THE NEUROPSYCHOLOGY OF SOCIAL FUNCTIONING IN CHILDREN WITH AUTISM SPECTRUM DISORDER

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ABSTRACT

Autism spectrum disorder (ASD) is a developmental disorder characterized by impairments in social interaction, social communication, and repetitive or stereotyped interests (APA, 2013). The hallmark deficits present in children with ASD are difficulties in social interaction and reciprocation (Troyb, Knoch, & Barton, 2011). Social deficits in children with ASD include difficulty creating social relationships, initiating social interactions, emotional reciprocity, sharing enjoyment, perspective taking, and inferring interests of others (Bellini, Peters, Benner, & Hopf, 2007; Troyb, Knoch, & Barton, 2011). Research has indicated that children with ASD have fewer reciprocal friendships as compared to their typically developing peers overall (Rotheram-Fuller, Kasari, Chamberlain, & Locke, 2010) and are mostly peripheral or isolated from their classroom social networks as opposed to their typical peers (Kasari, Rotheram-Fuller, Locke, & Gulsrud, 2012).

While numerous interventions have been proposed to remediate these social difficulties, and there has been a plethora of research with regard to the efficacy and effectiveness of social interventions, few studies have investigated the underlying neuropsychological components associated with these difficulties. The executive function theory posits that the deficits present in ASD are a reflection of an impairment of higher order cognitive skills, such as those needed to plan and generate goal directed behavior. This theory suggests that deficits in higher order skills, such as working memory, planning, inhibition, set-shifting, and monitoring underlie the various deficits

seen in the everyday functioning of people with ASD (Minshew, Webb, Williams, & Dawson, 2006). Executive deficits have been widely noted, albeit inconsistently, throughout the literature (Hill, 2004; Joseph & Tager-Flusberg, 2004; Pennington & Ozonoff, 1996); however, there is a paucity of research investigating the relationship between executive functions and social skills in children with ASD. The research thus far has been quite inconsistent with some studies failing to find any relationship between executive and social skills (Ozonoff et al., 2004; Landa & Goldberg, 2005) and others finding that some measures of executive functioning are related to social and/or adaptive skills (Gilotty, Kenworthy, Sirian, Black, & Wagner, 2002; Kenworthy, Black, Harrison, Della Rosa, & Wallace, 2009).

The current study sought to investigate the relationship between executive deficits and social skills among a group of children with ASD. A total of 23 children with ASD who were included in the regular education classroom, age 5 to 12 years old, were administered a battery of performance-based neuropsychological tests to measure shifting, inhibition, and working memory skills. The Behavior Rating of Inventory of Executive Function (BRIEF) teacher report questionnaire was used to measure the student's executive functions in everyday settings. Social skills were measured with a playground observation and a Friendship Survey that was administered to children with ASD and their peers to capture their social connectedness in the classroom.

Results indicated that children with ASD demonstrated impaired performance on performance-based measures of shifting, inhibition, and inhibition-switching. Performance-based measures of working memory skills were in the average range for the

children's age. Children demonstrated impairments on several BRIEF clinical scales including Shift, Initiate, Working Memory, and Monitor. The only performance-based measures that were significantly related to social functioning were inhibition and inhibition-switching. Children with better inhibition skills nominated more peers as friends; however, children with better inhibition-switching skills spent more time in solitary play on the playground. Overall, ratings-based measures of executive functioning were more related to social skills. A number of metacognitive skills including initiation, working memory, and planning and organization were significantly related to a greater proportion of playground time spent jointly engaged as well as fewer rejections by their peers. No relationships were found between executive functions and measures of overall social connectedness in the classroom. This indicates that executive skills (as measured by teacher-report) are extremely important with regard to peer interaction on the playground and well as peer acceptance. As a result, social interventions may need to directly target these skills in an effort to increase social engagement and acceptance. This study, however, failed to find a relationship between executive skills and overall social connectedness in the classroom. Given that as the child ages he/she will spend increasingly less time in the playground environment, it is essential that future research investigate the underlying skills necessary to make and maintain friendships.

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CHAPTER 1

INTRODUCTION

Autism spectrum disorder is a development disorder characterized by impairments in social interaction and communication as well as repetitive or stereotyped interests (APA, 2013). The rates of autism spectrum disorder (ASD) continue to rise and currently it is estimated that approximately 1 in 68 children have an ASD (CDC, 2014). The hallmark deficits present in children with ASD are difficulties in social interaction and reciprocation (Troyb, Knoch, & Barton, 2011). In general, children with ASD have a global lack of prosocial behavior (Lord, 1993). Children with ASD have difficulty initiating social interactions, show atypical responses to social stimuli, and demonstrate impairment in their use of multiple nonverbal behaviors such as eye gaze, facial expressions, and the use of gestures (APA, 2013). In addition to social deficits, children with ASD demonstrate social communication impairments affecting both verbal and nonverbal behaviors (APA, 2013). People with ASD also experience restricted, repetitive, and/or stereotyped behaviors or interests, which can significantly impact social interaction. These stereotyped interests are often abnormal because of their intensity or focus. Some individuals also demonstrate rigid and inflexible behavior and may have a strict adherence to routines and rituals. People with ASD may also exhibit stereotyped or repetitive motor mannerisms (APA, 2013).

Social deficits in children with ASD include difficulty creating social relationships, initiating social interactions, emotional reciprocity, sharing enjoyment,

perspective taking, and inferring interests of others (Bellini, Peters, Benner, & Hopf, 2007; Troyb et al., 2011). In spite of these difficulties, children with ASD are increasingly being placed in the general education setting as opposed to self-contained classrooms (Fuchs & Fuchs, 1994; Kasari, Freeman, Bauminger, & Akin, 1999). The social benefits of placing a child with ASD in a mainstream environment without further intervention are inconclusive.

Several studies have sought to investigate social functioning in children with ASD who were included in regular education classrooms. Research has indicated that children with ASD in mainstreamed settings were more socially included in lower grades than in higher grades (Rotheram-Fuller, Kasari, Chamberlain, & Locke, 2010). However, they had fewer reciprocal friendships as compared to their typically developing peers overall. Other studies have found that children with ASD were mostly peripheral or isolated from their classroom social networks as opposed to their typical peers (Kasari, Rotheram-Fuller, Locke, & Gulsrud, 2012). Children with ASD also had smaller social networks, fewer reciprocated friendships, and their friendships were poorer in quality than their age-matched peers (Kasari, Locke, Gulsrud, & Rotheram-Fuller, 2011).

Kasari and colleagues (2011) looked at playground observations in addition to student and teacher questionnaires, and found little association between the playground observations and the student surveys. Children with ASD were likely to be unengaged on the playground, despite their self-report of social involvement with peers, and regardless of the number of reciprocal friendships. This indicates that survey measures alone may not fully capture the global social functioning of students with ASD. The current study

used both survey and direct observation measures to capture the global social functioning of the student with ASD.

In spite of their widespread deficits in social relationships, few studies have investigated the ramifications of poor social relationships in children with ASD. Bauminger and Kasari (2000) investigated the effects of social functioning on feelings of loneliness in children with ASD. They found that lack of social involvement was linked to feelings of loneliness, indicating a desire for social involvement (Bauminger & Kasari, 2000). Although children with ASD may have difficulty navigating and maintaining social relationships, they still experience the cognitive effects of loneliness. This bolsters the need to increase our understanding of the social impairments in children with ASD in order to provide appropriate social intervention.

Numerous interventions have been proposed to remediate social difficulties. A number of research studies have investigated social skills interventions through various delivery models; however, few studies have investigated the underlying neuropsychological components that may impact the response to such interventions. The literature has failed to adequately investigate the neurocognitive substrates that may affect a child's ability to respond to particular social interventions.

Several theories have attempted to capture the etiology of the social communication deficits and restricted and stereotyped behaviors present in ASD. The weak central coherence theory is an information processing theory which posits that people with ASD struggle to integrate pieces of information into a meaningful whole

(Frith, 1989). In contrast, the theory of mind (ToM) explanation is a social cognitive theory which suggests that the social communication deficits in ASD are caused by a deficit in the ability to understand or identify the mental states of others (Frith, 1989). Lastly, the executive function theory surmises that the deficits present in ASD reflect the impairment of higher order cognitive skills needed to plan and generate goal directed behavior.

Unfortunately, no one single theory adequately captures each domain of impairment present in ASD. Although the weak central coherence theory captures both strengths and weaknesses present in ASD, research supporting this hypothesis is mixed given that not all individuals with ASD demonstrate weak central coherence (Happé & Frith, 2006). The theory of mind proposal suggests that the social communication deficits in ASD are caused by a deficit in the ability to understand or identify the mental states of others (Frith, 1989). However, some studies have found that when controlling for language ability, ToM is no longer related to social functioning in ASD (Happé, 1995).

Finally, the executive function theory posits that the deficits present in ASD are a reflection of an impairment of higher order cognitive skills, such as those needed to plan and generate goal directed behavior. This theory suggests that deficits in such higher order skills, such as working memory, planning, inhibition, set-shifting, and monitoring underlie the various deficits seen in the everyday functioning of people with ASD (Minshew, Webb, Williams, & Dawson, 2006). Although executive functioning as a causal factor in ASD has been controversial, executive deficits have been widely noted

throughout the literature (Hill, 2004; Joseph & Tager-Flusberg, 2004; Pennington & Ozonoff, 1996), suggesting that executive deficits may contribute to the presence of autistic symptoms.

The executive theory has most commonly been linked to the core deficits in repetitive and stereotyped behaviors (Lopez, Lincoln, Ozonoff, & Lai, 2005), but there is a paucity of literature relating deficits in executive functioning to impairments in social functioning. Given that impaired social functioning is the hallmark feature of ASD (Troyb et al., 2011) it is essential that any theory attempting to explain the etiology of ASD adequately captures deficits in this domain.

Although executive deficits in children with ASD have been widely noted throughout the literature, there are concerns regarding the measurement of executive functions. Historically, tasks were created in the laboratory to measure certain executive functions. It was assumed that poor performance on these performance-based measures would be representative of similar deficits in the in the everyday setting. Concerns have been raised, however, regarding the ecological validity of these tasks (Burgess, Alderman, Evans, Emslie, & Wilson, 1998; Burgess, et al., 2006; Toplak, West, & Stanovich, 2013). As a result, rating scales of executive function were developed as an ecologically valid measure of an individual's executive functions in the everyday setting. Rating-based measures are completed by the individual (self-report) or an informant who knows the individual well, generally a parent, guardian, or teacher. They consist of several questions designed to measure the individual's ability to complete problem solving tasks and achieve goals in everyday settings. Although rating measures were

created under the assumption that they measured similar constructs to those assessed by performance-based measures, there is a dearth of research investigating the relationship between the constructs measured by performance- versus ratings-based measures.

This project sought to address this gap in the literature by examining the relationship between various measurement tools of executive functioning in addition to the underlying neuropsychological components associated with social functioning. A better understanding of the underlying neuropsychological components associated with social functioning would aid in the creation of social interventions that are tailored to the specific needs of the child. In addition, the study sought to investigate the efficacy of the executive function theory of ASD by examining the association between executive deficits and social functioning. A correlation between executive and social functioning would support the validity of the executive function theory as an explanation of the etiology of ASD. Specifically, the research questions that will be addressed are:

1. Do children with ASD demonstrate consistent impairments in the areas of inhibition, set shifting and cognitive flexibility, as well as working memory?
2. What is the relationship between performance-based measures of executive functioning and the ratings-based behavioral questionnaire (BRIEF)?
3. What is the relationship between executive functions and social skills in children with ASD?

CHAPTER 2

LITERATURE REVIEW

Autism: Core Deficits and Characteristics

Autism spectrum disorder is a developmental disorder characterized by impairments in social interaction and communication as well as repetitive or stereotyped interests (APA, 2013). According to the Center for Disease Control and Prevention (2014), the rates of autism spectrum disorders (ASD) continue to rise and approximately 1 in 68 children have an ASD. ASD is much more common in males; approximately three times more males are diagnosed (Hill, 2004). ASD is not confined to any one region or community in the country. It equally affects children regardless of income, ethnicity, or locations (urban, suburban, or rural) (Guillermo, 2006). While each child with ASD has his/her own unique presentation, deficits in social interaction and reciprocation are hallmark symptoms (Troyb et al., 2011). Children with ASD have difficulty initiating social interactions and often show atypical responses to social stimuli (Cotugno, 2009; Troyb et al., 2011). They also generally demonstrate a marked impairment in their use of multiple nonverbal behaviors such as eye gaze, facial expressions, and the use of gestures (APA, 2013).

Social play and imitation skills are also impaired (Cotugno, 2009). In general, children with ASD have a global lack of prosocial behavior (Lord, 1993). As a result, children with ASD often avoid social interactions and become overly aroused when they find themselves in a social situation (Cotugno, 2009). Children with ASD struggle to

follow social cues and expectations; these deficits commonly result in rejection and isolation (Cotugno, 2009). Social deficits handicap the everyday adaptive functioning of children with ASD (Berger, Aerts, van Spaendock, Cools, & Teunisse, 2003).

Social communication impairments present in individuals with ASD generally affect both verbal and nonverbal behaviors. Although no longer part of the diagnostic criteria, some individuals experience a delay in the development of language while others fail to develop language at all. Children with ASD often exhibit difficulties having conversations, and the quality of their speech is often impaired. This impairment may be marked by atypical rate and prosody as well as the use of idiosyncratic or stereotyped speech (APA, 2013).

People with ASD also experience restricted, repetitive, and/or stereotyped behaviors or interests, which can significantly impact social interaction. These stereotyped interests are abnormal because of their intensity or focus. Some individuals also demonstrate rigid and inflexible behavior and may have a strict adherence to routines and rituals. People with ASD may also exhibit stereotyped or repetitive motor mannerisms (APA, 2013).

Theories of ASD

Several theories have attempted to capture the etiology of the social deficits and restricted and stereotyped behaviors present in ASD. As a result of the heterogeneous nature of ASD it is difficult to identify a single theory that is able to account for the deficits present in ASD. Further, this heterogeneity contributes to methodological

concerns. In order to obtain experimental control many studies are forced to control for a number of factors such as IQ and thus may only be representative of a specific subset of people with ASD. The weak central coherence theory is an information processing theory which posits that people with ASD struggle to integrate pieces of information into a meaningful whole (Frith, 1989). In contrast, the theory of mind (ToM) explanation is a social cognitive theory which suggests that the social communication deficits in ASD are caused by a deficit in the ability to understand or identify the mental states of others (Frith, 1989). Lastly, the executive function theory suggests that the deficits present in ASD reflect the impairment of higher order cognitive skills needed to plan and generate goal directed behavior.

The weak central coherence theory was originally introduced by Frith (1989). According to this theory, people with ASD focus on the individual parts of stimuli and neglect to understand their global explanation. This theory differs from others in that it attempts to capture both the strengths and weaknesses present in ASD. Several studies have found that people with ASD demonstrate intact or advanced performance on local processing tasks as compared to typical peers. People with ASD often demonstrate hyperability on tasks that involve great attention to detail; however, they struggle with tasks that require attention to the meaning of the whole. In contrast to many prevailing theories of ASD, this theory suggests the presence of right hemisphere dysfunction in people with ASD. Patients with acquired right hemisphere damage have demonstrated impaired integrative processing ability (Rozga, Anderson, & Robins, 2011).

Research supporting this hypothesis is mixed. Earlier studies reported that people with ASD were less susceptible to visual illusions than typical peers (Happé, 1996). Happé (1996) found that when children with ASD were asked to judge if two lines were the same length or straight or curvy they made judgments akin to the line's physical properties, whereas typical peers were susceptible to the illusion and would judge that two lines were dissimilar when they were actually the same length (Happé, 1996). This performance was interpreted as weak central coherence because the participants with ASD failed to integrate the targets within the visual context. Later research failed to replicate such findings (Hoy, Hatton, & Hare, 2004; Ropar & Mitchell, 1999, 2001) and found that participants with ASD were just as susceptible to visual delusions as their typical peers. These data, however, could be confounded by methodological concerns such as the ability to adequately measure central coherence through the use of visual illusions. Although research is mixed, the literature indicates that weak central coherence is neither universal in ASD, given that not all individuals with ASD demonstrate weak central coherence, and it is not specific in ASD and has been found in many other clinical populations such as depression, schizophrenia, and Williams syndrome (Happé & Frith, 2006).

Theory of mind (ToM) has also been used to explain social deficits seen among children with ASD. This social cognitive theory suggests that the social communication deficits in ASD are caused by a deficit in the ability to understand or identify the mental states of others (Frith, 1989). Since the ToM theory has been introduced a range of impairments in this domain have been documented. Children with ASD reportedly

demonstrate mentalizing impairments such as poor performance on tasks requiring them to reason with false beliefs (Baron-Cohen, 1989a). Although false belief testing is predominantly utilized to measure ToM, some children with ASD demonstrate intact ability on these measures; however, they continue to show impairments on more advanced and open-ended tasks such as difficulty with pretend play and pragmatic difficulties (Tager-Flusberg, 1992). Developmentally, these impairments reflect the early signs of understanding mental states and relating to others such as coordination of joint attention, imitation, and pretense. All of these behaviors have been documented as delayed in children with ASD (Chairman et al., 1997).

ToM deficits have been widely linked to impairments in social functioning and communication (Rozga et al., 2011); however, some studies have found that when controlling for language ability, ToM is no longer related to social functioning in ASD (Happé, 1995). Although ToM is a well documented impairment, future research is needed to understand the degree to which these deficits affect everyday social functioning in children with ASD. To date, ToM has been mostly linked with the social and communication impairments present in ASD; however, new research has attempted to link this theory to repetitive behaviors and stereotyped interests. A recent extension of this theory developed by Baron-Cohen and colleagues (2005) posits that in addition to the deficits in ToM that can be found among people with ASD (empathizing), they also possess enhanced ability to reason and predict the behavior of systems and "non-agentive" events (systematizing). Systematizing is the desire to analyze systems (Baron-Cohen, 2009). People with ASD appear to have an advanced ability to understand the

rules of that govern the system and predict how the system will behave (Baron-Cohen, 2006). This expansion, known as the Systemizing-Empathizing hypothesis, attempts to explain the non-social features of ASD, such as repetitive behaviors and interests; however, further empirical evidence is needed to support its validity (Rozga et al., 2011).

Finally, the executive function theory posits that the deficits present in ASD are a reflection of an impairment of higher order cognitive skills such as those needed to plan and generate goal directed behavior. This theory suggests that deficits in such higher order skills, including working memory, planning, inhibition, set-shifting, and monitoring underlie the various deficits seen in the everyday functioning of people with ASD (Minshew et al., 2006).

Each of these theories attempts to explain a portion of the deficits seen in ASD; however, no one theory is able to account for all observed deficits. While the ToM theory has been expanded in an effort to explain repetitive and stereotyped behaviors, this area requires much more empirical support by independent researchers. When controlling for language ability, research has demonstrated that ToM is no longer related to social functioning in ASD (Happé, 1995). Currently, the theory that attempts to account for majority of deficits present in ASD is the executive function theory. Although this theory appears to be the most prominent, there is a paucity of literature relating executive functions to social deficits in ASD. Thus, this project sought to address this gap in the literature.

Executive Functions in Children with ASD

History

Damasio and Maurer (1978) first described ASD as an executive disorder when they noted the behavioral similarities between people with ASD and those with frontal lesions. Communication impairments, for example, are most consistent with deficits found in patients with medial frontal lobe lesions. These deficits do not stem from damage to the language area of the brain and appear to be the result of a lack of initiative to communicate. Patients with frontal lesions also demonstrate deficits in nonverbal communication, as they fail to use gestures and tend to repeat speech known as echolalia. In addition, patients with frontal lesions struggle to adapt to changing environments resulting in perseverative and restricted behaviors. Damasio and Maurer (1978) hypothesized that deficits in social functioning are the result of other impairments in motility, attention, and ritualistic and compulsive behaviors. Overall, Damasio and Maurer (1978) claimed that ASD symptoms such as social deficits, poor communication, and perseverative behavior could be directly linked to frontal lobe functioning.

Although historically, executive functioning was considered a unitary construct, current thinking suggests that executive functions are made up by a number of higher order skills. The term, executive functioning, captures a set of cognitive processes that are needed to plan and generate goal directed behavior. Working memory, inhibition, cognitive flexibility, set shifting, monitoring, planning, and generativity are all considered executive processes. These brain based skills are developed early in life and

have been linked to neural correlates such as multiple cortico-cortical and cortico-striatal loops, but most notably, the frontal lobes are hypothesized to play an integral role (Gazzaniga, Ivry, & Mangun, 2002). The executive function theory has most commonly been linked to the core deficits in repetitive and stereotyped behaviors (Lopez et al., 2005). While the role of executive functions as a causal factor in ASD has been controversial, executive deficits have been widely noted throughout the literature. Deficits in cognitive flexibility and planning have been widely reported; however, there is inconsistent evidence with regard to the presence of difficulties in inhibition and working memory.

Cognitive Flexibility and Set Shifting

Deficits in cognitive flexibility and set shifting have been widely reported. Pennington and Ozonoff (1996) reported larger effect sizes for the relationship between cognitive rigidity and planning deficits in ASD than any other developmental disorder. Many other researchers have found converging evidence to suggest that children with ASD have poorer planning and flexibility as compared to their typically developing peers. The Wisconsin Card Sorting Test (WCST) is a common measure of cognitive flexibility. It requires participants to sort cards on one of three dimensions either color, number, and/or form according to an unspoken rule. The examiner provides feedback with regard to whether the participant's sort was correct or incorrect (e.g. "that's right" or "that's not right"), but does not provide any further information. A perseverative error occurs when the participant continues to sort to a category that was no longer correct and is thought to represent an underlying deficit in the participant's ability to shift set to the

new sorting criterion. Children with ASD have demonstrated highly perseverative performance on the WCST and they struggled to sort to the second or third rules (Bennetto, Pennington, & Rogers, 1996; Ozonoff & Jensen, 1999; Prior & Hoffman, 1990). In addition, children with ASD were able to identify the first category to which they sorted (color), but struggled to identify the subsequent categories (number and form) (Ozonoff & Jensen, 1999; Prior & Hoffmann, 1990).

Although children with ASD have demonstrated consistently impaired performance on the WCST, there is a paucity of literature investigating shifting ability as measured by other tasks. The WCST is rather complex and requires the use of several executive systems including working memory, inhibition, and the ability to encode and respond to verbal feedback. While perseverative errors indicate an inherent inability to shift sets, it may also reflect impairments in other executive functions. The current study addressed this gap in the literature by utilizing a card sorting task that did not involve sorting based upon specific changing rules or examiner feedback. Children with ASD were asked to sort cards with pictures of animals on them into two groups of four based on anything that was on the card. There were a number of correct possible sorts (color, raining vs. not raining, large vs. small animals, etc). Although children with ASD have consistently demonstrated impairments on the WCST, the current study sought to examine if these deficits persist with other measures of cognitive flexibility, and understand the relationship between cognitive flexibility and social functioning.

Inhibition

Several studies have noted that people with ASD perform poorly on the Wisconsin Card Sorting Test (WCST) as compared to controls. However, given the vast executive systems involved in performing the task (attribute identification, categorization, working memory, inhibition, selective attention, encoding verbal feedback), it is difficult to determine the nature of such deficits. Some researchers have posited that these deficits may be related to an inability to inhibit the prepotent response of sorting to the previous rule.

Many studies have found impaired inhibition in children with ASD. Ozonoff and Strayer (1997) aimed to isolate inhibitory mechanisms from other executive functions, to study the potential contribution of deficient inhibitory control in relation to other executive functioning deficits apparent in ASD, and to examine multiple aspects of inhibition. The authors used a Stop-Signal task which measured the ability to control a voluntary motor response and required little set shifting. For the Stop-Signal measure, participants were first required to categorize words as animals or non-animals. Then, they were presented with an auditory signal which indicated that they were to inhibit their categorization response for that trial. The Stop-Signal task thus measured the ability to inhibit a motor response. They also used a Negative Priming task which was thought to measure a more central cognitive inhibitory mechanism. The Negative Priming task required participants to indicate if certain letters were the "same" or "different" when shown a string of five letters. Previous research has indicated that distracter letters from previous trials cause performance to be slower when they appear on subsequent trials.

This is known as "negative priming" and is indicative of intact cognitive inhibition. The sample included 17 children with ASD and 13 neurotypical controls. Results indicated that there were no group differences present for either task. These results are consistent with previous findings, which concluded that children with ASD were highly perseverative, and had difficulty with shifting rather than motoric inhibition. The authors concluded that deficits in inhibition, therefore, do not contribute to poor performance on the WCST.

Ozonoff and Jensen (1999) also found inhibition to be intact in children with ASD. They investigated inhibitory abilities with the Stroop test which consists of three conditions: neutral inhibition, prepotent inhibition, and inhibition switching. For the neutral condition children were asked to read colors written in black ink and for the prepotent inhibition condition colors are written in a different colored ink (the color green may be written in red ink). For this condition the child was asked to name the ink color in which the word was printed and not to read the word, which required them to inhibition the prepotent response of reading the word. Finally, the inhibition-switching condition required the children to name the ink that the word was printed in, or if the word was in a box, they were to read the word. This required to children to switch between the previous rules. Results did not indicate any group differences between children with ASD and controls.

Ozonoff, Strayer, McMahon, and Filloux (1994) found somewhat different results. Children with ASD were presented with a Go-No Go task in which they were asked to press the space bar on a computer key-board when shown certain stimuli. The

task consisted of three conditions. In the first condition, considered neutral inhibition, the "go" stimulus did not change. In the second condition, or the prepotent inhibition condition, the "go" stimulus was the opposite of the previous condition so that children had to inhibit that prepotent response. The third condition was considered the flexibility condition (commonly referred to as inhibition switching). On this condition the "go" stimuli switched between the stimuli and the children had to switch accordingly. Results indicated that children with ASD performed as well as controls when inhibiting neutral responses, were moderately impaired when inhibiting prepotent responses (preventing a dominant response), and very deficient with shifting the response set (shifting cognitive strategies in the face of an environmental change).

Given the controversy in the literature regarding the presence of inhibitory deficits in children with ASD, additional research should be conducted to investigate if these results could be replicated and if children with ASD demonstrate consistent impairments in inhibition. Also, ASD severity was not taken into account. Thus, it is possible that inhibitory functioning is spared in a specific subset of high functioning children with ASD. The current study aimed to expand the literature in this area by investigating if inhibitory function was impaired in children with ASD. Furthermore, the project sought to add an ecological component to investigate what effect, if any, inhibitory skills had on the everyday social functioning for children with ASD.

Working Memory

Working memory is required for a number of executive tasks. On the aforementioned WCST and inhibitory control tasks, children are required to maintain multiple rules in their memory and perform tasks based on those rules. Given reported impairments in cognitive flexibility and inhibition, researchers have conjectured about the role of working memory in those skills. Thus, there has been much speculation that working memory is also impaired in children with ASD. Research, however, has been quite mixed. Ozonoff and Strayer (2001) assessed working memory using a number of visual and visuospatial tasks. They did not find any differences in working memory abilities between children with ASD and controls; however, children with ASD tended to have longer response times.

In contrast, Schuh and Eigsti (2012) found that children with ASD demonstrated impairment in both verbal and spatial working memory tasks relative to controls and the national normative scores. Bennetto and colleagues (1996) found similar results. They also utilized verbal and spatial measures of working memory. For the verbal working memory task children were presented with an incomplete sentence and asked to complete the sentence. These sentences were presented in a series of blocks and at the end of each block the participant was asked to recall each ending word in order. To measure spatial working memory, the participants were shown several pages of dots. They were asked to count out loud the number of dots and after an increasing number of pages asked to report, in order, how many dots were on each page. Results indicated that children with ASD were impaired on both measures of working memory.

Working memory skills are essential to effectively plan and execute goal-directed behaviors. A number of researchers have speculated the role of working memory in the impairment of other executive skills such as set shifting and inhibition. Research investing working memory impairment in children with ASD has been quite mixed; therefore, the current study sought to investigate if working memory deficits were present in the current sample of children with ASD. Furthermore, in an effort to understand the role of working memory in everyday social behavior, this study sought to investigate the relationship between working memory and social functioning in children with ASD.

The Relationship between Executive and Social Functions in ASD

The executive function theory posits that deficits in such higher order skills, such as working memory, planning, inhibition, set-shifting, and monitoring underlie the various deficits seen in the everyday functioning of people with ASD (Minshew et al., 2006); however, executive deficits have most commonly been linked to restricted interests and repetitive behaviors (Lopez et al., 2005) and few studies have investigated the relationship between executive functioning and social skills in children with ASD. Landa and Goldberg (2005) examined the relationship between executive, language, and social skills in children with ASD as compared to their peers matched on age, gender, and IQ. They utilized the Cambridge Neurological Test Automated Battery (CANTAB), a computerized battery, to measure working memory, spatial working memory, planning, cognitive flexibility, and inhibition. Social skills were measured by the Autism Diagnostic Interview (ADI) and Autism Diagnostic Observation Schedule (ADOS). No significant results were found between executive and social functions.

Ozonoff and colleagues (2004) utilized the same measures of executive and social functioning to analyze their relationship; however, they added a ratings-based measure of adaptive functioning. Again, no significant findings were present between executive and social skills; however, planning was related to adaptive communication skills. These studies, however, lacked an in vivo measure of social functioning. Social functions were measured with the ADOS which is a structured interaction designed to elucidate social dysfunction; however, it is conducted by an adult. Thus, the ADOS may not generalize well to how the child functions with his/her peers. Although Ozonoff and colleagues (2004) utilized a ratings-based measure of adaptive functioning in an effort to capture social and communicative functioning in the everyday setting, it was based on parent report and not a direct observation of peer interaction. In addition, executive functions were only measured by performance-based tests. The validity of performance-based tests has been questioned throughout the literature (Toplak et al., 2013). A ratings-based measure may provide an additional, and perhaps, a more valid measure of social functioning in everyday settings. The current study addressed these limitations by using both performance-based and a ratings-based measures of executive functioning in addition to an in vivo measure of social functioning.

Kenworthy, Black, Harrison, Della Rosa, and Wallace (2009) also sought to investigate the relationship between executive functions and ASD symptoms. They examined a wide range of executive skills, such as attention, fluency, flexibility, inhibition, planning, and working memory. They looked at both performance-based measures of executive functions and utilized parent- and teacher-report measures to get

an understanding of their skills in everyday settings. To measure ASD symptomatology they used a composite score that was achieved by combing the ADOS and the ADI. They hypothesized that a composite ASD symptom measure would be significantly related to parent- and teacher-report of executive functioning in everyday settings. The authors also thought that ASD symptoms would be related to performance-based measures of executive functions.

Participants included 89 children (74 male) with an ASD diagnosis. Each child received a comprehensive evaluation which included a detailed medical and developmental history, neuropsychological battery, ADOS, and ADI. The Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV) or Wechsler Abbreviated Scale of Intelligence (WASI) was used to assess their overall cognitive ability. Executive measures included the Behavior Rating Inventory of Executive Functions (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000), the Test of Everyday Attention for Children (TEA-Ch; Manly, Robertson, Anderson, & Nimmo-Smith, 1999), Tower of London-Drexel (Culbertson & Zillmer, 2000), and Semantic Fluency from the NEPSY (Developmental Neuropsychological Evaluations; Korkman, Kirk, & Kemp, 1998) or the Delis Kaplan Executive Functioning System (DKEFS; Delis, Kaplan, & Kramer, 2001).

Results indicated that category fluency and behavioral regulation were related to communication ability. Further, higher scores on divided attention and category fluency were related to fewer social symptoms. Divided attention required both dual attention and working memory skills to complete the attention task. The BRIEF MCI and BRI were also correlated with social symptoms; however, this was no longer significant when

accounting for shared variance. Finally, children with more behavioral regulation problems according to the BRIEF, exhibited more restricted and repetitive behaviors. Overall, performance-based measures were related to social symptoms whereas ratings-based measures were related to restricted and repetitive behaviors. This study provided some support for the ecological validity of performance-based measures because they demonstrated significant relationships with social symptoms; however, social symptoms were measured by the ADOS and ADI. This study lacked an in vivo measure of social functioning in an everyday setting with peers, making it difficult to generalize these findings to other settings. Kenworthy and colleagues (2009) failed to tap into a wide range of social behaviors, such as direct peer interaction and social involvement. The current study aimed to build upon this research by adding a direct observation of social functioning in an everyday setting with peers. Additionally, children with ASD and their peers were interviewed to measure the overall social connectedness of children with ASD in their classroom.

In addition to the link between executive functions and ASD symptomatology, executive functions have also been associated with poor adaptive behaviors in children with ASD. Adaptive behavior is thought of as everyday behaviors required for personal and social sufficiency. Children with ASD have consistently shown a differential impairment in adaptive functioning, commonly in the area of socialization. Cognitive researchers claim that impaired executive functioning serves as the etiology of adaptive deficits. Critics argue this research lacks ecological validity as a result of the overreliance on laboratory measures and results that do not generalize to autistic

symptomatology. Several researchers have addressed this claim using measurements that assess functioning in everyday settings.

Gilotty, Kenworthy, Sirian, Black, and Wagner (2002) used parent-report on the Vineland Adaptive Behavior Scale (VABS) (interview format) and parent ratings on the Behavior Rating Inventory of Executive Function (BRIEF) to assess the correlation between adaptive and executive functioning in everyday settings. They hypothesized that there would be a negative correlation as higher scores on the BRIEF represent more severe executive deficiencies. Participants included 35 children and adolescents diagnosed with high functioning ASD or Asperger's disorder (AD) ages 6 to 17 years (30 males). Results indicated that the VABS Communication, Social, and Overall composite scores were negatively correlated with the Initiate and Working Memory scales on the BRIEF. The Communication and Social domains on the VABS also negatively correlated with the Metacognitive composite index (MCI) on the BRIEF. Hierarchical regression analysis revealed that the MCI was a significant predictor of the Communication and Social domains on the VABS. Findings suggested metacognitive impairments, specifically in initiation and working memory, played a role in the social deficits paramount in ASD. One limitation of the study, however, was their reliance on parent-report; future research should include self or teacher reports to generalize these findings beyond the parent's perspective. The current study sought to build upon this literature by investigating the role of executive functions in the social functioning of children with ASD by using a direct observation to measure the social abilities of children with ASD as opposed to relying solely on parent report.

Issues Regarding the Measurement of Executive Functions

There are two main ways of assessing executive functioning in a clinical setting: performance-based or ratings-based measures. Performance-based measures involve standardized procedures with batteries that have generally been normed based on a representative sample of the population. They are administered by a clinician and generally measure accuracy or response time (Toplak et al., 2013). In contrast, ratings-based measures are usually completed by the individuals themselves (self-report) or an informant who knows that person well, often a parent, guardian, or teacher. The informant rates how the individual performs certain tasks in the everyday setting. There is a paucity of literature; however, which investigates the relationship between performance- and ratings-based measures of executive functions and if, in fact, they are measuring the same constructs that they were designed to capture.

Historically, tasks were created in the laboratory with the assumption that certain executive functions were required to perform the task accurately. Thus, poor performance on a specific task would represent deficits in the executive construct that test was designed to measure. For example, it is theoretically necessary to have efficient set-shifting abilities to perform well on the Wisconsin Card Sorting Test (WCST) and as a result, impaired performance indicates impaired shifting ability. This leads to the assumption that impaired set shifting on a laboratory or performance-based measure would be indicative of impairment in the everyday setting. Specifically, if an individual performed poorly on the WCST then he/she would also be expected to demonstrate impairments when attempting to complete everyday tasks that also rely on efficient

shifting (Burgess et al., 1998). Questions have been raised, however, regarding the ecological validity of these tasks (Burgess, et al., 1998, 2006; Toplak et al.). In response to these concerns, rating scales of executive function were developed as an ecologically valid measure of an individual's executive functions in the everyday setting. An important assumption in the development of these ratings-based measures was that they were measuring behaviors that were "importantly related with processes" that were assessed with performance-based measures (Toplak et al., 2013, p. 133). Although the measures were created under this assumption, there is a dearth of research investigating the relationship between the constructs measured by performance- versus ratings-based measures. As a result, an additional concern regarding the measurement of executive functions is the degree to which performance- and rating-based measures examine the same construct (Toplak et al., 2013).

Toplak and colleagues (2013) examined 20 studies investigating the relationship between performance- and ratings-based measures of executive function. Of the 20 studies, 13 were conducted with children. Seven of the studies reported results based on clinical samples, 20 studies utilized a combined clinical and nonclinical sample, and two studies utilized nonclinical adult samples. Sixteen studies reported correlational findings and four studies did not report actual *r* or *p* values because they did not find any significant results. Overall, when combining the data across studies, Toplak and colleagues (2013) found that only 68 of the 286 correlational analyses (24 %) were statistically significant and the magnitude was quite low with a median value of $r = .19$. The current study sought to build upon this literature, by examining the relationship

between performance-based measures of executive function and ratings-based measures in children with ASD. Given the current inconsistencies in the literature regarding the existence of and nature of impairment in executive functions in children with ASD, it is essential to obtain a better understanding of how executive functions are being measured in this population and how their measurement relates to reported impairment.

The literature on the presence of executive functioning deficits in ASD has been quite mixed. The first goal of this study was to investigate if children with ASD demonstrate consistent impairments in the areas of inhibition, set shifting and cognitive flexibility, as well as working memory. The second goal of this study was to examine the ecological validity of performance-based measures of executive functioning by investigating the relationship between performance-based and ratings-based measures of executive functions. Finally, this study examined the relationship between the executive functioning profile in children with ASD and their social functioning in school. While the executive function theory has most commonly been used to explain the presence of restricted and stereotyped behaviors in children with ASD, there have been inconsistent findings with regard to the relationship between executive functions and social skills. In addition, social skills have commonly been measured by parent-report or the ADOS. This project aimed to build upon this previous literature by first examining social functioning in children with ASD using a direct observation tool in addition to a measure of overall social connectedness in the classroom. The project also aimed to expand upon the executive function theory by extending it to social functioning in children with ASD.

Social Functioning in ASD

Impaired social functioning is a hallmark feature of ASD (Troyb et al., 2011). Children with ASD experience difficulty with creating social relationships, initiating social interactions, emotional reciprocity, sharing enjoyment, perspective taking, and inferring interests of others (Bellini et al., 2007; Troyb et al., 2011). Additionally, a primary adaptive deficit found in children with ASD is in the area of adaptive social functioning (Gilotty et al., 2002).

In spite of these difficulties, children with ASD are increasingly being placed in the general education setting as opposed to self-contained classrooms (Fuchs & Fuchs, 1994; Kasari et al., 1999). As a result of their social difficulties, parents strive to include their children in regular education for both the social and academic benefits. The benefits of social relationships among typically developing children are widespread, including increased academic achievement, reduced school drop-out, reduced risk of adjustment problems in the future (Bullock, 1992; Nowicki, Duke, Sisney, Stricker, & Tyler, 2004), and improved play and language skills (Rogers, 2000; Wolfberg & Schuler, 1993). However, the results of inclusion alone in improving social functioning in children with ASD have been inconclusive.

Rotheram-Fuller and colleagues (2010) sought to investigate the social involvement of children with ASD who were included in the general education classroom as compared to their age-matched first to fifth grade peers. Results indicated that children with ASD were more socially included in lower grades than in higher grades; however,

this was the same for their age-matched peers. According to a student survey, children with ASD nominated other children as friends and also received nominations from other children as friends. However, their nominations often did not match their typical peers, resulting in fewer reciprocal friendships. Only about 48.1% of children with ASD were "socially involved" in their classroom as compared to 91.1% of their typically developing peers. Children with ASD were also significantly lower in all measures of social involvement excluding rejection from peers. The authors concluded that, overall, children with ASD demonstrate friendships most like their typical peers in the early years, but this begins to wane in the upper grades.

Another study found that children with ASD had misconceptions about friendships as they consistently nominated children who did not report a reciprocal friendship. However, children with ASD who had at least one reciprocal friendship were more socially involved in their classroom's social network and more accepted by peers (Kasari et al., 2012). The authors reported that the most alarming finding was the vast difference in social network centrality between the children with ASD and their typically developing peers. This means that children with ASD were mostly peripheral or isolated from their classroom social networks as opposed to their typical peers who were mostly secondary (involved in the network but not the most nominated students in the class) or nuclear (most frequently nominated by classmates as having friends). This study indicated that although a portion of students with ASD were socially included, inclusion alone was not sufficient to increase the social involvement of all children with ASD in the classroom (Kasari et al., 2012).

While numerous studies have noted that children with ASD have few or impaired social relationships, few have enumerated the ramifications of this lack of social involvement. Bauminger and Kasari (2000) sought to investigate the relationship between friendships and loneliness in high functioning children with ASD. The authors noted the fundamental difference between solitude and loneliness is that solitude involves an individual choosing to be or play alone and this is usually a positive situation, whereas loneliness indicates sadness and/or exclusion. The authors utilized several questionnaires to determine if children with ASD experienced feelings of loneliness. Results indicated that children with ASD did feel lonely. The authors posited that this means high functioning children with ASD possess the desire for social involvement. When asked to define loneliness, children with ASD had much different understandings of the term as compared to their peers. Typical children defined loneliness in terms of the cognitive and emotional experience of loneliness, whereas children with ASD only defined the cognitive experience of loneliness. Even children with ASD who reported having at least one friend also reported that this friendship did not affect feelings of loneliness. This study provided significant findings for the field in that it captured the ramifications of impaired social relationships in high functioning children with ASD. Although children with ASD may have difficulty navigating and maintaining social relationships, they still experience the cognitive effects of loneliness. This bolsters the need to increase our understanding of the social impairments in children with ASD in order to provide appropriate social intervention.

Similar to the aforementioned study by Rotheram-Fuller and colleagues (2010), Kasari and colleagues (2011) also examined the peer relationships of included children with ASD and their age-matched peers. They found that children with ASD had impaired peer relationships as compared to their typical classmates. Children with ASD had smaller social networks, fewer reciprocated friendships, and their friendships were poorer in quality than their age-matched peers. While most of the children with ASD in their sample were on the social periphery, some were also considered isolated (13%). Also, social reciprocity with typical peers was extremely low. If a student with ASD nominated another classmate as a friend, this nomination was not often reciprocal. Only 18% of their friendships were reciprocal, as compared to 64% of their typical peers. The authors concluded that friendships for children with ASD may be better described as unilateral as opposed to reciprocal. This study failed to find differences in social functioning with age as opposed to the previous study by Rotheram-Fuller and colleagues (2010).

Kasari and colleagues (2011) also expanded previous research by adding a playground observation in addition to the student and teacher questionnaires. They found little association between the playground observations and the student surveys. Children with ASD were likely to be unengaged on the playground, despite their self-report of social involvement with peers. Even children who had the most reciprocal friendships remained on the periphery on the playground and were no more engaged than those students who did not receive any reciprocal nominations (Kasari et al., 2011). The authors posited that even if children with ASD have a reciprocal friend, the culture of the

playground may be too complex for them to grasp. This indicates that survey measures alone may not fully capture the global social functioning of students with ASD. The current study used both survey and direct observation measures to capture the global social functioning of the student with ASD. Additionally, in an effort to understand the underlying skills involved in social functioning, this project examined if there are different neuropsychological processes associated with the friendship survey measure as compared to a direct playground observation.

As a result of the core social dysfunction in children with ASD, numerous interventions have been proposed to remediate social difficulties. A plethora of studies have investigated social skills interventions through various delivery models; however, few studies have investigated the underlying neuropsychological components that may impact the response to such interventions. There is a lack of research examining the cognitive substrates that may affect a child's ability to respond to particular social interventions. The current project investigated the underlying neuropsychological components associated with social functioning. A better understanding of the underlying neuropsychological components associated with social functioning will aid in the creation of social interventions that are tailored to the specific needs of the child.

Executive and Social Deficits

Various theories have attempted to explain the etiology of ASD; however, not one theory has encompassed both of the main deficits present in ASD. The executive function theory has accounted for the deficits in repetitive behaviors and stereotyped

interests (Lopez et al., 2005); however, there is limited empirical support regarding the association between executive functions and social deficits present in ASD. Given that deficits in social functioning are the hallmark of an ASD, any theory attempting to explain the etiology of ASD must account for these impairments. The literature in this area is mixed and has some methodological shortcomings. First, although many studies utilize performance-based and ratings-based measures of executive functioning, none include an in vivo measure of social functioning with children with ASD and their peers. Social measures often include parent and teacher questionnaires and/or a direct observation of social behaviors, as measured by the ADOS, which is administered in a laboratory setting. Few studies quantified the social interactions between children with ASD and their peers. This study aimed to ameliorate these shortcomings by using a direct playground observation of social functioning as well as a measure of overall social connectedness in the classroom. The aims of this study were to investigate executive functions in children with ASD, examine the relationship between performance- and ratings-based measures of executive functions within this population, and evaluate the relationship between executive and social functioning. In addition, the study sought to contribute to the etiological literature by investigating the efficacy of the executive function theory of ASD. A correlation between executive and social functioning would support the validity of the executive function theory as an explanation of the etiology of ASD.

CHAPTER 3

METHODS

Objective

The purpose of this study was to understand the relationship between executive functioning and social skills among children with ASD. This study extends the research in the etiology of ASD so that more appropriate interventions may be created to improve social functioning in children with ASD.

Participants

Target Population and Accrual

All data were collected and managed by investigators from the University of Pennsylvania as part of a larger study of social skills interventions for children with ASD. The larger social skills study is investigating the efficacy of a social skills program that involves training the one-on-one aide of children with ASD to implement a social skills intervention in an in vivo environment. All data used for this dissertation were from the initial assessments of children prior to any intervention as part of the larger study.

A total of 29 children who were fully included in first through fifth grade general education classrooms (ages 5-12), were recruited and tested as part of this larger project, and consented to participate in the study. They completed all study measures; however six participants were excluded from the analyses due to a General Conceptual Ability (GCA) score below the cutoff of 65. A total of 19 males and 4 females participated. In terms of ethnic identification, 16 (69.6 %) students identified as Caucasian, 5 (21.7 %)

African American, one (4.3 %) Hispanic and one (4.3 %) mixed race. The mean age was 8.6 years with a standard deviation of 1.8. The youngest participant was five years of age and the oldest participant was 12 years old.

This study received Institutional Review Board (IRB) approval from Temple University and data were redacted and provided by the researchers at the University of Pennsylvania. The student sample was recruited from several large school districts in the Mid-Atlantic Area. All study activities were approved by the University of Pennsylvania IRB, as well as the respective school districts in which it was conducted.

Inclusion Criteria

Inclusion criteria for all participants: Children were included in this study if they:

- Had a diagnosis of ASD (documented within their school records).
- Met criteria for ASD on the ADOS.
- Were fully included in a general education classroom for 80% or more of the school day
- Were participating in the larger social skills intervention study.
- Were between the ages of 5 and 12 years old.
- Were in grades 1 through 5 with a one-to-one or classroom aide.
- Had an IQ $\geq$ 65 as measured by the Differential Abilities Scale – 2nd Edition. This was to ensure they had the verbal and nonverbal

abilities to fully comprehend the study measures (Kasari, et al., 2011). In addition, children with an IQ below this cut off generally have impairments in executive functions regardless of ASD.

Exclusion Criteria

Exclusion criteria for all participants: Children were not included in this study if they:

- Were not expected to stay in the school or the classroom for the duration of the study.
- Had a mental age-equivalent that is less than 4 years (Children less than 4 years do not typically respond well to the proposed intervention procedures).
- Had an IQ<65 as these students could have had impaired executive functions unrelated to ASD.
- Had additional diagnoses or sensory or motor impairments.
- Were not participating in the larger social skills intervention study.

Participant Recruitment and Screening

All schools interested in participating were asked to sign a letter of agreement which allowed research at their school. Then, each school was asked to distribute a "Recruitment Flyer" to parents of children with ASD who were included in regular education classrooms (grades 1 through 5). Parents were instructed to contact the study

investigator by phone if they were interested in hearing more about the project. The study investigator provided information about the study using the provided "Phone Script," and a meeting was scheduled to discuss their possible participation. If parents choose to participate, they were asked to sign the "Parent/Guardian Consent Form."

Once parents consented to join the study, parents of peers were provided with information on the "Friendships at School" study. To protect the confidentiality of the target students with ASD in the classroom they were not informed of the true purpose of the study. After the students were presented with the "Social Relationships of Elementary-Aged Children Recruitment Script – Children," peer parent consents were sent home with the classroom students. Children were asked to return signed consent forms to their teacher. In order to provide an accurate assessment of the classroom social environment, a minimum of 50% of the classroom was needed (Cairns & Cairns, 1994). As a result, assessments were only conducted within the classroom once a minimum of 50% of consents are returned. All consented children in this study (children with ASD and their classmates) were also asked to provide assent at the beginning of the study. The research team reviewed the study in detail with child appropriate language prior to administering any study measures so assure that children understood the study and their rights as a research participant. In addition, an assent comprehension test was also administered. Once children joined the study (both with initial parent consent on the "Parent/Guardian Classroom Consent Form - Friendships at School" and child assent on the "Children's Classroom Assent"), the Friendship Survey was administered to children

with ASD and their classmates. Playground observations were only collected for the target student with ASD.

Early Withdrawal of Subjects

As stated in the consent form, all participants could withdraw at any time in the study by stating they wished to formally withdraw. Children with ASD could also choose not to participate in the assessment activities during the assent process or at any time during the study or during the assessment. No participants elected to withdraw from the study.

Procedure

After receiving school, parent, and student consent and assent, the assessment process was conducted over two sessions. The initial assessment of only the child with ASD involved administration of the Autism Diagnostic Observation Schedule (ADOS), The Differential Abilities Scale, Second Edition (DAS-II), and select subtests from the Development Neuropsychological Assessment, Second Edition (NEPSY-II). These tests were administered individually in a quiet area of the child's school by graduate and doctoral level researchers.

This assessment lasted approximately 1.5- 2 hours. At that time, the teacher was also asked to complete the Behavior Rating Inventory of Executive Functions (BRIEF), a questionnaire used to rate the student's executive functions in everyday settings.

At the second visit, the Friendship Survey was administered to the larger classroom (to any students who had provided both parental consent as well as student assent). Finally, a playground observation (POPE) was conducted on the child with ASD during an unstructured lunch or recess time at school.

Child Measures

ASD symptoms were measured using the Autism Diagnostic Observation Schedule (ADOS) (Lord et al., 1999). The ADOS is widely considered the "gold standard" to confirm an ASD diagnosis (Reaven, Hepburn, & Ross, 2008). It is a semi-structured, standardized observational measure of social interaction, communication, play, and imaginative use of materials that takes 45-60 minutes to complete. The child's expressive language ability and chronological age determined which of four possible modules were used. The measure can be validly used with children who have a minimum cognitive developmental level of 15-months or higher. Children are categorized based on the ADOS as meeting criteria for autistic disorder or a different ASD. These cut-off scores differ based on the module administered.

Each module combines a series of structured and unstructured social-communicative sequences which involve a hierarchy of presses for particular social behaviors (Lord et al., 2000). Module 1 is intended for children who do not demonstrate the consistent use of speech. Module 2 is for children with some phrase speech but who are not verbally fluent. Module 3 is intended to be used with verbally fluent children with whom playing toys is age appropriate. Verbal fluency is considered the ability to

use flexible sentences with multiple clauses that describe logical connections spontaneously (Lord et al., 2000). Module 4 is for verbally fluent adults or adolescents with whom playing is not age appropriate; thus, this module was not utilized for the current study. Each module includes a standardized diagnostic algorithm which is composed of a set of the social and communicative behavior ratings and is consistent with the standards of the DSM-V (APA, 2013) and ICD – 10 (WHO, 1993) criteria for autism. The ADOS has high interrater reliability (88.2% - 91.5%) (Lord et al., 2000). Test/retest reliability and validity were also high (Lord et al., 2000).

Children's cognitive abilities were measured using the Differential Abilities Scales – 2nd Edition (DAS-II; Elliott, 2007). The DAS-II is an intellectual assessment that measures reasoning and conceptual thinking. The core battery yields composite scores in three categories: Verbal, Nonverbal, and Spatial. In addition a Special Nonverbal Composite (SNC) can be obtained which provides a global functioning score with the elimination of the verbal subtests; this can be particularly beneficial for students with ASD who have language difficulties. In addition to the core battery the DAS-II contains nine diagnostic subtests. For the purpose of this project two diagnostic subtests (Recall of Digits Backwards and Recall of Sequential Order) were administered in order to gain a Working Memory composite score. The Working Memory Composite score is highly reliable with an internal consistency of .95, test/retest reliability of .83, and a standard error of measure of 3.53 (Dumont, Willis, & Elliott, 2008). The global composite score yielded a General Conceptual Ability (GCA) score (M = 100, SD = 15). Both the GCA and SNC are highly reliable with and internal reliability of .96 (Elliott, 2005) and a test-

retest coefficient of .90 for the GCA. The subtests are grouped into cognitive batteries specified for age bands identified as Early Years (2 years 6 months to 6 years 11 months) and School-Age (7 years to 17 years 11 months), with subtests that are common to both batteries; however, for the purpose of consistency only the School Age battery was administered.

Executive functions were measured using the Developmental Neuropsychological Assessment, Second Edition (NEPSY-II; Korkman et al., 2007). The NEPSY-II is a co-normed and multidimensional assessment of neurocognitive abilities in children and adolescents from ages 5 – 16 years old. The NEPSY-II provides a flexible battery of subtests and it is designed to allow the administration of specific subtests. Internal reliability for the NEPSY ranges from adequate to very high (r =.67 to r = .93). Test-retest reliability is also considered adequate to high. The two subtests used for this study were Animal Sorting which is a measure of set-shifting and flexibility and inhibition which assesses the participants' ability to inhibit prepotent responses and switch depending on a set of rules. Animal Sorting is designed to measure the child's ability to form concepts, by sorting animals into categories, and shift between sets by shifting from one concept to another. The child sorted cards into two groups of four cards each by using anything that is on the card. The Inhibition subtest is designed to assess the ability to inhibit automatic responses, utilize novel responses, and switch between response types. The child was shown a series of black and white shapes or arrows and named either the shape or direction or an alternate response depending on the color of the shape or arrow. The Inhibition task had three parts, a naming trial in which the child was asked

to rapidly name the shapes or direction of arrows, an inhibition trial in which the child was asked to name the opposite shapes or arrow direction, and a switching trial in which the child was asked to switch between conditions based on the color of the shape or arrow. For the purpose of this study, only the inhibition and switching trials were included in the analysis because the goal was to analyze their inhibition and shifting abilities, as opposed to rapid naming, which was measured by the naming trial.

Test-retest reliability for animal sorting ranged from .63 - .71 for ages 8 to 12 years (Brooks, Sherman, & Strauss, 2010). Test-retest reliability for the Inhibition-Naming Total Completion Time for ages 8 to 12 years ranged from .74 - . 82, Inhibition-Inhibition Total Completion Time ranged from .66 -.81, and Inhibition-Switching Total Completion Time ranged from .75-.82 (Brooks et al., 2010). Inhibition Total Errors test-retest reliability was marginal to high ranging from .57-.77 (Brooks et al., 2010).

In order to measure children's social involvement, children were administered the Friendship Survey (Cairns & Cairns, 1994). This survey asked children to list who they liked to hang out with and who they did not like to hang out with in their classroom. These children were labeled as friends or rejects, respectively. This list was used to determine the child's overall number of friendships. After this list was generated, children were instructed to star their best friend and circle their top three friends. Finally, children were asked to list the names of children in their classroom who liked to hang out together in groups. If children had difficulties with reading or writing, this survey was administered using an interview format.

Coding Social Network Centrality (Cairns & Cairns, 1994).

Social network centrality (SNC) refers to the student's overall social involvement or prominence of the child in the classroom. SNC is a valid measure and has been previously used to measure social involvement in children with ASD (Chamberlain et al., 2007; Kasari et al., 2011; Rotheram-Fuller et al., 2010). In order to determine social involvement, three scores were calculated: the student's "individual centrality"; the group's "cluster centrality"; and the student's "social network centrality." Maintaining accordance with the methods developed by Cairns and Cairns (1994), the first two scores were utilized to determine the third score (Farmer & Farmer, 1996). Utilizing the categorizations set forth by Farmer and Farmer (1996), there were four levels of social involvement in the classroom which range from isolated to nuclear. Codes ranged from 0 to 3 respectively. This categorization provided a more detailed description of how well children were integrated into peer networks.

Other derived scores from this measure that were utilized for the study were outdegrees, indegrees, and rejections. Outdegrees represented the number of peers that the student with ASD nominated as friends, Indegrees represented the number of friendship nominations the child with ASD received from his/her peers, and Rejections were the number of times that peers indicated that they did not like that student.

Playground Observations

The Playground Observation of Peer Engagement (POPE; Kasari et al., 2005; Kasari et al., 2011) was used to measure children's playground engagement. The

measure was developed to measure peer engagement in children with ASD (Frankel, Gorospe, Chang, & Sugar, 2010; Kasari et al., 2011). The POPE utilizes a fixed interval system to code behaviors relevant to children's engagement with peers on the playground. The fixed interval is comprised of 40 seconds of observation and 20 sections to allow for coding. All observations were conducted by independent coders and lasted for at least ten minute sessions during recess or lunch play period. Observers were trained by the Principal Investigator (PI) and considered reliable with a criterion $\alpha > 0.80$. Additionally, reliability ($\alpha > .80$) was collected over the course of the intervention to assess and prevent coder drift. There were five levels of engagement: solitary, proximal, parallel play, parallel aware, onlooker, joint engagement, and engaged in a game with rules. The scores on the POPE indicated what proportion of time was spent in each level of engagement. Table 3.1 from Kasari and colleagues (2011) describes each level of playground engagement.

Table 3.1: Engagement States from the Playground Observation of Peer Engagement

Level of Engagement	Description
Solitary/Isolated	Child plays alone, with no peers within 3 feet, and no mutual eye gaze with other children
Proximity	Child plays alone within 3-foot range of per
Onlooker	Child has one-way awareness of child who is farther than 3 feet. It appears the child is watching another child or group of children or a game with interest or the intent to participate
Parallel	Child and peer are engaged in a similar activity but there is no social behavior
Parallel Aware	Child and peer engaged in similar activity and mutually aware of each other during activity
Joint Engagement	Child and peer direct social behavior, e.g., offering objects, conversing, toy-taking, and other activities with a turn-taking structure

Table 3.1: Continued

Level of Engagement	Description
Games with Rules	Child participates in organized sports such as 4-square, basketball, or handball and/or engages in fantasy or pretend play OR a fantasy game that the child or his/her peers have created provided all children are playing by a set of rules that the children have specified. A game has to be with another child

*Kasari, C., Locke, J., Gulsrud, A., & Rotheram-Fuller, E. (2011). Social networks and friendships at school: Comparing children with and without ASD. *Journal of Autism and Developmental Disorders,* 41(5), 533-544.

Teacher Measures

The Behavior Rating of Inventory of Executive Function (BRIEF; Gioia et al., 2000) teacher report questionnaire was used to measure the student's executive functions in everyday settings. The BRIEF is an 86 item scale involving statements about the child's life in which the teacher must rate "never" "sometimes" or "often." It yields eight clinical scales including the Inhibit, Shift, and Emotional Control subdomains which together result in the Behavioral Regulation Index score (BRI); the Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor combine to form the Metacognition Index Score (MCI). The MCI and BRI are combined to obtain an overall Global Executive Composite score (GEC).

A description of each scale is listed in the manual. The Inhibit scale assessed the student's inhibitory control and impulsivity, or the ability to inhibit or resist impulses. Shift indicated the child's ability to be flexible and move from one situation or activity to the next. This includes the ability to transition, tolerate change, solve problems flexibly,

shift attention and mindset, and change focus from one topic to another. Emotional Control assessed the child's ability to control and modulate emotional responses. The Initiate scale measured the ability to begin a task or activity as well as generate ideas and problem solving strategies independently. Working Memory measured the ability to hold information in mind and manipulate that information as needed to complete a task, generate goals, plans, and sequence steps necessary to achieve a goal. In terms of the Plan/Organize scale, the Plan component measured the ability to anticipate future events, determine goals, and the appropriate sequence of steps in advance to carry out a task and achieve a goal. The Organization aspect assessed the ability to put information into a meaningful order and understand and key concepts. Organization of materials assessed the child's ability to maintain an orderly work, play, and storage space. Finally, the Monitor Scale measured both task-oriented and self-monitoring abilities. The task monitoring consisted of the child's ability to check their work and asses his/her performance during or shortly after a task to ensure the achievement of a goal. The self-monitoring component assessed the child's interpersonal awareness or his/her ability to keep track of the effect that his/her behavior has on others.

Teachers were asked to complete this questionnaire based on the targeted student. The BRIEF took no longer than 15 minutes to complete. The internal consistency of this measure is generally high with Cronbach's Alpha ranging from .80 - .98. Test-retest reliability for the teacher form was .92 .90 and .91 for the BRI, MCI, and GEC respectively and the measure has high criterion validity (Gioia et al., 2000).

CHAPTER 4

RESULTS

Descriptive statistics and frequencies were computed to identify outliers, the distribution of variables, and any missing or incorrectly entered data. According to the Shapiro-Wilk Test of Normality, most of the measures of executive functioning were normally distributed with the exception of the Emotional Control scale from the BRIEF. The social measures (with the exception of outdegrees), however, were not normally distributed according to this same test. Given the small recruitment size in addition to the six children who had to be removed from the study due to their low IQ, the power for many statistical analyses was limited. Therefore, both parametric and nonparametric analyses were computed, depending on which was most appropriate for each question. The tests used are noted within each analysis.

Research Question 1

The first research question was to determine if children with ASD demonstrated impairments on measures of executive functioning. First descriptive analyses were performed to explore the mean and range of GCAs. The GCAs ranged from 71 to 111 with the mean in the lower end of Average as compared to the national normative sample ($M = 90.48$, $SD = 11.40$). Next, descriptive analyses were performed to examine the mean and standard deviation of scores on executive measures. Results are displayed in Table 4.1. Each standardized test utilized was normed with a representative sample, and the functioning levels indicate the mean level of the current sample as compared to the

test's norming sample. On the NEPSY-II subtests, the mean performance of participating students with ASD was Below Average for their age, indicating mild impairments in shifting, inhibition, and the switching component. The current sample, however, did not demonstrate impairments in the area of working memory as measured by the DAS-II with performance in the lower end of Average on the Working Memory Index.

Executive functions in the everyday setting were measured using the BRIEF teacher-rating form. Higher scores on the BRIEF indicated more impaired functioning and scores over 65 were considered elevated. The current sample demonstrated elevated scores on Shifting, Initiation, Working Memory, and Monitor scales. Their scores on the reminder of scales including Inhibit, Emotional Control, Planning and Organization, and Organization of Materials were within normal limits indicating age appropriate functioning in these areas.

Table 4.1: Mean Scores and Functioning Level for Executive Functioning Measures

NEPSY-II	Mean (SD)	Level
Animal Sorting	6.35 (2.3)	Below Average
Inhibition	6.74 (3.5)	Below Average
Inhibition-Switching	7.21 (3.1)	Below Average
DAS-II		
Working Memory	90.273 (16.1)	Average
BRIEF		
Inhibit	60.57 (13.7)	Within Normal Limits
Shift	66.24 (14.0)	Elevated
Emotional Control	64.43 (16.6)	Within Normal Limits
Initiation	65.14 (11.0)	Elevated
Working Memory	66.95 (11.5)	Elevated
Planning and Organization	63.10 (10.4)	Within Normal Limits
Organization of Materials	61.81 (13.0)	Within Normal Limits
Monitor	64.57 (12.8)	(Mildly) Elevated

Research Question 2

In order to assess executive functioning, clinicians generally utilize direct measures administered in a testing environment and behavioral questionnaires which assess the child's everyday functioning based on a rater who is familiar with the child, such as a parent or teacher. Although direct measures are validated and standardized, questions have been raised with regard to their ecological validity or their ability to translate to real world functioning. As a result, the current study sought to investigate the relationship between direct measures from an executive battery with the ratings from the questionnaire to examine if these direct measures were, in fact, translatable to everyday functioning. A bivariate correlation was performed with the subtests from the NEPSY-II and DAS-II with their corresponding clinical scales from the BRIEF. Results are shown in Table 4.2. Higher scores in the BRIEF indicated more impaired executive functioning; however, higher scores on the executive functioning subtests indicated more advanced skills. Thus, a negative relationship would be expected between the BRIEF and executive subtests. If the child performed well on the executive subtest then a lower score on the BRIEF would be expected. Two of the three BRIEF scales were negatively correlated with NEPSY-II subtests. The Animal Sorting subtest was negatively correlated with the Shift clinical scale from the BRIEF and the Working Memory Index was also negatively correlated with the Working Memory scale from the BRIEF. This indicates that for this particular sample the executive subtests for these skills were related to their real world functioning. The Inhibition subtests from the NEPSY-II, however,

were not significantly correlated with the BRIEF Inhibit scale, indicating that this subtest does not generalize well to the real world for this particular sample.

Table 4.2: Correlations between Executive Subtests and Behavioral Questionnaires

Executive Functioning Subtest	BRIEF Scale		
NEPSY-II	Shift	Inhibit	Working Memory
Animal Sorting	-.495*		
Inhibition		.151	
Inhibition Switching		.275	
DAS-II			
Working Memory			-.456*

Research Question 3

The next research question sought to understand the relationship between executive functions and social skills in children with ASD. To explore these relationships, the standard scores from the NEPSY-II subtests, the Working Memory Index score from the DAS-II, and the standard scores from the BRIEF clinical scales were correlated with outdegrees, indegrees, rejection, and the proportion of time spent in solitary play, games, and jointly engaged play. Initially, a Pearson correlation was utilized, and as a result, the social network centrality score was excluded from the initial analyses due to its ordinal nature. SNC was included in the nonparametric tests to follow. Results are displayed in Table 4.3.

Results indicated that the majority of direct measures of executive functioning were not related to social skills, with the exception of Inhibition. Better performance on the Inhibition subtest from the NEPSY-II was associated with an increased amount of friendship nominations (outdegrees) made by the child with ASD. A greater number of

BRIEF clinical scales, however, were associated with social functioning. Children with more impaired initiation skills (according to the BRIEF) spent more time engaged in solitary play. Higher, more impaired, scores on the Working Memory scale were related to more rejections from peers; whereas, better Working Memory skills were related to more time spent jointly engaged on the playground. Organization also appeared to affect social functioning. Children with more impaired Planning and Organizational skills as well as Organization of Materials also received more rejections from their peers. Interestingly, time spent engaged in games on the playground was not related to any of the executive measures. Although the Working Memory scores on the DAS-II and BRIEF were correlated, only the BRIEF scale was related to social functioning.

Table 4.3: Pearson Correlation between Executive Subtests and Social Measures

NEPSY-II	SNC	Indegrees	Outdegrees	Rejection	Solitary	Games	Joint Engagement
Animal Sorting	--	.012	-.117	-.105	-.027	.206	.175
Inhibition	--	-.121	**.448***	-.053	.214	-.073	-.062
Inhibition Switching	--	-.188	-.005	.032	.385	-.008	.041
DAS-II							
Working Memory	--	.280	.155	-.307	.122	.211	.143
BRIEF							
Inhibit	--	.075	.200	.033	.284	-.154	.098
Shift	--	-.025	.267	-.001	.062	-.149	.190
Emotional Control	--	-.025	.235	-.122	.252	-.091	.113
Initiation	--	-.137	-.119	.373	**.515***	-.319	-.386
Working Memory	--	-.223	-.100	**.539***	.345	-.365	**-.440***
Planning and Organization	--	-.011	-.211	**.475***	.117	-.366	-.330
Organization of Materials	--	-.114	-.125	**.615****	.144	-.208	-.339
Monitor	--	-.011	.059	.271	.371	-.331	-.107

*p ≥ .05 ** p ≥ .01

In order to understand the relationship between SNC and executive measures the frequencies of SNC scores were analyzed to ensure an adequate distribution. Results indicated an adequate distribution of scores. Three students had an SNC of zero, eight students had an SNC of one, eleven students had an SNC of two, and one student had an SNC of three. A Spearman correlation was then computed to examine the relationship between executive functions and SNC. Participants' SNC was not included in the Pearson analysis because it consists of ordinal data. No relationships were found between performance-based measures (NEPSY-II and DAS-II subtests) or the BRIEF questionnaire and social network centrality. Results are displayed in Table 4.4.

Table 4.4: Spearman Correlation between Executive Functioning Subtests and SNC

NEPSY-II	SNC
Animal Sorting	.181
Inhibition	-.103
Inhibition Switching	.009
DAS-II	
Working Memory	.153
BRIEF	
Inhibit	-.147
Shift	-.176
Emotional Control	-.154
Initiation	-.239
Working Memory	-.346
Planning and Organization	-.108
Organization of Materials	-.275
Monitor	-.192

*p ≥ .05 ** p ≥ .01

Bivariate correlations revealed some relationships between executive skills and social functioning; however, this analysis was unable to account for the effect of other variables on this relationship. Namely, overall IQ has been associated with executive skills in that children with lower overall IQs generally demonstrate more impaired executive skills. This remained consistent in the current sample, as each direct measure of executive functioning (subtests from the NEPSY-II and DAS-II) were significantly positively correlated to GCA (See Table 4.5). Far fewer BRIEF scales were related to GCA. Only the Initiation and Planning and Organization clinical scales were significantly related to GCA.

Table 4.5: Correlation between Executive Measures and GCA

Executive Functioning Subtest	GCA
NEPSY-II	
Animal Sorting	.755**
Inhibition	.494*
Inhibition Switching	.758**
DAS-II	
Working Memory	.751**
BRIEF	
Inhibit	-.063
Shift	-.369
Emotional Control	-.214
Initiation	-.535*
Working Memory	-.426
Planning and Organization	-.558**
Organization of Materials	-.240
Monitor	-.420

*p ≥ .05 ** p ≥ .01

The process of examining the effect of IQ on the relationship between executive and social skills took several steps. First, in order to assess for any differences by group, the sample was divided into two groups based on GCA. GCA consists of a standard

score that has a mean of 100 and a standard deviation of 15. Thus, children with GCAs greater than one standard deviation below the mean of 100 (GCA <85) were compared to children who had GCAs within one standard deviation of the mean (GCA > 85). Due to the small sample size univariate analyses were run to compare these two groups. The Mann-Whitney U test, a nonparametric test, was computed and results are depicted in Table 4.6, which revealed significant differences between the two groups on Animal Sorting, Inhibition-Switching, and the Working Memory Index from the DAS-II. Inhibition was not different between groups and no group differences arose on any BRIEF clinical scale.

Table 4.6: Mann Whitney U Test of the Differences between Groups Based on GCA

		Mann-Whitney U	Wilcoxon W	Z	Asymp Sig.	Exact Sig.
GCA	*NEPSY-II*					
	Animal Sorting	17.500	38.500	-2.048	.041	.041[b]
	Inhibition	26.000	47.000	-1.761	.078	.087[b]
	Inhibition-Switching	10.500	31.500	-2.522	0.12	.009[b]
	DAS-II					
	Working Memory	10.000	25.000	-2.548	.011	.009[b]
	BRIEF					
	Inhibit	42.500	162.500	-.196	.845	.850[b]
	Shift	30.500	150.500	-1.133	.257	.267[b]
	Emotional Control	30.500	150.500	-1.133	.258	.267[b]
	Initiation	25.500	145.500	-1.522	.128	.132[b]
	Working Memory	45.000	165.000	.000	1.000	1.000[b]
	Planning and Organization	33.500	153.500	-.898	.369	.381[b]
	Organization of Materials	34.000	55.000	-.859	.390	.424[b]
	Monitor	32.000	152.000	-1.014	.310	.340[b]

*p ≥ .05 ** p ≥ .01

In order to understand the relationship between executive functioning and social skills while controlling for IQ, a partial correlation was performed with these variables. Results are depicted in Table 4.7 and are somewhat different than the Pearson correlations. The direct measure of Inhibition from the NEPSY-II remained significant with the number of friendship nominations the child with ASD made; however, a new finding emerged with the Inhibition-Switching measure. Namely, Inhibition-Switching was positively correlated with time spent in solitary play on the playground. The remainder of direct measures of executive functioning as measured by the NEPSY-II and DAS-II did not demonstrate any significant relationship to social inclusion measures.

The BRIEF Scales, however, maintained their relationship with social variables, although some findings varied when controlling for IQ. Similar to the bivariate correlations, poorer scores on the Initiation scale from the BRIEF were significantly related to more time engaged in solitary play on the playground. However, when controlling for GCA, more impaired Initiation skills were also significantly related to less time in joint engagement. Another finding that emerged was the relationship between Planning and Organization and joint engagement on the playground. Children with poorer Planning and Organization skills not only received more rejections from their peers, but also spent less time jointly engaged on the playground. In bivariate analyses, poorer Planning and Organization skills were related to an increase in rejections. All significant relationships found in bivariate analyses remained significant when controlling for GCA.

Table 4.7: Correlation between Executive Functioning Subtests and Social Measures Controlling for GCA

NEPSY-II	Indegrees	Outdegrees	Rejection	Solitary Play	Games	Joint Engagement
Animal Sorting	.204	-.230	.026	-.082	.015	.411
Inhibition	-.049	**.490***	.030	.226	-.240	-.002
Inhibition Switching	-.104	-.059	.239	**.550***	-.326	.207
DAS-II						
Working Memory	.422	.374	-.285	.145	.023	.359
BRIEF						
Inhibit	.066	.204	.023	.287	.-143	.092
Shift	-.902	.305	-.066	.080	-.059	.158
Emotional Control	-.061	.250	-.163	.266	-.038	.089
Initiation	-.266	-.112	.343	**.631****	-.220	**-.538***
Working Memory	-.326	-.090	**.527***	.398	-.290	**-.548***
Planning and Organization	-.12	-.225	**.471***	.165	-.275	**-.484***
Organization of Materials	-.159	-.118	**.601****	.157	-.155	-.382
Monitor	.085	-.087	.227	.425	-.253	-.176

*p ≥ .05 ** p ≥ .01

CHAPTER 5

DISCUSSION

A number of theories have attempted to explain the deficits associated with ASD. The executive function theory posits that the deficits present in ASD are a reflection of impairment in higher order cognitive skills required to plan and execute goal directed behavior. Executive deficits in children with ASD have been reported throughout the literature, albeit with many inconsistencies. These deficits have commonly been linked to the core deficits in repetitive and stereotyped behaviors (Lopez et al., 2005), but there is a dearth of literature relating deficits in executive functioning to impairments in social functioning. Given that impaired social functioning is the hallmark feature of ASD (Troyb et al., 2011), the current study sought to expand on the existing literature by investigating the relationship between executive functions and social skills in children with ASD.

Executive Functions in ASD

Cognitive Flexibility and Set Shifting

The first question, which has been debated in the literature, was if children with ASD demonstrate impairments in specific executive functions. Pennington and Ozonoff (1996) reported a number of larger effect sizes for the relationship between cognitive rigidity and planning deficits in ASD than any other developmental disorder. Many other researchers have found converging evidence to suggest that children with ASD have poorer cognitive flexibility and set shifting skills as compared to their typically

developing peers (Bennetto et al., 1996; Joseph & Tager-Flusberg, 2004; Ozonoff & Jensen 1999). Consistent with previous literature, the current sample performed below age expectations on performance-based measures of cognitive flexibility or shifting. In addition, the current sample demonstrated elevated scores on the BRIEF Shifting scale. Thus, shifting was impaired as measured by both performance- and ratings-based measures.

Inhibition and Inhibition Switching

Although deficits in cognitive flexibility have been widely noted throughout the literature, findings have been quite inconsistent with regard to inhibition and working memory. Some studies have found that children with ASD demonstrated impairments in inhibition and working memory (Joseph & Tager-Flusberg, 2004; Ozonoff et al., 1994); whereas other researchers have found these skills to remain intact (Ozonoff & Jensen, 1999). Ozonoff and colleagues (1994) found that people with ASD performed as well as controls when inhibiting neutral responses, were moderately impaired when inhibiting prepotent responses (preventing a dominant response), and very deficient with shifting the response set (shifting cognitive strategies in the face of an environmental change). In terms of inhibition, results were consistent with Ozonoff and colleagues (1994) as well as Joseph and Tager-Flusberg (2004), in that the current sample demonstrated impairments when inhibiting prepotent responses and when shifting the response set on performance-based measures of inhibition. The current sample, however, did not demonstrate elevated impairment on the BRIEF Inhibition clinical scale. This indicates that for this sample,

performance- and ratings-based measures may have been capturing different components of inhibition.

Working Memory

Working memory deficits have been highly controversial throughout the literature with a number of studies citing the presence of working memory deficits (Bennetto et al., 1996; Joseph & Tager-Flusberg, 2004; Schuh & Eigsti, 2012) while others found working memory to be intact in children with ASD (Ozonoff & Strayer, 2001). Our findings were consistent with Ozonoff and Strayer (2001) in that children with ASD demonstrated age appropriate skills on performance-based measures of working memory. An important difference between the current study and previously reported studies is the lack of control group. Whereas previous studies have compared children with ASD to a control group the current study only compared them to the national normative sample. This may account for some of the differential findings. For example, the only study that reported performance as compared to the national norming sample reported the proportion of children who scored below the national average level as opposed to investigating if the mean group score was below the national average (Schuh & Eigsti, 2012). Schuh and Eigsti (2012) found that a greater proportion of children with ASD scored below the national average as compared to the control group in which only one student scored below the national level. The mean score of the ASD group, however, was in the Average range when compared to the national average. Thus, although the current study appeared to find conflicting results many of the conflicts may stem from the way deficits were defined and reported.

In addition, all of the studies utilized different measures of various executive skills. A number of measures were not nationally normed, but devised solely for research purposes. Although working memory measures are designed to capture the same underlying ability and the same construct, their inherent differences result in differential task demands, which may have contributed to the current findings.

Interestingly, although the current sample demonstrated age-appropriate working memory on performance-based measures, they demonstrated elevated scores on the BRIEF Working Memory clinical scale. Again, it appears that performance- and ratings-based measures may be tapping into different aspects of working memory.

Additional Ratings-Based Measures

The current study examined the scores on the BRIEF clinical scales to understand if children with ASD demonstrated elevated scores on measures of executive functioning in the everyday setting. In addition to the skills discussed above, this sample demonstrated elevated scores on the Initiation and Monitor Scales. The Emotional Control, Planning and Organization, and Organization of Materials scales were all considered within normal limits.

Ecological Validity of Performance-Based Measures of Executive Functions

Previous literature has been quite mixed, but has largely found performance-based and ratings-based measures to be unrelated. When Toplak and colleagues (2013) analyzed the findings from 20 studies (285 correlations), they found that only 24 % of the correlational analyses between performance- and ratings-based measures were

significant. The current study found 50% of the correlations between measures to be significant, but there were only four correlational analyses conducted. In the current sample, scores on the Shifting clinical scale from the BRIEF were significantly related to Shifting as measured by the NEPSY. Likewise, The Working Memory clinical scale from the BRIEF was also significantly related to the Working Memory Composite score on the DAS-II. Inhibition, however, was not significantly related between the two measures (BRIEF and NEPSY). This indicates that for this sample, the performance-based measures for shifting and working memory demonstrated some ecological validity as they were related to the ratings-based measure. The ecological validity of the inhibition measure, however, is questionable given that is was not related to the ratings-based measure.

Toplak and colleagues (2013) analyzed studies that utilized clinical, nonclinical, and mixed groups. Thus, it is possible, that the nature of the clinical population may have played a role in the relationship between the two types of measures. Of all the studies reviewed by Toplak and colleagues (2013), the clinical populations consisted of children with epilepsy, traumatic brain injury, attention deficit hyperactivity disorder, Tourette syndrome, schizophrenia, and other "mixed" clinical samples of children and/or adults referred to outpatient settings. None of the studies, however, utilized ASD as a clinical population. The current study is the first to investigate the relationship between performance-based measures of executive functioning and ratings-based measures. However, the current sample only included a subset of children with typical intellectual functioning who were included in the regular education setting, thus it may not be

representative of children with ASD as a whole. For this specific population, performance-based measures of cognitive flexibility and working memory appeared representative of their ability to execute tasks in the everyday setting that required these skills. However, given the unique difficulties that are specific to ASD, it is essential to conduct additional research with larger sample sizes in order to understand the ability of performance-based measures to generalize to functioning in everyday settings.

The Relationship between Executive and Social Functions in ASD

The final goal of the current project was to examine the relationship between executive functions and social skills in children with ASD. Previous literature has been quite mixed. Some studies have failed to find any relationship between executive and social skills (Landa & Goldberg, 2005; Ozonoff et al., 2004) and others have found executive functions to be related to both social and adaptive functioning (Kenworthy et al., 2009; Gilotty et al., 2002). Kenworthy and colleagues (2009) found that higher scores on performance-based measures of divided attention and category fluency as well as the BRIEF Metacognition and Behavioral Regulation indices were related to fewer social challenges as measured by the ADOS and ADI. Thus, both performance- and ratings-based measures were related to social functioning. Deficits in executive functions have also been associated with poor adaptive functioning in ASD (Gilotty et al., 2002). Gilotty and colleagues (2002) found that the parent-report on the VABS Communication, Social, and Overall composite scores were negatively correlated with the Initiate and Working Memory scales on the BRIEF (parent-report). Hierarchical regression analysis revealed that MCI was a significant predictor of the Communication and Social domains

on the VABS. Overall, they found that metacognitive impairments, specifically in initiation and working memory, played a role in the social deficits paramount in ASD. Ozonoff and colleagues (2001) also found a relationship between executive skills and adaptive functioning in that planning was related to the VABS Communication Composite.

In the current sample, several significant relationships between executive measures and social skills emerged. Overall, ratings-based measures were more related to social skills as compared to performance-based measures. The only performance-based measures that were related to social skills were inhibition skills. Children with higher performance on the inhibition measures nominated more children as friends; however, inhibition was not related to the number of friendship nominations received by the child with ASD or their overall social connectedness. Other studies have not found inhibition to be related to social skills (Landa & Goldberg, 2004; Ozonoff et al., 2004); however, social skills have consistently been measured with the ADOS and ADI. The current study captured a different aspect of social functioning by quantifying relationships based on the child with ASD and his/her peer's reports of friendships. Thus, it is difficult to compare these results.

Inconsistent findings between previous literature and the current study are likely related to issues with measurement. First, the current study did not measure any attentional abilities. Kenworthy and colleagues (2009) found divided attention to be related to social functioning. Although divided attention tasks require working memory, they do not provide an isolated measure of working memory. In fact, the isolated

measure of working memory was not found to be related to social skills (Kenworthy et al., 2009).

An unexpected relationship was also found between the performance-based test of inhibition switching and time spent in solitary play on the playground. Specifically, if a child was better at inhibiting a prepotent response and switching between rules based on environmental stimuli in a laboratory setting, they spent more time in solitary play on the playground. Thus, this skill did not translate to their ability to engage or interact with their peers on the playground. This could be related to the failure of the inhibition measure to relate to inhibition skills in the everyday setting, as the performance-based and ratings-based measures of inhibition were not correlated. Another explanation, however, is that intact inhibitory skills may be disadvantageous for playground engagement. If the child is hypervigilant and constantly inhibiting his/her behaviors, that child may fail to join peers on the playground resulting in more time spent in solitary play. However, given the small sample size, further research should be conducted to examine if this finding would be replicated in a larger sample.

Overall, ratings-based measures were more related to social skills. Poor Initiation skills were related to increased time in solitary play and decreased time in joint engagement. Initiation measures the child's ability to begin a task independently; therefore, children with impaired initiation skills may fail to independently approach their peers to play. This likely results in the child remaining in solitary play because he/she does not have adequate skills to approach his/her peers or generate ideas regarding how to initially approach his/her peers

Ratings-based measures of working memory were also related to playground engagement. Children with poor working memory spent significantly less time jointly engaged on the playground. This may be related to the unstructured nature of the playground and the need for the child to keep multiple pieces of information about social discourse in mind, constantly change and update that information, and act according to such information. This would place great demands on the child's working memory and children with more impaired working memory skills may not be able to keep up with this swift social pace on the playground leading to less time jointly engaged with their peers.

Similarly, poor planning and organizational skills were related to decreased joint engagement on the playground. Children with poorer planning and organizational skills likely struggle to anticipate steps involved in social play and social discourse as well as struggle to plan steps to carry out a social goal thus leading to a less joint engagement with peers on the playground.

Elevated scores on several clinical scales from the BRIEF, including Working Memory, Planning and Organization, and Organization of Materials were related to an increase in peer rejection. The reason for the relationship is likely related to the explanation of why these skills are associated with poor joint engagement. If children with poor working memory fail to keep multiple pieces of social information in mind, as well as change and update that information, they may engage in socially inappropriate behaviors because they failed to maintain the social rules in their mind. Likewise, children with poor planning and organizational skills may also engage in behaviors considered odd or unacceptable by peers because they do not have the adequate skills

necessary to anticipate social steps and plan a sequence of steps to achieve socials goals. This may lead to the child engaging in behaviors that are not deemed appropriate by peers, which can result in an increase in peer rejection. These findings are consistent with Gilotty and colleagues (2002), who found that metacognitive impairments, specifically initiation and working memory, were highly related to adaptive social functioning. The current study built upon this literature by demonstrating that metacognitive impairments are not only related to parent-report of adaptive social functioning, but actual engagement on the playground.

Although ratings-based measures were related to playground engagement, neither measure of executive functions (performance or ratings) was significantly related to social connectedness in the classroom. This may indicate that our measures of executive functions do not adequately translate to the skills necessary to develop and maintain social relationships. The skills necessary to engage with peers on the playground are considerably different than those required to make and maintain friendships. It can be inferred that friendships require mutual interests, the ability to talk about interests, and relate to one another, in addition to engaging in social play. Thus, those social relatedness skills may not be associated with the skills required to engage on the playground.

This means that although children may be engaged on the playground, these skills did not necessarily translate to their ability to make friendships in the classroom. Overall, playground engagement was unrelated to social connectedness as measured by social networks. This is consistent with previous research, as Kasari and colleagues (2011)

found that even children with a number of reciprocal friendships were often on the periphery of the playground. The authors posited that even if children have reciprocal friendships, the culture of the playground may be too difficult for them to grasp. However, the opposite may also be true, that even children who were more engaged in the playground did not necessarily have more reciprocal friendships. If the goal of the social intervention is to increase social connectedness, it should target both playground engagement and the social skills necessary to create and maintain friendships. Playground engagement is very important in elementary school when a great proportion of social interaction occurs during this time. However, as the child progresses through elementary and into middle and high school, less and less time will be spent on the playground. As a result, it may be important to address skills necessary for playground engagement as well as skills needed to develop friendships. An intervention that addresses both components would likely increase social skills on a more global level in an effort to help the child maintain social connectedness as he/she progresses throughout school.

The Executive Function Theory

This study supports previous research citing that children with ASD demonstrate impairments on performance-based measures of executive functioning. In addition, the current sample demonstrated elevated scores on ratings-based measures of several other executive functions, including shifting, initiation, working memory, and monitoring. However, although children demonstrated executive impairments, executive skills were only related to some measures of playground engagement and were not significantly

related to overall social connectedness. Thus, in the current study, executive skills did not appear to be related to the child's ability to have reciprocal relationships and be connected in the classroom. Given that social skills are the hallmark deficit in ASD, in order for executive dysfunction to be considered a causal factor in the disorder, it should theoretically be related to the child's overall social functioning, including his/her ability to have reciprocal relationships and be involved in the social structure of the classroom. Therefore, although children with ASD clearly demonstrated executive impairments, the current data do not provide support for executive dysfunction as a causal factor in ASD.

Limitations and Future Directions

The current sample size was quite small; thus, the current study should be replicated with a larger sample size to allow more sophisticated statistical procedures to be performed. In addition, the sample could be divided into age groups to determine the differences in executive deficits as a factor of age and the effects of age on the relationships between executive and social skills.

Given that the current study found that executive skills were related to playground engagement, future research should investigate the role of executive skills in response to social skills interventions. To put this another way: do certain executive skills determine if children would benefit from specific social skills interventions? Additionally, research should investigate if the remediation of executive deficits increases the child's ability to respond to social interventions. Another important direction for future research is to examine if improving executive skills alone without specific social skills interventions

would have any effect on social functioning. For example, children with poorer working memory skills (as measured by the BRIEF) received more rejections from their peers and spent less time jointly engaged. Would remediating working memory deficits alone have any effect on the number peer rejections or their playground engagement?

There has been a debate in the literature with regard to the most effective way to capture executive functioning skills not only in children with ASD, but with all clinical populations. To date, with the exception of the current project, no study has investigated the relationship between scores on performance-based versus ratings-based measures of executive functions in children with ASD. Although executive deficits are documented throughout the literature, the majority of studies have utilized performance-based measures of executive functions, making it difficult to understand how these deficits affect functioning in the everyday setting. Future research should investigate this relationship to inform the most effective and ecologically valid way to capture executive deficits among children with ASD.

This study had several limitations. First, the sample size was quite small; therefore, it makes generalizing these results problematic. These data, however, could serve as pilot data for a larger study. In addition, this sample only included children with an IQ over 65 who were included in the general education setting. This also limits the generalizability of the data given that it was a very specific subset of children with ASD that were included.

Another limitation was the lack of a performance-based measure of planning. Planning deficits in children with ASD have been noted throughout the literature (Bennetto et al., 1996; Joseph & Tager-Flusberg, 2004; Ozonoff & Jensen, 1999). Although planning skills were captured on the BRIEF questionnaire, a performance-based measure was omitted. This was largely related to time constraints as children were pulled out of their classroom for testing and the duration of the testing sessions were purposefully kept short. Planning skills as measured by the BRIEF were related to rejections and playground engagement, thus it would be interesting to understand the relationship between performance-based measures of planning and social skills.

Conclusion

In summary, a number of ratings-based measures of executive functioning were associated with social skills in children with ASD. Initiation, working memory, and planning and organizational skills were all related to engagement on the playground. In addition, similar skills were related to an increase in peer rejection. This indicates that executive skills (as measured by teacher-report) are extremely important with regard to peer interaction on the playground and well as peer acceptance. As a result, social interventions should directly target these skills in an effort to increase social engagement and acceptance.

Similar to previous research (Landa & Goldberg, 2005; Ozonoff et al., 2004), the current study found few relationships between performance-based measures of executive functioning and social skills. This contributes to the debate in the literature with regard

to the ecological validity of these measures (Toplak et al., 2013). Even when children demonstrated impairments on performance-based measures, they were rarely related to social skills. While performance-based measures are created to isolate and assess very specific skills, they may not be the most representative of that skill in the everyday setting. Based on these data ratings-based measures were related to everyday social functioning and therefore may be a more ecologically valid measure of executive skills.

Overall, relationships did emerge between executive and social skills, indicating the importance of intact executive functioning for social engagement and peer acceptance. This study, however, failed to find a relationship between executive skills and overall social connectedness in the classroom. Given that as the child ages he/she will spend increasingly less time in the playground environment, it is essential to study the underlying skills necessary to make and maintain friendships. Understanding these underlying skills will help inform the creation of interventions to target and increase specific abilities so that children may make meaningful friendships and maintain them over time.

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