 2000). The eight clinical scales are inhibit, shift, emotional control, initiate, working memory, plan/organize, organization of materials, and monitor. Other behavior rating scales that may be used to assess executive functions include the Brown Attention Deficit Disorder Scales for Children (BADDS), the Behavior Assessment Scales for Children–Second Edition (BASC–2), or the ADHD–IV Rating Scale.

Brown ADD Scale–Adolescent Version

The Brown ADD Scale–Adolescent Version (Brown, 1996) is another behavior checklist used to assess executive functioning. The scale is normed for high school-age students, with a total of 40 items and five broad cluster scores: activation, attention, effort, affect, and memory. Although this checklist is designed to assess weaknesses often observed in attention deficit disorder, the ratings translate easily into the broad executive skills or self-regulation of affect, working memory, initiation, sustained attention, and goal-directed persistence (Dawson & Guare, 2004).

Dysexecutive Questionnaire

The Dysexecutive Questionnaire (DEX) is a 20-item questionnaire for ages 16 to 87 that provides a measure of disability associated with dysexecutive difficulties. The five item clusters are: inhibition, intentionality, executive memory, positive affect, and negative affect (Kenworthy et al., 2008; Wilson et al., 1996).

Frontal Systems Behavior Scale (FrSBe)

The FrSBe is formally known as the Frontal Lobe Personality Scale (FLoPS). This scale is a 46-item questionnaire for ages 18 to 95. It is composed of three subscales: Apathy, Disinhibition, and Executive Dysfunction (Grace and Malloy, 2002; Kenworthy et al., 2008).

Behavioral Flexibility Rating Scale-Revised (BFRS–R)

The BFRS–R is designed for ages 2 to 19 years and measures insistence on sameness or lack of behavioral flexibility in ASD. The BFRS–R is a 16-item scale that asks respondents to rate the child's response to five situations (Kenworthy et al., 2008; Peters-Scheffer et al., 2008; Pituch et al., 2007).

Process-Oriented approach to assessment of executive function.

While the use of standardized assessment is useful and provides much needed information about an individual's functioning, the process oriented approach involves careful observations about how the adolescent performs the assessment task, as well as, the clinician's use of a set of methods to observe and interpret this performance on any measure of cognition, academic functioning, or behavior (McCloskey et al., 2009). This approach involves the use of careful observations while the formalized assessment is administered. The process approach can be employed effectively to help generate and test hypotheses about a adolescent's use or disuse of executive function capacities. This allows for the identification of patterns in executive function use or disuse across multiple assessments (McCloskey et al., 2009). Assessment of the child's executive capacities in this manner would provide the information to help complete four questions that form the framework for report writing. The four questions are: (a) What executive functions can the child use effectively?; (b) What executive functions does the child have difficulty using?; (c) What needs to be done to help the child?; and (d) Who can do what needs to be done to help the child? (McCloskey et al., 2009).

Executive function areas affected in autism.

Social.

Executive dysfunction theory (Hughes et al., 1994) posits that autistic individuals are primarily compromised in their ability to control, manage, and monitor simultaneous cognitive processes (Harris et al., 2008). Dawson and Guare (2004) report that children with autism and with nonverbal learning disabilities (NLD) often demonstrate problems with self-regulation of affect, metacognition, and flexibility. Children who are generally inattentive to detail may have significant difficulty “reading” the social scene, thus preventing them from developing a clear picture or context of a given social situation. They are often unaware of social cues or social feedback. Thus, failure to appreciate social details, impulsiveness, and impaired sensitivity to social feedback make it difficult for children with autism to read a relationship, make an appropriate decision based on the social feedback, and monitor effectiveness (Levine, 1999). Furthermore, children with autism may have difficulty processing simultaneous visual-spatial information and therefore may have difficulty decoding and reacting to nuances of body language and facial expression (Levine, 1999). Finally, the introspective capacity to analyze and reflect consciously on personal social ability (social metacognition) may be problematic for children with autism because they do not seem to be effective observers and analyzers of themselves or the social scene and its requirements (Flavell, 1985; Levine, 1999).

Levine (1999) describes Selman's (1981) five levels and five stages of social development that typical children may undergo when dealing with social interactions and friendships. Children with autism may be impaired in any or all of the following levels.

Level 0: Egocentric or undifferentiated perspectives: At this level, children are unable to distinguish their own perspectives from those of others. Children understand social relationships in terms of the availability or proximity of a toy or person in their physical reach. Children with autism often may be unable to develop past this level.

Level 1: Subjective or differentiated perspectives: In this level, children understand that the perspective of another person may be different from their own, and they recognize the uniqueness of the feelings of others. Friendships are based more on common likes or dislikes rather than simply close proximity. Children with autism have significant difficulty recognizing others perspectives.

Level 2: Self-reflective or reciprocal perspectives: This level describes children's ability to think about their own thoughts and feelings from the perspective of someone else. In other words, they can put themselves in someone else's mind and see how they might look to others.

Level 3: Third person or mutual perspectives: At this level, children are able to take a third-party perspective and distances themselves from both parties in order to study the relationship as a whole. Relationships tend to be more close and supportive of the other person's needs and can withstand conflict.

Level 4: Societal or in-depth perspectives: Social perspectives at this level become generalized into the concept of society's moral point of view. Individuals share perspectives on a deeper, nonverbal level, share common interests, and the relationship grows through experience.

Asher (1983) describes and observes in his study of social competency and popularity that "socially adept children seem to have the ability to read the social situation and adapt their behavior to the ongoing flow of interaction" (Levine, 1999). Asher's (1983) lists 12 social competencies associated with popularity. These social competencies are also areas in which children with autism may be impaired.

Rumsey (1985) conducted the first study that explicitly investigated executive function in autism. Rumsey (1985) found that autistic individuals were significantly impaired relative to controls on all key variables on the WCST. Rumsey cogently described the potential relevance of these findings to autistic social deficits, observing that successful social functioning, like the card sort test, requires "integration and weighing of multiple contextual variables, selective attention to relevant aspects of the environment, and inductive logic." Thus, executive function deficits could potentially explain not only the inflexible and rigid behavior of autistic individuals, but also their impaired ability to engage in reciprocal social-communicative interactions, which require evaluation of and selection of appropriate responses to a constant stream of subtle, multidimensional, and context-specific information (Bennetto et al., 1996).

Another landmark study by Baron-Cohen et al.(1985) examined the social impairment of autism. They hypothesized that the social and communicative abnormalities of autism derive from a specific inability to understand other people's minds and to interpret behavior in terms of underlying mental states. From this viewpoint, the profound social abnormalities of autism arise from a domain-specific psychological deficit in social cognition and particularly the ability to mentalize the contents of another person's mine (Joseph, 1999). The emergence of the theory of mind (TOM) hypothesis of autism served as an important impetus for the executive dysfunction account of autism.

Planning.

Planning involves the identification and organization of steps needed in order to achieve a goal (Barnard et al., 2008; Lezak, 1995). Ozonoff et al.(1991) assessed children with autism using the Tower of London of Hanoi and found impaired planning skills as compared to typical peers. Planning deficits in autism are evident when participants' intelligence quotient (IQ) falls within the learning disabled range (Hughes et al., 1994) but not when IQ is within the normal range (Barnard et al., 2008).

Inhibition.

Inhibition is fundamental to selectively attending to goal-related stimuli whilst ignoring interfering stimuli. Variations on the Stroop test (Stroop, 1935) revealed that autistic children and adolescents display similar levels of interference compared to normally developing age-matched controls (Barnard et al., 2008; Eskes, Bryson, & Mccormick, 1990; Ozonoff & Jensen, 1999).

Set-shifting.

Set-shifting is also known as cognitive flexibility in much of the literature. This executive function refers to the ability to shift from one line of responding to another. Also, this requires an inhibition of one response instead of another. Studies have shown that children, adolescents, and adults with autism are less likely to change responses where appropriate compared to age and IQ-matched controls (Barnard et al., 2008; Ozonoff & Jensen, 1999; Rumsey, 1985).

Fluency.

Fluency refers to the ability to generate multiple, specific responses or novel ideas. Turner (1999) found that individuals with autism generated fewer novel words and ideas and produced less complex designs than verbal IQ-matched controls.

Working memory.

Working memory refers to the ability to simultaneously process and store information while performing cognitive tasks (Barnard et al., 2008). Many studies have explored the possibility that executive dysfunction in autism may be derived from a core deficit in working memory (Joseph, 1999). However, studies by Bennetto et al.(1996) and Russell et al.(1996) revealed that a deficit in working memory capacity, although perhaps characteristic of autism, is not specific to autism and is likely a manifestation of the broader neurological impairment common to autistic children (Joseph, 1999). Difficulties with memory also manifest in behaviors such as problems with social learning from experience and difficulty with recall of names and faces (Levine, 1999).

Self-monitoring.

Self-monitoring serves as a quality control mechanism by enabling an individual to know how he or she is performing while doing something and how he or she just performed immediately after doing something. Self-monitoring permits self-regulation (Levine, 1999). There are many forms of self-monitoring that are needed for optimal behavior. Behavioral and social self-monitoring is needed to comply with rules of discipline and to relate effectively to others (Levine, 1999). Dysfunction of self-monitoring may be apparent in behavioral and social functioning in children with autism, as they may seem oblivious to social cues and feedback, unable to note the effect of their behavior on others or read cues to indicate success or failure.

Self-control/determination.

Levine (1999) also discusses dysfunction in the previewing controls such as social prediction, anticipation, and transition readiness, which is also consistent with deficits in autism. Facilitation and inhibition controls may also be impaired in autism. Facilitation and inhibition controls enable an individual to review options for behavior, for verbal communication, for undertaking a task, or for various forms of problem solving and then facilitate the possibility that is most likely to succeed while inhibiting the other choices. Signs of poor facilitation and inhibition in autism may include loud speech, emotional overreaction to stimuli, and generally deficient problem-solving skills (Levine, 1999). These deficits may be compared to deficits found in McCloskey's (2009) deficits found in the self-determination level of executive control.

Self-awareness/self-realization.

The concept of theory of mind (TOM) can be compared to McCloskey's (2009) level of self-realization. Individuals with ASD are typically quite deficient in the executive capacities of self-awareness, both in themselves and in others. without a sense of self, it is quite difficult for a person to develop any meaningful sense of others; without realizing oneself as a "self", it is not possible to realize others as "selves" (McCloskey et al.2009).

Summary of literature review.

The literature on executive functioning is extensive. While there is a significant amount of literature on executive functioning and disorders such as ADHD, the literature continues to have gaps with regards to an executive functioning profile specific to autism. The McCloskey, Perkins, and Van Divner model (2009) has beautifully integrated and conceptualized all of the executive functioning literature to date and added further dimensions and depth to the executive functioning literature. This aim of this study was to add to the literature on executive functioning specific to autism and hopefully fill in the gap of a specific profile of executive functioning in adolescents with autism.

Research questions and hypotheses

Research questions.

1. How do adolescents with autism perform on the Behavior Rating Inventory of Executive Function (BRIEF)?
2. Is there a specific pattern of strengths and weaknesses of executive functions for adolescents with autism?
3. Are executive functions of adolescents with autism impaired across the range of skills assessed on the BRIEF?
4. Do executive functions in adolescents with autism improve as the student gets older?

Hypotheses

Hypothesis 1.

It was predicted that adolescents with autism who are assessed using the BRIEF would show a profile of executive function impairment in most, if not all, areas assessed on the instrument.

Hypothesis 2.

It was predicted that adolescents with autism would show a slight but not significant increase in executive function capacity as they got older (from middle school age to high school age).

Hypothesis 3.

It was predicted that if an adolescent exhibited an improvement in executive functions, the improvement would most likely be due to external controls (i.e., external supports or modifications).

Chapter 3

Method

Participants.

The sample was comprised of 76 male and female public middle and high school students (ages 12 to18) with autism spectrum disorder (ASD). There were 65 male participants and 11 female participants. All participants were enrolled in a public school, birth to age 21 program specifically designed for the treatment of autism. All participants had an educational classification of autism and an individualized educational plan (IEP). Middle school and high school participants could be educated in one of the following placements, all of which are specialized programs: center-based, self-contained; off-site, self-contained; off-site, partially mainstreamed; or off-site, fully mainstreamed. Participants who were educated on-site at the center-based program were described as having nonverbal to limited verbal fluency and lower functioning on the autism spectrum. Participants educated at self-contained classrooms in regular middle and high school settings were described as higher on the autism spectrum and were to be mainstreamed, depending on their educational needs and functioning level. Teachers completing the BRIEF questionnaires all had an autism certification (coursework) that is required to work in the program.

Measure.

All domains of executive functioning were assessed as follows: All participants were assessed using the Behavior Rating Inventory of Executive Function (BRIEF) Teacher Form. The BRIEF is an 86-item standardized questionnaire. The BRIEF Teacher Form requires approximately 15 minutes to complete the rating of a student.

The standardization sample is based on age (5 to18) and gender. Each item response reflects the teacher's perception of behavioral manifestations of executive functions of the student with autism. Executive functions are measured based on the teacher's ratings of the frequency of the given behavior for each item. BRIEF items on the questionnaire are scored as: 1 = Never, 2 = Sometimes, and 3 = Often. Each executive function domain is summed to reflect the raw score. The raw scores are then converted to T scores, with corresponding percentile ranks. Each T score has a mean of 50 and a standard deviation of 10. Each T score reflects the student's score in relation to the scores of participants in the standardization sample. A T score of 65 or above suggests a clinically significant deficit in executive functioning. The higher the score is above 65, the greater the deficit in specific domains of executive functioning. The T scores were obtained from all the domains, including inhibit, shift, emotional control, initiate, working memory, plan/organize, organization of materials, and monitor. T scores for the inhibit, shift and emotional control domains were summed to obtain the behavioral regulation index (BRI). T scores from the initiate, working memory, plan/organize, organization of materials, and monitor scales were summed to obtain the metacognition index (MI). Finally, the BRI and MI indexes were summed to obtain the global executive composite (GEC). Below is a list of each subdomain of the executive functions and the corresponding behavioral definitions (Gioia et al., 2000).

1. Inhibit: The student is able to delay a response long enough to consider the options; impulse control; the student is able to end the activity at the appropriate time.

2. Shift: The student transitions from one situation or activity smoothly and is able to flexibly use problem-solving ability.
3. Emotional Control: Modulates his or her own emotional responses in an appropriate manner.
4. Initiate: The student is able to begin a task or activity independently and generate his or her own ideas.
5. Working Memory: The student is able to hold information in mind while manipulating it for some purpose; keeps information in short term memory.
6. Plan/Organize: The student is able to develop goals and establish objectives to meet those goals, keep a daily schedule, or work at an appropriate pace to accomplish a task.
7. Organization of Materials: The student is able to organize his or her materials and work in an orderly manner.
8. Monitor: The student is able to check his or her own work and keeps track of own performance during or after finishing a task.
9. Behavioral Regulation Index: Ability to shift cognitive set and modulate emotions and behavior by the appropriate inhibitory control; enables successful problem-solving and supports self-regulation.
10. Metacognition Index: Ability to initiate, plan, organize, and sustain future-oriented problem-solving in working memory; ability to cognitively self-manage tasks and monitor own performance.
11. Global Executive Composite: A summary that encompasses all eight clinical scales.

Procedure

The principal investigator (PI), a school psychologist, reviewed archival testing data for each participant. The archived testing data was the BRIEF Teacher Form. The archival data was housed within the psychologist's testing files and all identifying information was removed for each participant. Therefore, there was no way to link each BRIEF protocol with an individual student. Each BRIEF Teacher Form only contained the student's age, gender, and placement level (on-site or off-site), which reflects the student's level of functioning on the autism spectrum.

Chapter 4

Results

This chapter will present the data analyses of the Teacher BRIEF ratings of students with autism, including statistical analyses of T scores, percentile ranks, and cumulative frequencies of clinically significant BRIEF T scores and percentile ranks.

Demographic data.

The study was conducted using archival data consisting of BRIEF Teacher Form ratings of adolescent students with autism. The sample was comprised of 76 male and female public middle and high school aged students (ages 12-18) with autism Spectrum Disorder (ASD). All participants were enrolled in a public school, birth to twenty-one program specifically designed for the treatment of autism. All participants had educational classification of autism and had an Individualized Educational Plan (IEP). Middle school and high school aged participants were educated in one of the following placements, all of which were contained under the specialized program umbrella: center-based, self-contained; off-site, self-contained; off-site, partially mainstreamed; or off-site, fully mainstreamed. Middle and high school aged participants that were educated on-site at the center-based program were described as non-verbal to limited verbal fluency and lower functioning on the autism spectrum. Middle and high school aged participants educated at self-contained classrooms in regular middle and high school settings were described as higher on the autism spectrum and mainstreamed depending on their educational needs and functioning level. Teachers completing the BRIEF questionnaires all have an autism certification to teach children with autism that is required to work in the program.

The gender, age, grade, and placement characteristics of the sample population are summarized in Tables 1 through 4.

Table 1

Frequency of Gender Characteristics of BRIEF Protocols

Gender	Frequency	%
Male	65	86
Female	11	14
Total	76	100

Table 2

Frequency of Age Characteristics of BRIEF Protocols

Age	Frequency	%
12	10	13
13	7	9
14	15	20
15	15	20
16	6	8
17	16	21
18	7	9
Total	76	100

Table 3

Frequency of Grade Characteristics of BRIEF protocols

Grade	Frequency	%
6	9	12
7	4	5
8	10	13
9	25	33
10	14	18
11	7	9
12	7	9
Total	76	100

Table 4

Frequency of Placement Characteristics of BRIEF Protocols

Placement	Frequency	%
OSFI	25	33
OSPI	4	5
OS	6	8
OSSC	41	54
Total	76	100

Note. OSFI refers to Off-site, Fully Included; OSPI refers to Off-site, Partially Included; OS is On-Site (Center-Based); OSSC is Off-Site, Self-Contained.

BRIEF ratings analyses.

BRIEF Teacher Form T scores are summarized in Table 5, based on the number of students above and below a T score of 65, the score used by the BRIEF authors to indicate a clinically significant level of executive function difficulty.

Table 5

BRIEF Scale T scores by Significance Category for the Total Sample

BRIEF Scale	T score <65		T score ≥65	
	n	%	*n*	%
Inhibit	35	46	41	54
Shift	18	24	58	76
Emotional control	35	46	41	54
Initiate	5	7	71	93
Working memory	5	7	71	93
Plan/Organize	22	29	54	71
Organization of materials	41	54	35	46
Monitor	13	17	63	83

Teacher ratings produced BRIEF T scores ranging from average to extremely high. T scores in the average range indicate a relative lack of concern about executive function difficulties. The more the T score is outside the average range, the greater the concern for the executive function difficulties being reported. For each scale, teacher ratings produced scores that ranged as follows: The inhibit scale T scores ranged from 44 to 116; shift T scores ranged from 45 to 131; emotional control T scores ranged from 45 to 127; initiate T scores ranged from 55 to 101; working memory T scores ranged from 43 to 111; plan/organize T scores ranged from 48 to 101; organization of materials T scores ranged from 44 to 136 and monitor T scores ranged from 48 to 105.

For five of the eight BRIEF scales (shift, working memory, plan/organize and monitor), a large majority of teacher ratings of students produced T scores in the clinically significant range (T scores greater than or equal to 65). The initiate and working memory scales were rated as highly problematic for more than 90% of the students. Teacher ratings produced roughly even divisions between clinically significant and clinically nonsignificant score levels for the remaining three scales: inhibit, emotional control, and organization of materials.

BRIEF Teacher Form percentile ranks are summarized in Table 6. These percentile ranks are based on the number of students above and below a percentile rank of 90, which is the percentile rank used by the BRIEF authors to indicate a clinically significant level of executive functioning difficulty.

Table 6

BRIEF Scale Percentile Ranks by Significance Category for the Total Sample

BRIEF Scale	Percentile Rank <90		Percentile Rank ≥90	
	n	%	*n*	%
Inhibit	29	38	47	62
Shift	14	18	62	82
Emotional control	35	46	41	54
Initiate	5	7	71	93
Working memory	5	7	71	93
Plan/Organize	14	18	62	82
Organization of materials	40	53	36	47
Monitor	13	17	63	83

Teacher ratings produced BRIEF scale percentile ranks ranging from average to extremely high. Percentile ranks in the average range indicate a relative lack of concern about executive function difficulties. The more the percentile rank is above the average range, the greater the concern for the executive function difficulties being reported. For each scale, teacher ratings produced scores as follows: The inhibit scale percentile ranks ranged from 45 to 99; the shift scale percentile ranks ranged from 50 to 99; the emotional control percentile ranks ranged from 50 to 99; the initiate scale percentile ranks ranged from 78 to 99; the working memory scale percentile ranks ranged from 50 to 99; the plan/organize scale percentile ranks ranged from 64 to 99; the organization of materials percentile ranks ranged from 50 to 99; and the monitor scale percentile ranks ranged from 50 to 99.

As anticipated, the frequency of scale percentile ranks in the clinically significant range, based on teacher ratings was similar to the frequency of T scores, but with a few important differences. The proportion of students whose ratings produced scores in the clinically significant range increased for the inhibit, shift, and plan/organize scales. The five BRIEF scales (shift, initiate, working memory, plan/organize and monitor) with high percentages of T scores in the clinically significant range also reflected high proportions of percentile ranks in the clinically significant range, with even higher proportions for the shift and plan/organize scales. As with T scores, teacher ratings produced roughly even divisions between clinically significant and clinically nonsignificant score levels for the inhibit, emotional control, and organization of materials scales, although the inhibit scale proportion increased in favor of more clinically significant scores.

BRIEF Teacher Form cumulative frequencies of the number of clinically significant T scores are summarized in Table 7, based on the percentage of students whose BRIEF scores were within the clinically significant range.

Table 7

Cumulative Frequencies of the Number of Clinically Significant BRIEF T Scores Earned by Students

Number of T Scores	*n*	%
8	19	25
7	19	25
6	6	8
5	7	9
4	13	17
3	6	8
2	3	4
1	2	3
0	1	1

Teacher ratings resulted in four or more BRIEF scale T scores in the clinically significant range for 84% of the students. Teacher ratings resulted in clinically significant T scores for all eight BRIEF scales for 25% of the students, and another 25% received clinically significant T scores for seven of the eight scales.

Table 8 summarizes the cumulative frequency of the number of clinically significant percentile rank scores.

Table 8

Cumulative Frequencies of the Number of Clinically Significant BRIEF Percentile Ranks Earned by Students

Number of Ranks	*n*	%
8	22	29
7	18	24
6	8	11
5	9	12
4	9	12
3	6	8
2	1	1
1	2	2
0	1	1

Teacher ratings resulted in four or more BRIEF scale percentile ranks in the clinically significant range for 88% of the students. Teacher ratings resulted in clinically significant percentile ranks for all eight BRIEF scales for 25% of the students, and another 25% received clinically significant percentile ranks for seven of the eight scales.

Based on each student's specific pattern of BRIEF scale percentile ranks in the clinically significant range, a BRIEF scale profile was constructed for each student and cumulative frequencies were generated for the number of students exhibiting specific profiles. This analysis resulted in 25 different profiles.

The profile and the number of scales in the clinically significant range for each profile are shown in Table 9.

Table 9

BRIEF Scale Profiles Resulting From Teacher Ratings for the Total Sample

BRIEF Scale Profile	Number of Elevated Scales	Number Exhibiting the Profile	Percent Exhibiting the Profile
22222222	8	22	29
22222212	7	11	15
22222211	6	1	1
22222122	7	2	3
22222112	6	2	3

(continues)

Table 9 (continued)

BRIEF Scale Profiles Resulting From Teacher Ratings for the Total Sample

BRIEF Scale Profile	Number of Elevated Scales	Number Exhibiting the Profile	Percent Exhibiting the Profile
22212112	5	1	1
22122222	7	3	4
22122212	6	1	1
22122211	5	2	3
22122112	5	1	1
21122222	6	1	1
12222222	7	2	3
12122222	6	3	4
12122212	5	4	5
12122211	4	2	3
12122112	4	1	1
12121112	3	1	1
12111211	2	1	1

(continues)

Table 9 (continued)

BRIEF Scale Profiles Resulting From Teacher Ratings for the Total Sample

BRIEF Scale Profile	Number of Elevated Scales	Number Exhibiting the Profile	Percent Exhibiting the Profile
12111111	1	2	3
11122222	5	1	1
11122212	4	4	5
11122211	3	4	5
11122122	4	2	3
11122112	3	1	1
11111111	0	1	1

Note. 1 indicates a clinically nonsignificant percentile rank; 2 indicates a clinically significant percentile rank. Each digit in the profile represents a separate BRIEF scale in the following order: inhibit, shift, emotional control, initiate, working memory, plan/organize, organization of materials, and monitor.

The most frequently occurring percentile rank profile, accounting for 29% of all the profiles, presented with all eight of the scales of the BRIEF being within the clinically significant range. The second most frequent profile presented with all BRIEF scales within the clinically significant range except the organization of materials scale. This profile accounted for another 15% of the profiles. These two profiles accounted for the pattern of BRIEF scale teacher ratings for 44% of the sample. No other single profile type among the remaining 23 accounted for more than 5% of the sample.

BRIEF ratings by gender.

BRIEF Teacher Form T scores are summarized in Table 10 for male and female students separately. As shown in the table, the total number of females in the sample was much smaller than the number of males. Additionally, the proportions of females earning T scores in the clinically significant range were much greater than the proportions of males. Female and male proportions of clinically significant T scores were most similar for the shift, initiate, and working memory scales.

Table 10

BRIEF Scale T Scores by Significance Category for Male and Female Students

	Males				Females			
	T <65		T ≥65		T <65		T ≥65	
BRIEF Scale	*n*	%	*n*	%	*n*	%	*n*	%
Inhibit	32	49	33	51	3	27	8	73
Shift	15	23	50	77	3	27	8	73
Emotional control	33	51	32	49	2	18	9	82
Initiate	5	8	60	92	0		11	100
Working memory	5	8	60	92	0		11	100
Plan/Organize	18	28	47	72	4	36	7	64
Organization of materials	36	55	29	45	5	45	6	55
Monitor	12	18	53	82	1	9	10	91

BRIEF Teacher Form percentile ranks are summarized in Table 11 for male and female students separately. Consistent with the T score results, the proportions of females earning percentile ranks in the clinically significant range were much greater than the proportions of males. Female and male proportions of clinically significant percentile ranks were most similar for the initiate and working memory scales.

Table 11

BRIEF Scale Percentile Ranks by Significance Category for Male and Female Students

	Males				Females			
	Percentile Rank				Percentile Rank			
	<90		≥90		<90		≥90	
BRIEF Scale	*n*	%	*n*	%	*n*	%	*n*	%
Inhibit	26	40	39	60	3	27	8	73
Shift	14	22	51	78	0		11	100
Emotional control	33	51	32	49	2	18	9	82
Initiate	5	8	60	92	0		11	100
Working memory	5	8	60	92	0		11	100
Plan/Organize	10	15	55	85	4	36	7	64
Organization of materials	36	55	29	45	4	36	7	64
Monitor	13	20	52	80	0		11	100

Table 12 summarizes the cumulative frequencies of the number of clinically significant BRIEF scale T scores for male and female students separately.

Table 12

Cumulative Frequencies of the Number of Clinically Significant BRIEF T Scores Earned by Male and Female Students

	Males		Females	
Number of T Scores	*n*	%	*n*	%
8	18	28	1	9
7	13	20	6	55
6	4	6	2	18
5	6	9	1	9
4	13	20		
3	5	8	1	9
2	3	5		
1	2	3		
0	1	1		

Teacher ratings for the male population resulted in four or more BRIEF scale T scores in the clinically significant range for 83% of the students. Teacher ratings for the female population resulted in four or more BRIEF scale T scores in the clinically significant range for 91% of the students. Teacher ratings resulted in clinically significant T scores for all eight BRIEF scales for 28% of the male students, and another 20% received clinically significant T scores for seven of the eight scales. Teacher ratings resulted in clinically significant T scores for all eight BRIEF scales for only 9% of the female students. A majority of the female students(55%) however, received teacher ratings resulting in clinically significant T scores for seven of the eight scales.

Table 13 summarizes the cumulative frequencies of the number of clinically significant BRIEF scale percentile ranks earned by a student resulting for male and female students separately.

Table 13

Cumulative Frequencies of the Number of Clinically Significant BRIEF Percentile Ranks Earned by Male and Female Students

	Males		Females	
Number of Ranks	*n*	%	*n*	%
8	21	32	1	9
7	12	18	6	55
6	6	9	2	18
5	8	12	1	9
4	9	14		
3	5	8	1	9
2	1	2		
1	2	3		
0	1	2		

Teacher ratings resulted in four or more BRIEF scale percentile ranks in the clinically significant range for 85% of the male students. Teacher ratings resulted in four or more BRIEF scale percentile ranks in the clinically significant range for 91% of the female students. Teacher ratings resulted in clinically significant percentile ranks for all eight BRIEF scales for 32% of the male students, and another 18% received clinically significant percentile ranks for seven of the eight scales. Teacher ratings resulted in clinically significant percentile ranks for all eight of the BRIEF scales for only 9% of the female students, whereas 55% of female students revealed BRIEF scale percentile ranks for seven of the eight scales.

Table 14 shows frequencies of percentile rank profiles of scores within the clinically significant range, based on BRIEF teacher ratings, separately for the male and female students of the sample.

Table 14

Gender-Based BRIEF Scale Profiles Resulting From Teacher Ratings

BRIEF Scale Profile	Number of Elevated Scales	Males		Females	
		n	%	*n*	%
22222222	8	20	31	2	18
22222212	7	9	14	2	18
12122212	5	4	6		
11122212	4	4	6		
11122211	3	4	6		
22122222	7	3	5		
12222222	7	1	1	2	18
22122112	5	1	1	2	18
22222122	7	0	0	2	18

(continues)

Table 14

Gender-Based BRIEF Scale Profiles Resulting From Teacher Ratings (continued)

BRIEF Scale	Number of	Males		Females	
Profile	Elevated Scales	*n*	%	*n*	%
22122211	5	2	3		
12122211	4	2	3		
12111111	1	2	3		
12122222	6	1	1	1	10
11122122	4	2	3		
22122212	6	1	1		
22222211	6	1	1		
21122222	6	1	1		
22212112	5	1	1		
11122222	5	1	1		
12122112	4	1	1		
12121112	3	1	1		
12111211	2	1	1		

(continues)

Table 14

Gender-Based BRIEF Scale Profiles Resulting From Teacher Ratings (continued)

BRIEF Scale Profile	Number of Elevated Scales	Males		Females	
		n	%	*n*	%
11122112	3	1	1		
11111111	0	1	1		

Note. A 1 indicates a clinically nonsignificant percentile rank; a 2 indicates a clinically significant percentile rank. Each digit in the profile represents a separate BRIEF scale in the following order: inhibit, shift, emotional control, initiate, working memory, plan/organize, organization of materials, and monitor.

The most frequently occurring percentile rank profile for male students, accounting for 31% of all male profiles, presented with all eight of the scales of the BRIEF being within the clinically significant range. The second most frequent profile presented with all the BRIEF scales within the clinically significant range, except the organization of materials scale. This profile accounted for another 14% of the male profiles. These two profiles accounted for the pattern of BRIEF scale teacher ratings for 45% of the male sample. No other single profile type among the remaining 22 accounted for more than 6% of the male sample. The most frequently occurring percentile rank profile, accounting for 54% of the female sample, presented with seven of the eight scales of the BRIEF being within the clinically significant range. The second most frequently occurring percentile rank profile for the female sample resulted in 18% of the sample, with all eight scales within the clinically significant range. Ten percent of the female sample had six of the eight scales within the clinically significant range.

BRIEF ratings by educational program.

For purposes of analysis, the sample was divided into the educational program categories of inclusion (full or part time) and noninclusion. BRIEF Teacher Form T scores are summarized in Table 15 for the two educational program groups.

Table 15

BRIEF Scale T Scores by Significance Category for Inclusion and Noninclusion Program Student Groups

	Inclusion				Noninclusion			
	T <65		T ≥65		T <65		T ≥65	
BRIEF Scale	*n*	%	*n*	%	*n*	%	*n*	%
Inhibit	17	59	12	41	18	38	29	62
Shift	6	21	23	79	12	26	35	74
Emotional control	15	52	14	48	20	43	27	57
Initiate	4	14	25	86	1	2	46	98
Working memory	5	17	24	83	0		47	100
Plan/Organize	9	31	20	69	13	28	34	72
Organization of materials	17	57	12	43	24	51	23	49
Monitor	10	34	19	66	3	6	44	94

As anticipated, the proportions of students in the noninclusion programs earning T scores in the clinically significant range were greater than the proportions of students in the inclusion programs for seven of the eight BRIEF scales. The only scale that was not within the clinically significant range for inclusion students was the organization of materials scale.

BRIEF Teacher Form percentile ranks are summarized in Table 16 for the inclusion and noninclusion groups separately.

Table 16

BRIEF Scale Percentile Ranks by Significance Category for Inclusion and Noninclusion Program Student Groups

	Inclusion				Noninclusion			
	Percentile Rank <90		Percentile Rank ≥90		Percentile Rank <90		Percentile Rank ≥90	
BRIEF Scale	*n*	%	*n*	%	*n*	%	*n*	%
Inhibit	15	52	14	48	14	30	33	70
Shift	4	14	25	86	10	21	37	79
Emotional control	15	52	14	48	20	43	27	57
Initiate	4	14	25	86	1	2	46	98
Working memory	5	17	24	83	0		47	100
Plan/Organize	6	21	23	79	8	13	41	87
Organization of materials	16	55	13	45	24	51	23	49
Monitor	9	31	20	69	4	12	43	88

Consistent with the T score results, the proportions of students in noninclusion programs earning percentile ranks in the clinically significant range were greater than the proportions of students in inclusion programs for seven of the eight BRIEF scales. The organization of materials domain was not within the clinically significant range for either group (inclusion or noninclusion).

Table 17 summarizes the cumulative frequencies of the number of clinically significant BRIEF scale T scores for students in inclusion and noninclusion programs separately.

Table 17

Cumulative Frequencies of the Number of Clinically Significant BRIEF T Scores Earned by Students in Inclusion and Noninclusion Educational Programs

	Inclusion		Noninclusion	
Number of Scores	*n*	%	*n*	%
8	6	21	13	28
7	6	21	13	28
6	3	10	3	6
5	2	7	5	11
4	4	14	9	19
3	3	10	3	6
2	2	7	1	2
1	2	7	0	
0	1	3	0	

Ninety-two percent of the students in the noninclusion programs earned percentile ranks in the clinically significant range for four or more BRIEF scales, whereas 73% of the inclusion students earned percentile ranks in the clinically significant range for four or more BRIEF scales.

Table 18 summarizes the cumulative frequencies of the number of clinically significant BRIEF scale T scores for students in inclusion and noninclusion programs separately.

Table 18

Cumulative Frequencies of the Number of Clinically Significant BRIEF Percentile Ranks Earned by Students in Inclusion and Noninclusion Educational Programs

	Inclusion		Noninclusion	
Number of Ranks	*n*	%	*n*	%
8	7	24	15	32
7	6	21	12	25
6	3	10	5	11
5	4	15	5	11
4	3	10	6	12
3	2	7	4	9
2	1	3	0	0
1	2	7	0	0
0	1	3	0	0

The proportions of students in the noninclusion programs earning percentile ranks in the clinically significant range were greater than the proportions of students in the inclusion programs. The percentage of noninclusion students who exhibited four or more BRIEF scales within the clinically significant range was 91%. The percentage of inclusion students who exhibited four or more BRIEF scales within the clinically significant range was 80%.

Table 19 shows frequencies of BRIEF scale profiles of percentile ranks within the clinically significant range, based on BRIEF teacher ratings, separately for the two educational program groups.

Table 19

BRIEF Scale Profiles Resulting from Teacher Ratings by Educational Program Groups

BRIEF Scale Profile	Number of Elevated Scales	Inclusion		Noninclusion	
		n	%	*n*	%
22222222	8	7	24	13	28
22222212	7	4	14	7	15
11122212	4	0	0	4	9
12122212	5	1	3	2	4

Note. A 1 indicates a clinically non-significant percentile rank; a 2 indicates a clinically significant percentile rank. Each digit in the profile represents a separate BRIEF scale in the following order: inhibit, shift, emotional control, initiate, working memory, plan/organize, organization of materials, and monitor.

Only the four most common profiles are listed in Table 19. Additional profile types were found in fewer than 5% of the cases of either group. In total, there were only 18 profile matches across the two groups, i.e., 42% of the inclusion group presented with profiles that did not match the profiles of the noninclusion group, and 62% of the noninclusion group presented with profiles that did not match a profile found in the inclusion group. Consistent with the findings presented in other tables in this section, the unique noninclusion group profiles included fewer clinically significant scales and the inclusion group unique profiles included more clinically significant scales.

Chapter 5

Discussion

The purpose of this study was to use archival data collected using the Behavior Rating Inventory of Executive Functions (BRIEF) Teacher Form to examine the executive functions difficulties of adolescents with autism. The following research questions were examined;

Research questions.

1. Is there a specific pattern of executive functions strengths and weaknesses that emerges from teacher ratings of adolescents with autism?
2. Do teacher BRIEF ratings of adolescents with autism reflect clinically significant levels of impairment across the range of executive functions assessed on the BRIEF?
3. Based on teacher BRIEF scale ratings, do teacher judgments of the executive functions capacities of adolescents with autism differ by student gender?
4. Based on teacher BRIEF scale ratings, do teacher judgments of the executive functions capacities of adolescents with autism differ by placement setting?

Summary of results.

Overall, results of the analyses revealed that teacher ratings of student behaviors thought to reflect executive functions difficulties yielded scores in the clinically significant range in most executive functions domains of the BRIEF for a large majority of the adolescents included in this study. This indicates that students 12 to 18 years old with autism exhibit executive dysfunction on most domains of the BRIEF. In general, teacher BRIEF ratings reflected clinically significant levels of executive function deficits across the age range and across placement setting for both male and female students. The results of analysis of the data can be summarized as follows:

Teacher BRIEF ratings of adolescents, ages 12 to 18, with autism reflected widespread executive function deficits for all domains of the BRIEF, with the exception of one domain, organization of materials. The BRIEF score patterns most frequently of these students reflected clinically significant deficits extending across four or more BRIEF scales (84% based on T scores; 88% based on percentile rank) and most often affecting seven or all eight of the BRIEF domains (50% based on T scores; 53% based on percentiles).

This study revealed that teacher BRIEF ratings reflected clinically significant levels of concern for a large majority of the students related to behaviors indicating executive function difficulties within the BRIEF domains of shift, initiate, working memory, plan/organize, and monitor. Teacher ratings reflected concerns for fewer students related to behaviors indicating executive function difficulties within the BRIEF domains of inhibit and emotional control and concern for a much smaller number of students related to behaviors indicating executive function difficulties within the organization of materials domain.

Based on BRIEF ratings, teacher judgments of the executive functions of adolescents with autism did not differ by student gender, although there were many fewer females (n = 11) in the sample than males (n = 54). This study revealed that both male and female students were rated by teachers as exhibiting clinically significant executive functions impairments in many domains of the BRIEF. A greater percentage of the female sample was rated as having more executive function difficulties than the male sample. Teacher ratings produced clinically significant scale T scores for four or more BRIEF scales for 91% of the female sample and 56% of the male sample. The difference between teacher ratings of female and male students that produced seven or eight clinically significant scale scores also included a higher percentage of female students (64%) compared to male students (50%), but the difference between the two gender groups was not as great at this most extreme level of impairment. Ratings of female and male students reflected scale score patterns identical to the total group, with fewer clinically significant scores resulting from ratings of inhibition, emotional control, and organization of materials.

Based on BRIEF ratings, teacher judgments of the executive function capacities of adolescents with autism do differ by placement setting. Students who were in self-contained or noninclusion settings exhibited more impaired executive functioning capacities than did students who were within an inclusion setting. Teacher ratings produced clinically significant T scores for four or more BRIEF scales for 92% of the students in noninclusion settings compared to 77% of students in inclusion settings. The difference between teacher ratings of students in noninclusion and inclusion settings that produced seven or eight clinically significant scale scores also included a higher percentage of noninclusion students (56%) compared to male students (42%), but the difference between the two groups was not as great at this most extreme level of impairment. Ratings of students in noninclusion and inclusion settings reflected scale score patterns identical to the total group, with fewer clinically significant scores resulting from ratings of inhibition, emotional control, and organization of materials.

Discussion of findings.

These research questions addressed the degree to which executive function capacities are compromised for 12- to 18-year-old students with autism. Teacher ratings reflected clinically significant levels of concern with behaviors thought to reflect difficulties with executive functions across all ages, genders, grade levels and placement settings. Students who were educated in a noninclusion or self-contained setting displayed more impaired or clinically significant weaknesses with executive functions than students who were educated in the inclusion settings. High percentages of both male and female adolescents were rated as having executive functions difficulties, but a greater number of concerns was expressed for a larger percentage of the female than the male students. Due to the limited number of female students in the sample, the female students may have been slightly overrated by the teachers, reflecting a greater concern regarding the female population's deficit in executive skills.

Regarding the specific executive function domains of the BRIEF, greater numbers of students were rated in the clinically significant range for the shift, initiate, working memory, plan/organize, and monitor domains. Fewer students were rated as having clinically significant difficulties with the inhibit, emotional control, and organization of materials domains, with the organization of materials scale being the least likely of all domains to be rated by teachers as problematic for this sample of students. This pattern held for the separate male and female groups and the different educational program settings, as well as for the total group.

Given the highly structured nature of the educational programming provided to these students with autism, the lower incidence of observed problems with the organization of materials scale is not a particularly surprising finding. The external modifications and supports in place for these students greatly reduced the likelihood of observing difficulties in student behaviors. Had these students not been receiving the level of external supports in place in their programs, it is likely that ratings for the BRIEF organization of materials scale would have been clinically significant, as well. Reasons for the lower incidence of clinically significant ratings for the inhibit and emotional control scales are much less apparent. One explanation may be that many of the inclusion students in the sample did not exhibit observable externalizing behaviors (i.e., acting out in class or calling out in class).

While the research base for studies conducted on executive function deficits of children with autism is limited, the results of this study were consistent with the few previous research studies reported in the professional literature. The definition of executive functions varies by theory and model; however, researchers commonly agree that executive function is an overarching term representing a broad collection of directive cognitive capacities that are responsible for intentional, goal-oriented, purposeful behavior. These multiple executive function capacities form the basis of self-regulation and include, but are not limited to, the cueing and directing of working memory, inhibition and delay of responding, planning, organization, anticipatory/preparedness for acting, goal selection, performance monitoring, and error correction. Although individual executive functions have distinct roles, together they form an interrelated network of directive capacities that control and regulate cognition, emotion, and behavior. Executive functions are most likely to be activated in situations that place demands on individuals beyond the use of automatic routines or when novel solutions to problems are required (Borkowski & Burke, 1996).

It has been proposed that deficient executive functions involved in cueing and directing flexibility, set maintenance, organization, planning, and working memory may be the primary cognitive deficits of autism (Hughes et al., 1994; Ozonoff & Jensen, 1999; Ozonoff et al., 1991). Executive dysfunction in autism including impairments in tasks requiring response inhibition, working memory, planning, and attention have been identified in both childhood and adulthood (Bennetto et al., 1996; Hughes et al., 1994; Luna et al., 2007; Minshew et al., 1999; Ozonoff et al., 2004; Reed, 2002; Turner 1999; Zelazo et al., 2002; van der Geest et al., 2001). Results of the current study were consistent with the findings of the sources cited above. Based on teacher ratings from the BRIEF, students with autism exhibited a number of behaviors likely to be reflective of executive function difficulties. The following discussion addresses these executive function difficulties by BRIEF scale domains.

Working memory.

Based on BRIEF teacher ratings, many students in the sample experienced difficulties with behaviors that reflected a lack of effective cueing and direction of working memory. BRIEF working memory scale ratings ranked first in frequency of clinically significant scores for students in the sample (frequency of clinically significant T scores, 93%; frequency of clinically significant percentile ranks, 93%). Working memory refers to the ability to simultaneously process and store information whilst performing cognitive tasks (Barnard et al., 2008 pp. 127). Many studies have explored the possibility that working memory deficits may play a critical role in autism (Joseph, 1999). The BRIEF working memory scale is composed of items that reflect difficulties with focusing and sustaining attention for tasks, thought to reflect a lack of the use of executive functions to cue and direct these working memory capacities. As reflected in the BRIEF working memory scale items, students rated in the clinically significant range on this BRIEF scale experienced difficulties that included demonstrating a short attention span, having trouble remembering things even for a short time, having trouble concentrating, being easily distracted, and needing assistance to stay on task.

Initiate.

Based on BRIEF teacher ratings, many students in the sample experienced difficulties with behaviors that reflected a lack of effective use of the initiate function. BRIEF initiate scale ratings ranked first in frequency of clinically significant scores for students in the sample (frequency of clinically significant T scores, 93%; frequency of clinically significant percentile ranks, 93%). As reflected in the BRIEF initiate scale items, students rated in the clinically significant range on this BRIEF scale experienced difficulties that included lacking self initiation, needing to be told to begin a task, and having trouble thinking of a different way to solve problems.

Monitor.

Based on BRIEF teacher ratings, many students in the sample experienced difficulties with behaviors that reflected a lack of effective use of the monitor function. BRIEF monitor scale ratings ranked second in frequency of clinically significant scores for students in the sample (frequency of clinically significant T scores, 83%; frequency of clinically significant percentile ranks, 83%). As reflected in the BRIEF monitor scale items, students rated in the clinically significant range on this BRIEF scale experienced difficulties that included not checking work for mistakes, often leaving work incomplete, and not noticing when their behavior caused a negative reaction. Students rated in the clinically significant range on this BRIEF scale had significant difficulty monitoring simultaneous cognitive processes. These monitoring difficulties are seen primarily in the social arena, as students with autism have difficulty monitoring the environmental social cues, social feedback, and facial expressions of others.

Shift.

Based on BRIEF teacher ratings, many students in the sample experienced difficulties with behaviors that reflected a lack of effective use of the shift function. BRIEF shift scale ratings ranked third in frequency of clinically significant scores for students in the sample (frequency of clinically significant T scores, 76%; frequency of clinically significant percentile ranks, 82%). This executive function cues a change of focus or alteration of perceptions, emotions, thoughts, or actions in reaction to what is occurring in the internal or external environments. Studies have shown that children, adolescents, and adults with autism are less likely to change responses where appropriate compared to age- and IQ-matched controls (Barnard et al., 2008; Ozonoff & Jensen, 1999; Rumsey, 1985). As reflected in the BRIEF shift scale items, students rated in the clinically significant range on this BRIEF scale experienced difficulties that included difficulty accepting a different way to solve a problem, becoming upset in new situations, acting upset by a change of plans, being disturbed by a new teacher or class, thinking too much about the same topic (perseveration), and getting stuck on one topic.

Plan/Organize.

Based on BRIEF teacher ratings, many students in the sample experienced difficulties with behaviors that reflected a lack of effective use of executive function cues for planning and organizing. BRIEF plan/organize scale ratings ranked fifth in frequency of clinically significant scores for students in the sample (frequency of clinically significant T scores, 71%; frequency of clinically significant percentile ranks, 82%). As reflected in the BRIEF working memory scale items, students rated in the clinically significant range on this BRIEF scale experienced difficulties that included having difficulty remembering to hand in homework, lacking follow-through, and underestimating the time required to complete tasks. The difficulties that many students experience with the behaviors of this BRIEF domain are recognized by the teachers in the programs that serve these student's as a significant amount of educational programming is devoted to providing the external controls needed to enable students to be successful academically despite their difficulties with organization and planning.

Inhibit.

Based on the BRIEF teacher ratings, some students with autism exhibited behavior difficulties that reflected problems with cueing and directing inhibition of impulsive responding. BRIEF inhibit scale ratings ranked sixth in frequency of clinically significant scores for students in the sample (frequency of clinically significant T scores, 54%; frequency of clinically significant percentile ranks, 62%). The inhibit executive function cues the resistance of urges to perceive, feel, think, or act on first impulse. As reflected in the BRIEF inhibit scale items, students rated in the clinically significant range on this BRIEF scale experienced difficulties that included needing to be told "no" or “stop,” not thinking about the consequence of their actions, interrupting others, exhibiting impulsivity, not “putting on the brakes” when needed, not remaining seated, and getting out of control more often than peers.

Emotional control.

Based on BRIEF teacher ratings, a relatively smaller number of students in the sample experienced difficulties with behaviors that reflected a lack of effective control of emotional reactions. BRIEF emotional control scale ratings ranked seventh in frequency of clinically significant scores for students in the sample (frequency of clinically significant T scores, 54%; frequency of clinically significant percentile ranks, 54%). As reflected in the BRIEF emotional control scale items, students rated in the clinically significant range on this BRIEF scale experienced difficulties that included overreacting to small problems, having frequent mood changes, and having explosive, angry outbursts.

Organization of materials.

Based on BRIEF teacher ratings, relatively few students in the sample experienced difficulties with behaviors that reflected a lack of cueing for the organization of materials. BRIEF organization of materials scale ratings ranked eighth in frequency of clinically significant scores for students in the sample (frequency of clinically significant T scores, 46%; frequency of clinically significant percentile ranks, 47%). As reflected in the BRIEF organization of materials scale items, students rated in the clinically significant range on this BRIEF scale experienced difficulties that included leaving messes that others had to clean up, losing personal belonging, and having a messy desk. As noted earlier in this discussion, the relatively low number of students rated in the clinically significant range on this BRIEF scale is likely due, at least in part, to the fact that the educational programming provided to these students greatly reduced the number of opportunities to observe the kinds of behaviors reflected in the scale items, thereby reducing the likelihood that a student would be rated as exhibiting these behaviors often (within the significant range).

Implications of the findings.

This study revealed that teachers' ratings with the BRIEF reflected a high level of executive function deficiency in the behaviors of adolescents with autism. The educational impact and implication is that these students require a high degree of external support to be successful learners. Students with autism who are educated in inclusion settings appear to exhibit fewer problem behaviors and therefore appear to be making greater use of executive functions capacities than are students who are educated in self-contained settings. The implication is that a greater number of students in inclusion settings have more capacity to cue shifting, planning, organizing, focusing and sustaining, and monitoring, to initiate activities and/or responses, to transition between tasks, and to have more emotional control reflected in their behavior. Conversely, a greater number of students in self-contained educational settings exhibit more executive function impairments and therefore require a higher degree of external support. These students exhibit a greater degree of externalizing behaviors and appear to have less developed executive control, therefore requiring more external support. The executive function deficits of these students likely affect their functioning across multiple arenas of involvement, including control in relation to self (intrapersonal arena), control in relation to others (interpersonal arena), control in relation to the environment around them (environment arena) and control in relation to academic production (symbol system arena) (McCloskey et al., 2009). The executive function deficits demonstrated by students with autism necessitate involvement in educational programs that address these students' needs for greater external prompting for regulation of perceptions, feelings, thoughts, and actions in all four arenas rather than a program that only focuses on the presentation of academic material.

Although this study suggests that students with autism exhibit executive functions deficits, it is important to recognize that executive functions are only responsible for cueing and directing perceptions, feelings, thoughts, and actions. The assumption here is that the student has adequate perceptions, feelings, thoughts, and actions to cue and direct. In direct example, a student who lacks the ability to demonstrate social skills that reflect effective use of perceptions, feelings, thoughts, and actions towards others will appear to be executively deficient, not because of a lack of cueing and directing of social skills, but rather because of a lack of social skills.

Finally, the results this study imply that regardless of functioning level based on placement (higher functioning students placements are in off-site inclusion settings, whereas lower functioning students are in on-site, center-based noninclusion settings), students with autism require an intense amount of external support to help deal with their perceived executive function deficits. In the absence of self-regulation due to executive functions deficits, teachers must provide external prompts in multiple forms (verbal, visual, tactile) for regulation.

This study revealed executive function deficits in multiple domains for the majority of the students in the sample, regardless of educational placement (inclusive versus noninclusive) or age. These findings suggest that external supports for self-regulation may need to remain in place throughout the educational careers of these students in order for them to be academically successful. Given that executive function capacities follow a developmental progression dependent on the maturation of the neural circuitry of the frontal lobes, it has been suggested that one of the most powerful intervention tools for developmental delays in the effective use of executive functions is time itself (McCloskey et al., 2009). In the case of students with autism, however, this may not be the case, as the executive functions deficits may be reflecting more innate neural damage rather than merely a delay in neural maturation. O'Hearn et al.(2008), for example, reported that despite some developmental gains, mature executive functioning is limited in autism. Since previous research has established that dysfunction of the frontal lobe may underlie some of the behavioral characteristics of autism, as well as lead to impaired processing of complex information across all domains, improvement of many executive function capacities may be limited in cases of autism, thereby necessitating a high level of external support throughout the life span of individuals with autism.

Limitations of study.

While this study added to the literature on adolescents with autism, it is limited by the relatively small sample size. Also, the participants in this study were students from a highly specialized and structured program specifically designed for students with autism located in a single state. Additionally, this study only examined teacher ratings of adolescents ages 12 through 18. While this researcher may broadly conclude that this study could generalize to other age ranges of students with autism, there were no participants outside the age range of 12 to 18. Also, the sample was mostly comprised of male participants, making it difficult to know whether the findings would apply to a large sample of female students. A final limitation of this study is that data on other aspects of cognitive, academic, social, and emotional functioning were not collected, thereby precluding an examination of the relationship of executive functions and level of functioning in these other domains. Such additional information would be highly useful in that it would enable further clarification of the issue of whether the deficits observed in the executive functions are truly deficits in the ability to cue and direct other aspects of functioning or rather reflective of deficits in the other areas of functioning.

Future directions.

While the literature base on executive functions is rapidly growing, investigation of the relationship between executive function deficits and autism has not been a major focus of most studies. This study attempted to add to the relatively small body of literature in this area. Future research may investigate a wider age range of students with autism in order to clarify further the relationship between executive function difficulties and students with autism across a broader age span. A future study including more female participants would allow researchers to clarify the findings related to female students with autism. Another area for future research would be to study students with autism within a more typical school setting, who receive less structured and intense supports, to determine if significant executive function deficits exist and to what extent these deficits impact the educational experience of these students. Finally, this study could be broadened to investigate the relationships among cognitive, academic, social and emotional functioning and executive function deficits for students with autism.

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