University of Alberta

Sensory Motor Factors And Daily Living Skills Of Children With Autism Spectrum Disorder

by

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Abstract

This study examines the relationship between motor skills, sensory processing ability, and daily living skills in children with Autism Spectrum Disorder (ASD). Twenty children with ASD between 5 and 7 ½ years of age with average cognitive ability were tested using the Movement Assessment Battery for Children, Short Sensory Profile (SSP), and Self Care Functional Skills Scale of the Pediatric Evaluation of Disability. Seventy-five per cent of the children demonstrated significant motor difficulties, and 85% demonstrated atypical processing of sensory information (based on 'probable' and 'definite' difference categories of the SSP). The average score on the PEDI Self Care scale was more than 2 standard deviations below the mean. In hierarchical regression analysis, neither motor skills nor sensory processing accounted for a significant portion of variance in the children's daily living skills. Based on the person-environment-occupation model, implications for practice and future directions for research are discussed.

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CHAPTER 1: INTRODUCTION

Problem Statement

Children with Autism Spectrum Disorder (ASD) struggle to cope with the demands of daily life in a variety of contexts (Carter et al., 1998; Liss et al., 2001). The social and communication difficulties used for diagnosis of ASD directly contribute to the struggles faced by these children. However, the degree to which difficulties in motor skills and processing of sensory information also limit their performance of age appropriate daily living activities is not clear. Children with ASD have been described as clumsy, or having delayed and atypical motor development (Ghaziuddin & Butler, 1998; Kohen-Raz, Volkmar, & Cohen, 1992; Rinehart, Bradshaw, Brereton, & Tonge, 2001). Greenspan and Wieder (1997) reported that 94% of their sample of 200 persons with ASD had sensory processing deficits based on chart review. Leary and Hill (1996) suggest that movement disturbance features may significantly impact the life experience of persons with ASD, and therefore warrant closer examination.

Occupational therapists are concerned with the ability of children with ASD to function within their home, school, and community environments, and seek to support the development of their daily living skills. Theories of occupational performance indicate that motor and sensory processing abilities contribute to one's ability to successfully complete activities of daily living (Baum & Baptiste, 2002). Consequently, occupational therapists often address the sensory and motor difficulties of children with ASD based on the assumption that this will help to remediate difficulties in a variety of daily living skills.

The general purpose of this study was to examine the contribution of deficits in motor skills and sensory processing to difficulties in daily living activities in children with ASD. To date, there has been no published study which has examined the relationship between these three variables in kindergarten and early school-aged children with ASD. Understanding this relationship will enable occupational therapists to more effectively support the development of children's daily living skills and appropriately target their interventions, so that these children can function as successfully and independently as possible in their environments.

Definition of Terms

In this paper, the term 'Autism Spectrum Disorder' includes the diagnoses of autistic disorder, Asperger's Syndrome, and Pervasive Developmental Disorder (Spence, Sharifi, & Wiznitzer, 2004). When the term 'autism' is used, it refers to 'autistic disorder', or to the term 'autism' as referred to by authors describing their research.

Literature Review

Theoretical Background

Successful performance of daily living activities such as dressing or eating is affected by three types of inter-related factors: those originating within the person/child (e.g. cognitive delays), those linked to the environment (e.g., quiet or noisy), and those specific to the occupation or task (e.g., clearly structured) as detailed by the Person Environment Occupation model of practice (Baum & Baptiste, 2002). This perspective emphasizes the identification of any constraints within the child, which limit the child's performance and might be reduced through occupational therapy intervention. In many cases, intervention is likely to focus on constraints within the child and how to address these constraints. The current study focused on specific factors within the child to determine the degree to which these factors were associated with successful performance of daily living skills. Factors within the task and environment were not addressed directly within this study but are acknowledged as important for success.

Occupational therapy practice is based on the principle that the child's sensorimotor performance components (e.g., manual dexterity, tactile processing) are important for the development of specific motor skills (e.g., buttoning) used to perform the daily living tasks (e.g., putting on a paint shirt) involved in functioning in environments such as home or school (Baum & Baptiste, 2002; Case-Smith, 1995). Motor skills may be defined as "tasks performed outside the context of environmental demands" or "discrete tasks that are the result of motor learning or practice" (Haley & Baryza, 1990, p.6). Much of our understanding of motor function has been within a hierarchical approach such as the Motor Outcome Assessment Hierarchy (Haley & Baryza). This hierarchy has five levels of motor outcome variables: self-initiated movements, pre-functional motor determinants, motor performance and control variables, motor skills, and adaptive motor function. In this model, underlying components (such as balance or strength) are addressed before moving to develop functional cognitively directed movements (Haley & Baryza). While this hierarchy has support from a developmental perspective in that it describes stages of motor development, the actual connection between motor function levels and daily living skills has received limited attention. Case-Smith (1995) explored this relationship in 35 preschool children with mild to moderate motor delays by looking at correlations between standardized measures of fine motor skills (Peabody Developmental Motor Scales), performance components (in-hand manipulation, strength, stereognosis, tactle defensiveness), and functional performance (self-care skills, mobility, social function) as measured by the Pediatric Evaluation of Disability Inventory. She found little correlation between fine motor skills ($r = .22, .25$), performance components ($r = .21$ to $.29$), and self-care skills. Gross motor skills were not addressed. The findings suggest that, while motor functioning contributes to functional performance, it is not the only component of importance. Other factors also have an impact on functional performance.

Sensory processing theory (Dunn, 2001) emphasizes the important contribution that sensory processing makes to functioning successfully in a given environment. Difficulties in sensory processing and/or modulation are thought to interfere with functioning both directly, by impeding specific skill development, and indirectly, through limiting participation in childhood occupations that allow skill development (Parham & Mailloux, 1996). For example, the development of an appropriate pencil grasp may be impeded by poor tactile processing (direct), or by the avoidance of performing graphic tasks (indirect). Dunn's Model of Sensory Processing focuses specifically on the effect of sensory processing on functional skills. She described four different sensory processing patterns based on individual neurological thresholds and self-regulation strategies which are thought to affect both the individual's response in daily situations and their individual temperament (Dunn, 2001). The four patterns are: avoiding sensory input (hypersensitive to and actively avoiding input), sensation seeking (under-responsive to and actively seeking sensory input), sensory sensitivity (hypersensitive to sensory input), and low registration (fail to register sensory input from the environment). The relationship of sensory processing patterns and functioning has been examined in 15 children with Fragile X Syndrome, with some measures of sensory processing associated with occupational performance (Baranek et al., 2002). Not surprisingly, sensory processing components were not a sufficient explanation for difficulties in occupational performance, with findings suggesting that multiple factors likely play a role. Using a sample of 30 typically developing children and 38 children with suspected sensory processing deficits, White, Mulligan, Merrill, and Wright (2007) found that children who demonstrated difficulties in sensory processing were likely to also experience difficulty with activities of daily living. To date, the relationship of sensory processing and activities of daily living in children with Autism Spectrum Disorder has received relatively little attention.

Occupational performance models point to the dynamic nature of human systems, with many factors contributing to the performance of complex occupational behaviors. However, these models do not provide a way to predict the relative importance of different factors for successful performance of daily activities. In addition, the Motor Outcome Assessment Hierarchy, and the model of sensory processing do not consider all of the possible factors within the child that affect occupational performance. Still, they do provide a theoretical perspective for considering the relationship of functional performance and areas where there may be specific constraints for children with Autism Spectrum Disorder.

Motor abilities of children with ASD

Empirical studies of the motor abilities of children with ASD consistently confirm the presence of motor difficulties during their development. These studies are considered by the level of the Motor Outcome Assessment Hierarchy they address. First, studies addressing motor performance and control variables are presented. The purported increased prevalence of left handedness in children with autism was explored by Hauck and Dewey (2001). They found that having a hand preference was more important than whether it was left or right, but did not find the expected higher prevalence of left handedness in their sample of 40 children with autism, aged 2.5 to 7 years. Children with a definite hand preference performed better on motor, language, and cognitive tasks than children with autism who did not show a definite hand preference. Kohen-Raz, Volkmar, and Cohen (1992) explored another aspect of motor control. The postural patterns of 91 children with ASD, aged 6 to 20 years, were compared with those of 166 typical children, 18 children with mental retardation, and 20 adults with vestibular disorders. The posture of children with autism was more variable and less stable than that of typical children. A recent study (Jansiewicz et al., 2006) compared the performance of 40 boys with autism, ages 6 to 17, and 55 typically developing boys on a standardized neurologic examination which targets a range of subtle neuromotor signs. The boys with autism displayed significant difficulty on several motor measures. Thus, difficulties with motor performance and control are often present in children with a diagnosis of ASD.

Aspects of movement such as activity level and repetitive behaviors are viewed as a type of movement disorder by Gabriels, Cuccaro, Hill, Ivers and Goldson (2005). Leary and Hill (1996)'s review examined activity level and repetitive behaviors, finding that these variables were strongly and inversely related to adaptive functioning, regardless of intelligence. They reviewed the nature of movement disturbances in children with autism, which included both the loss of typical movements as well as the presence of excessive movements. In particular, they considered the impact of movement disturbance on the social and communicative core characteristics of autism and proposed that these movements can affect both the individual's experience of the world and the perception of him/her by others.

Studies have also examined the motor skills of children with ASD, typically involving standardized measures of motor skills. Ornitz, Farley, and Guthrie (1977) found significant delays in early motor development in a group of 74 children with autism in comparison to 38 typical children. Further, a delay in motor development was associated with a delay in early language and/or perceptual development. In a comparison of the motor skills of 11 children with High Functioning Autism (HFA) to 9 children with Asperger Syndrome (AS), motor clumsiness and below average gross and fine motor skills was evident in both groups (Ghaziuddin, Butler, Tsai, & Ghaziuddin, 1994). In a later study comparing 12 children with autism, Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS)(n=12), or Asperger Syndrome (n=12), mean scores indicated below average gross and fine motor skills, with children with autism described as the most clumsy with the lowest scores (Ghaziuddin & Butler, 1998). Manjiviona and Prior (1995) also found that 21 children with autism or Asperger's Syndrome exhibited significant motor impairment, with considerable variability in motor ability within each group. Green et al. (2002) found that both children with Asperger's Syndrome (n=10) and those with Developmental Coordination Disorder (n=10) had significant motor impairment.

Researchers have also explored the role of motor planning in the motor difficulties of children with ASD, postulating possible deficits in executive functioning. Even simple motor activities involve executive control, including anticipating, adjusting movement in response to external feedback, and coordinating components into a goal-directed sequence. This targets the adaptive motor function level of the Motor Outcome Assessment Hierarchy. Hughes (1996) found that children with autism had difficulty executing goal directed tasks (n=88). Smith and Bryson (1998) reported that children with autism (n=60) performed poorly on gesture imitation tasks, and hypothesized difficulty integrating perceptual information as well as difficulty taking on another person's perspective. They supported Hughes' contention that difficulty in planning movements directed towards a goal is not sufficiently accounted for by an explanation involving sequencing. More recently, Van Vuchelen, Roeyers, and De Weerdt (2007) confirmed difficulties in motor imitation in 25 boys with autism in comparison with 17 typically developing boys. They also concluded that motor imitation deficits are part of broader motor competence problems in children with autism and found support for the role of perceptual motor factors in the motor imitation difficulties. Dewey, Cantell, and Crawford (2007) noted that 49 children with ASD demonstrated a generalized impairment in gestural performance, in comparison to 46 children with developmental coordination disorder, 27 children with attention deficit hyperactivity disorder and 78 typically developing children. They suggested that gestural impairments could not be accounted for solely by motor coordination deficits and postulated deficits in self-other mapping, sensory processes, or the internal representation of movement as possible factors. Rogers, Bennetto, McEvoy and Pennington (1996) found partial support for an executive deficit hypothesis, involving the planning of movements (n=32). Persons with autism did not differ in their ability to make normal movements, but rather in their ability to imitate non-meaningful movements. Children with autism (n=23) displayed specific difficulty with movement preparation, while movement execution was intact (Rinehart, Bradshaw, Brereton, & Tonge, 2001).

As Baranek (2002) stated in her review of literature on sensory and motor difficulties in children with ASD, "many demonstrate atypical features (e.g., low muscle tone, oral-motor problems, repetitive motor movements, dyspraxia) or test in the delayed ranges on standardized motor assessments, particularly as the complexity of tasks increases" (p. 398). As mentioned above, impairments in executive control of motor skills might explain these children's greater difficulties with more complex motor tasks. These deficits related to adaptive motor function could interfere with children's ability to perform daily living skills. This relationship has not been formally measured. So the question remains, to what extent are atypical and delayed motor skills related to these children's ability to perform self care activities of daily living?

Sensory processing in children with ASD

Sensory processing refers to "functions related to sensation occurring in the central nervous system; includes reception, modulation, integration, and organization of sensory stimuli" (p. 480, Bundy, Lane, & Murray, 2002). In her review of literature on sensory processing in children with autism, Baranek (2002) noted that unusual sensory responses, including hypo and hyper responses, preoccupations with sensory features, and paradoxical responses to sensory experiences are 'common concerns' in this population. She described auditory processing problems in particular, with patterns of both under and over arousal. In a more recent review of empirical evidence, Rogers and Ozonoff (2005) concluded that sensory symptoms were more frequent in children with autism than in typical children, but that these symptoms did not necessarily differentiate children with autism from children with other developmental disabilities. They also found more empirical evidence supporting hypo-responsiveness in children with autism, particularly in observational studies, than for hyper-arousal. The evidence reviewed was confounded by differences in methods and the sensory modalities addressed, underscoring the need for further research in this area.

Sensory processing difficulties in children with Autism Spectrum Disorder have frequently been studied using parent report on the Sensory Profile (Dunn, 1999). Watling, Deitz, and White (2001) found that parents of 40 young children with autism reported deficits in 8 out of 10 factors as measured with the Sensory Profile. For example, there were deficits in tactile sensitivity, under-responsive/seeks sensation, and auditory filtering. Children with autism (n=38) differed in their sensory processing from both typical children (n=1075) and children with attention deficit hyperactivity disorder (n=61) (ADHD) based on parent report using the Sensory Profile (Ermer & Dunn, 1998). Similar results were described by Kientz and Dunn (1997) for 32 children with autism who demonstrated a different pattern of sensory processing from typical children (n=64). Tomcheck and Dunn (2007) confirm the extensive prevalence of sensory processing deficits in children with autism, reporting that 95% of preschool children with Autism Spectrum Disorder (n=281) showed sensory processing dysfunction on the Short Sensory Profile (SSP) Total Score. Baker, Lane, Angley and Young (2008) found that sensory processing difficulties were associated with social, emotional and behavioral responses of 22 children under 5 years of age with ASD when comparing SSP and Vineland Adaptive Behavior Scale (VABS) Maladaptive Behavior scores.

Researchers have also found sensory processing deficits on other caregiver report instruments. Using the Temperament and Atypical Behavior Scale, the self regulatory behavior of young children aged 15 to 45 months was evaluated. Seventy-five children with autism showed severely atypical scores in detached and hypersensitive/active behaviors, with atypical under-reactive and deregulated behaviors also identified (Bagnato & Neisworth, 1999). While testing a new caregiver report instrument called the 'Sensory Experiences Questionnaire,' overall sensory symptoms were reported for 69% of the 56 children with autism (Baranek, David, Poe, Stone, & Watson, 2006). In addition, children with autism displayed a unique pattern of sensory processing involving hypo-responsiveness that differentiated them from children with typical development and developmental delay. Liss, Saulnier, Fein, and Kinsbourne (2006) developed an expanded version of the Sensory Profile and used it to examine patterns of sensation and attention in children with autism. They discovered a pattern of over-focused sensation and attention, involving over-reactivity, perseverative behavior and interests, over-focused attention, and strong memory in 43% of their sample of children with autism (n=144).

Structured interviews with parents were used by Leekam, Nieto, Libby, Wing, and Gould (2007) to elicit information regarding sensory processing. They used the Diagnostic Interview for Social and Communication Disorders, an instrument that collects information about a range of behaviors and developmental skills including sensory symptoms. Sensory abnormalities were found in at least 90% of individuals with autism (n=33). Children with autism differed from comparison children (language impaired, developmental disability, typical) in both the frequency and pattern of sensory abnormality (abnormalities across multiple sensory domains). In addition, sensory differences were found to persist across both age and IQ.

Although there is considerable evidence of sensory processing difficulties in children with Autism Spectrum Disorder based on parent report, it is important to note that data gathered from observation does not always agree with that from parent report (Goldberg, Landa, Lasker, Cooper, & Zee, 2000). For example, Miller, Reisman, McIntosh, and Simon (2001) found that 8 children with autism were physiologically under-reactive to sensation based on electrodermal skin responses, while behavioral ratings indicated sensory over-reactivity. Baranek, Foster, and Berkson (1997) identified the need to include multiple measures such as careful observations of stereotyped behaviors when studying sensory processes in this group.

Baranek (1999) used retrospective video analysis to examine the ability of sensory motor measures to predict autism during infancy. She found that subtle symptoms of autism, including motor/object stereotypies and sensory modulation, were reported by parents of 32 children as early as 9 to 12 months of age, and may be helpful in earlier diagnosis of autism. In a study examining whether subtypes of autism could be identified, over half of the sample (n=166) fell into a subtype which included sensory disturbances (Eaves, Ho, & Eaves, 1994).

Although there is evidence of sensory processing difficulties in children with autism, the effect that these difficulties may be having on children's ability to perform daily living skills remains unclear. One study (Pfeiffer, Kinnealey, Reed, & Herzberg, 2005) explored the relationship between sensory modulation dysfunction, symptoms of affective disorders, and adaptive behaviors in 50 children and adolescents with Asperger's Syndrome. Although relationships between sensory defensiveness and anxiety, and depression and hyposensitivity were identified, the relationships between sensory modulation, affective symptoms, and adaptive behavior were mixed. Daily living skills were not specifically addressed as an adaptive behavior. The authors concluded that further research is needed in this area. Rogers, Hepburn, and Wehner (2003) reported that 26 children with autism and 20 children with Fragile X Syndrome experienced significantly more sensory symptoms overall than 24 typical children and 32 children with mixed developmental disabilities. Further, they noted that atypical sensory reactivity was related to overall adaptive behavior, but not to overall developmental level or to IQ. Rogers and Ozonoff (2005) state "It is clear that a deeper understanding of the atypical sensory related behaviors in autism awaits further empirical investigation... the theory underlying the empirical investigations is not the same theory that underlies the clinical sensory integration work" (p.1265). In the current study, sensory processing theory was used in an attempt to understand what relationship sensory processing has to the daily living skills of children with autism.

Daily living skills

Daily living skills refer to the "practical skills needed to take care of oneself and contribute to a household and community" (Carter et al, 1998, p. 291). In the case of children, these skills vary with the age of the child, with increased task expectations as children get older. In studying children with autism, these skills are most often measured using the 'Daily Living Skills' scale of the Vineland Adaptive Behavior Scales (VABS) (Sparrow, Cicchetti, & Balla, 2005). This instrument measures the broad concept of adaptive functioning, which consists of the adaptive skills involved in using the individual's capacity to function within the everyday environment, including social and communication skills, as well as the more practical area of daily living skills. The current literature review focused specifically on daily living skills.

In a study comparing the adaptive behavior of children with autism to children with PDD-NOS (n=40) (Paul et al., 2004), there was no significant difference between the two groups in Daily Living Skills on the VABS, with the exception of community based skills with an expressive communication component (e.g., phone use). The performance of both groups of children fell significantly below average in Daily Living Skills. Similarly, in a comparison of children with autism to children with Asperger's Syndrome (n=68), there was no significant difference between the two groups in Daily Living Skills as measured by the VABS, with both groups scoring below average (Szatmari, Archer, Fisman, Streiner & Wilson, 1995).

The daily living skills of children with autism were also significantly impaired in a group of 9 year olds (Liss et al., 2001). This impairment was more pronounced in a group with High Functioning Autism (n= 35) than in the group with Low Functioning Autism (n= 40) when compared with age and nonverbal IQ matched controls (n= 48). IQ was very predictive of adaptive behavior in low functioning children, while tests of language and verbal memory were stronger predictors of adaptive behavior in the higher functioning children.

The rate of growth of adaptive skills in 210 children with autism was examined by Freeman, Del'Homme, Guthrie, and Zhang (1999). They found that daily living skills improved with age, and that the groups with high and middle IQs showed a significantly faster growth rate than the low IQ group. Carter et al. (1998) explored the performance of subgroups of children with autism on the VABS based on verbal ability and intellectual functioning (n=684). They found that most groups demonstrated the expected pattern of a relative strength in Daily Living Skills and a relative weakness in Socialization. Importantly, "in contrast to intellectual functioning, adaptive behavior is modifiable" (p. 300), even though cognitive functioning will limit, to some extent, the level of adaptive functioning that can be achieved. Since daily living skills can be changed, and can determine an individual's ability to function independently and successfully in the community, it is important to determine how best to address this skill area.

Summary

It has been clearly established that many children with ASD have motor difficulties, which may take the form of delayed skill development, the presence of unusual movements, or qualitative differences in movement. It is also clear that children with autism show difficulties in processing sensory information from their environment. For children with ASD, daily living skills are typically below the level expected for their age. Occupational therapy theory indicates that skills such as sensory processing and motor skills are foundational to the development of children's daily living skills. However, this relationship has not been tested empirically in typically developing children nor children with ASD. It is not clear which area makes the greatest contribution to daily living skills nor whether it is better to consider the contribution of both motor skills and sensory processing when addressing daily living skills.

Objective

Overall, the purpose of this study was to understand the motor, sensory processing, and daily living skills of school aged children with ASD of average intelligence. More specifically, this study examined the following research questions:

1. How much of the variance in daily living skills of young children with ASD is accounted for by their motor skills as measured by the Movement Assessment Battery for Children (M-ABC) (Henderson & Sugden, 1992)?

2. How much of the variance in daily living skills of young children with ASD is accounted for by their sensory processing, as measured by the Short Sensory Profile (SSP) (Dunn, 1999)?

3. How much of the variance in daily living skills of young children with ASD is accounted for by both motor skills and sensory processing deficits?

CHAPTER 2: METHOD

Recruitment

A convenience sample was drawn from 3 non-profit agencies in Calgary and 1 in Edmonton that provide home and community based intervention to young children with Autism Spectrum Disorder. The term Autism Spectrum Disorder refers to diagnoses including autistic disorder, Asperger's Syndrome, pervasive developmental disorder, childhood disintegrative disorder, and Rett's Syndrome (Spence, Sharifi, & Wiznitzer, 2004). Children diagnosed with childhood disintegrative disorder and Rett's Syndrome were not included in this study as these are two uncommon forms for ASD. To be included, the diagnosis had to have been made by a developmental pediatrician or chartered psychologist either individually or as part of a multidisciplinary team and had to be based on criteria specified in the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR) (American Psychiatric Association [APA], 2000). In addition, parents in the study needed to speak English in order to read and understand the Short Sensory Profile and respond to interview questions. Since no participants displayed any difficulties with English during the initial phone call, none were excluded based on English comprehension.

Initially, the principal investigator (PI) performed a file review to determine whether the inclusion criteria of age and diagnosis were met, as well as to determine whether any cognitive testing had been performed previously. Contact information of potential participants was then passed on to administrative agency staff, who contacted parents via telephone to invite their participation in the research study. Once their initial interest was established, they were contacted by the PI to schedule interview and assessment times. One potential participant was identified through an autism parent association newsletter but did not meet the inclusion criterion discussed below.

Children between the ages of 5 years 0 months and 7 years 6 months were included. These ages were chosen because the development of independence in daily living skills becomes particularly important in the children's home and school environments during this age range and a range of foundational motor skills have been acquired. Sensory processing patterns have emerged and parents have identified ways in which these patterns affect daily life.

Screening

The K-BIT Matrices sub-test score (Kaufman & Kaufman, 1990) was used to screen for inclusion criteria, ensuring that participants were relatively homogeneous, and to describe children's cognitive level. This was administered to children who had not received other cognitive testing. The K-BIT, a standardized screening measure to assess verbal and non-verbal intelligence, has normative data on 2564 persons ages 4 to 90 years grouped into 15 age bands. This test can be administered by a trained paraprofessional. The Matrices sub-test, with 48 items, was used to examine the child's ability to perceive relationships and complete analogies, skills Kaufman and Kaufman (1990) describe as fluid thinking. The visual stimuli include both meaningful objects and abstract designs. The child points to the correct response from five pictures. The authors recommend using only the Matrices subtest when testing persons with language problems "including those with autism" (p. 6). The Matrices take 5 to 10 minutes to administer. Testing is discontinued after all 5 items in a unit are failed. Test-retest reliability for children ages 5 to 12 years old was .83. The Matrices were correlated at .67 with the Performance IQ of the Weschler Intelligence Scale for Children-III for a sample of 207 children evaluated for special education (Canivez, Neitzel, & Martin, 2005). Most children in the current study were able to complete the Matrices test without difficulty. A few children required a short break after several items, and then were able to return to complete the test.

The goal was to include children with a K-BIT standard score of 85 or above in the study, since a score of less than 85 indicates 'below average' intellectual ability. A cognitive delay may result in a different relationship of motor skills and daily living skills. One child scored close to the cutoff on the K-BIT if standard error of measurement was considered (standard score of 79) so all other measures were completed. It was later decided to include this child, as the data did not significantly alter the statistical analysis. Another child scored 73 on the K-BIT Matrices sub-test and no further data were collected.

One additional child was excluded from the study. The child began testing but was unable to complete the Movement Assessment Battery for Children (MABC) (Henderson & Sugden, 1992) due to difficulties attending to and completing tasks. His results were not included in the study. Initial screening of the files resulted in only participants who appeared to meet criteria being invited to participate and a low rate of children being excluded.

Participants

Twenty children participated in the study. Eighteen children were male (90.0%) and 2 were female (10.0%). The high proportion of males reflects the greater prevalence of males with ASD, with the disorder reported in males four to five times more frequently than in females (APA, 2000; Fombonne, Zakarian, Bennett, Meng, & Mclean-Heywood, 2006). Fourteen children had been diagnosed with autism (70.0%); 5 children with Pervasive Developmental Disorder, Not Otherwise Specified (25.0%); and 1 child with Asperger's Syndrome (5.0%). Thirteen of the children had received their diagnosis from a developmental pediatrician (65.0%), while 4 had received their diagnosis from a chartered psychologist (20.0%), and 3 from a multidisciplinary team (15.0%). Most of the children were diagnosed with ASD at ages 3 and 4 (see Table 1) which is typical for children with ASD (Chakrabarti & Fombonne, 2005; Charman & Baird, 2002; Mandell, Novak & Zubritsky, 2005). The majority of the children had been receiving treatment for two years (see Table 1). Only 1 of the children was taking any medication, and this was to control the child's asthma.

***Table 1:* Characteristics of Children (N=20)**

Demographic variable	Frequency	Percentage
Age at diagnosis [years]		
1	1	5.0
2	4	20.0
3	8	40.0
4	6	30.0
5	1	5.0
Years in treatment		
1	4	20.0
2	11	55.0
3	3	15.0
4	2	10.0

Of the 20 families, 1 was of Asian descent (5.0%), while the remaining 19 (95.0%) were Caucasian. Most of the parents had completed a college degree, as shown in Table 2. This was based on the highest level of education reported for either the father or the mother. In terms of family constellation, there was a fairly even distribution of number of children in the families ranging from one to four children (see Table 2).

Table 2: **Family Characteristics (N=20)**

Demographic variable	Frequency	Percentage
Level of education of parents		
Completed high school	1	5.0
Specialized training	4	20.0
Some college	1	5.0
Undergraduate degree	10	50.0
Graduate degree	4	20.0
Number of children in the family		
1	6	30.0
2	7	35.0
3	4	20.0
4	3	15.0

The children ranged in age from 60 to 89 months old with a mean age of 71.4 months (SD= 8.1). Non verbal intelligence was determined using the K-BIT Matrices sub-test for 16 of the children. The remaining 4 children had undergone cognitive testing within 12 months prior to participating in the study. Three of these children were tested using the Weschler Preschool and Primary Scale of Intelligence 3 (WPPSI 3) (Weschler, 2002), and one with the Stanford Binet Intelligence Scales (5^{th} Edition) (Roid, 2003). In these cases, the non-verbal score on these measures was used in the descriptive analyses in order to be consistent with the K-BIT scores. The mean non-verbal IQ was 98.90 (SD=8.96), with a range of 79 to 113.

Procedures

Once children were identified as meeting criteria, the assessments were administered by the PI. The Short Sensory Profile (SSP) (Dunn, 1999) and the Self Care Functional Skills scale of the Pediatric Evaluation of Disability Inventory (PEDI) (Haley, Coster, Ludlow, Haltiwanger, & Andrellos, 1992), a structured interview, were completed by the parent/caregiver with the PI at the agency office or at the parents' home (n=2), according to the parents' schedule and convenience. Typically, parents met with the PI initially to review the information letter (see Appendix A), complete the research consent form (see Appendix B), and provide the necessary demographic information (see Appendix C) and PEDI responses via interview. The children completed the K-BIT first, and then performed the Movement Assessment Battery for Children (MABC). Most children were seen for the MABC without their parents present, during which time the parent completed the SSP. For the majority of the children (n=18), the MABC was administered in a quiet setting at the agency offices. At the conclusion of the child's testing, the therapist was available to respond to any questions the parents had regarding the SSP items. As a result, all SSP items were completed.

Inter-rater reliability was established by discussion of items on the PEDI prior to formal data collection. In addition, a trial interview was audio-taped and rated independently. There was 100% point by point agreement on all self care items. To ensure continued inter-rater reliability, two additional interviews were recorded by the principal investigator and scored independently by a second rater. One of these recordings could not be clearly understood and therefore was not rated. The other recording was rated and yielded a 92% point by point agreement on items. Where disagreements occurred, these were resolved via discussion and reference to the PEDI manual. Consensus scores were used in the analyses.

The MABC (Henderson & Sugden, 1992) was consistently administered by the PI. To ensure continued adherence to administration and scoring, every fifth assessment was observed by the treating occupational therapist and scored independently. Mean point by point inter-rater reliability was 78.1%, ranging from 62.5% to 100%. Where disagreements occurred, these were resolved via discussion and reference to the MABC manual. Consensus scores were used in the analyses.

Measurement of Predictive Variables

Two predictor variables were identified in this study: the motor skills of the children in the sample, and their sensory processing abilities. The motor skills of the children were measured using the Movement Assessment Battery for Children (MABC) (Henderson & Sugden, 1992). This is a standardized norm referenced tool designed to identify motor impairment in children aged 4 to 12 years. Skills evaluated include both fine motor and gross motor items, with total impairment scores and percentiles specified. Examples of the items include threading beads (timed), catching a bean bag, and balancing on one foot. There are three components; manual dexterity, ball skills, and balance. Test-retest reliability over a 2 week period is reported to be acceptable with 97% of 5-year-old children, 91% of 7-year-olds, and 73% of 9-year-olds scoring in the same category of impairment. Reliability in the current study was measured more stringently with point-by-point agreement. Cronbach's alpha has been reported as .75 for children with developmental coordination disorder (Civetta & Hillier, 2008).Validity studies have included comparison with the Bruininks-

Oseretsky Test of Motor Proficiency (r=.53), another test of motor skills. When children's scores were grouped into four levels of ability, analysis revealed a significant relationship between the two tests. Construct validity studies comparing the performance of typical children with those of children expected to have difficulties due to conditions such as learning disability, low birth weight, and prematurity indicate adequate validity using the quantitative portion of the test (Henderson & Sugden, 1992). The measure has been used with children with autism spectrum disorder in the literature (Green et al., 2002; Hilton, Wente, LaVesser, Ito, Reed, & Herzberg, 2007) and by the clinical agency in this study.

The MABC takes 20-30 minutes to administer to a well coordinated child of average intelligence, or longer for a child with significant motor difficulties. Testing can be completed over more than one session if the child becomes fatigued. Verbal instructions as well as task demonstration and a chance for the child to practice can be provided to ensure that the child understands what is required. All of the participants in this study were able to complete the MABC in one session of approximately 30-40 minutes, although some required a break partway through the test before returning to the remaining test items. Some children required simplified language and non-verbal gestures for giving instructions.

In this study, the percentile equivalent for the total impairment score was used to predict daily living skills. In addition, a qualitative rating scale was devised and used in this study, to capture the therapist's clinical impression of the children's motor abilities. For each item of the 8 items administered, the children were rated on a scale from 1 (no concerns) to 4 (some major concerns). See Appendix D for a copy of this rating scale.

Children's ability to process sensory information was measured using the Short Sensory Profile (Dunn, 1999). This norm referenced caregiver rating scale was developed for use with children between the ages of 3 and 10 years. It takes approximately 15 minutes to complete. Mothers or primary caregivers typically complete the profile. Sample items include 'limits self to certain [food] textures', 'seeks all kinds of movement and this interferes with daily routines', and 'responds negatively to unexpected or loud noises'. This instrument uses 38 items to determine children's ability to process a variety of sensory information across seven different factors, with performance categorized as typical (within one standard deviation of the mean), probably different (between 1 and 2 standard deviations either above or below the mean), or definitely different (two or more standard deviations above or below the mean) from that of typical children. These three category scores were used first to describe the sample and then again in the regression analysis. The SSP does not include items related to social/emotional abilities and fine motor development which are part of the full Sensory Profile, increasing the likelihood that scores on the measure of motor skills were independent of scores on the measure of sensory processing in this study. It also helped that the social/emotional deficits associated with autism did not confound measurement of sensory processing skills. Cronbach alpha is reported as .95. In the current study, Cronbach's alpha was .91. The test-retest and inter-rater reliability of the SSP has not been measured. The SSP discriminates between typical children and children with previously identified sensory processing difficulties (Dunn, 1999). The construct validity of the SSP was supported in a study comparing SSP scores with physiological measures of response to sensory stimulation (McIntosh, Miller, Shyu, & Hagerman, 1999).

Considerable research has been performed on the validity of the full version of the Sensory Profile. It consistently discriminates between typical children and those with a variety of disabilities, including autism, Attention Deficit Hyperactivity Disorder (ADHD), Asperger Syndrome, and Fragile X Syndrome (Baranek et al., 2002; Dunn & Bennett, 2002; Dunn, Myles, & Orr, 2002; Ermer & Dunn, 1998; Kientz & Dunn, 1997; Watling, Deitz & White, 2001).

The categories for the total SSP score (typical performance, probable difference, definite difference) were used in the regression analysis. Information related to the 7 factor scores was included for descriptive purposes.

Measurement of the Outcome Variable

The daily living skills of the children were measured using the Self Care Scale (functional skills) of the Pediatric Evaluation of Disability Inventory (PEDI) (Haley, Coster, Ludlow, Haltiwanger, & Andrellos, 1992). This scale uses 73 items in an interview format to address eating, grooming, dressing, bathing, and toileting skills. Responses are rated as either 'able' or 'unable' to perform skills. Sample items include 'uses a knife to butter bread, cut soft foods', and 'puts on and removes front-opening shirt, including fasteners.' Examples of specific groupings of items are included in Appendix E. This judgment based norm referenced instrument was developed for use with parents of children aged 6 months to 7 years 6 months of age and provides both standard scores and scaled scores of children's abilities. There were 126 children without disabilities in the normative sample between ages 5 and 7 years old. Standard scores were used in this study and have a mean of 50 and a standard deviation of 10. In terms of the test's reliability, internal consistency reliability using Cronbach's alpha coefficients range from .95 to .99; intraclass correlation coefficients for inter-interviewer reliability ranged from .96 to .99; and reliability for two respondents ranged from .74 to .96. In the current study, the internal consistency coefficient was .90. In terms of the concurrent validity of the PEDI, self-care scores were related to motor scores on the Battelle Developmental Inventory Screening Test with correlations of .85 to .93 for children with and without motor disabilities and .92 to the self-care domain of the Wee-Functional Independence Measure. Discriminant validity analyses indicated that the summary scores accurately predicted whether a child belonged to a non-disabled or clinical group, except for some scores in the infant age group (6 months to 2 years). Responsiveness to change has been examined in a cursory way indicating positive results to date (Haley, Coster, Ludlow, Haltiwanger & Andrellos, 1992). The interview takes an average of 20 minutes to complete. Only mothers were interviewed in this study to maintain consistency across interviews and to be consistent with respondent for the Short Sensory Profile.

Although the Vineland Adaptive Behavior Scales are frequently used in the literature to evaluate the adaptive functioning of children with ASD, the measure covers the broad concept of adaptive functioning, including social and communication skills, as well as practical daily living skills. There are a total of 41 items in the "caring for self" subscale with 23 items in the birth to 8 years grouping.

The PEDI Self Care scale was selected for this study as it focuses on specific daily living tasks and has considerably more items (n=73). There are several items that target skills appropriate to the age group of the current study and it includes items which are known to be problematic for children with ASD (e.g., toileting, hairbrushing). The PEDI is also useful clinically as it indicates the next skills the child will likely be developing.

CHAPTER 3: RESULTS

Motor Skills

On the MABC, the mean percentile rank was 13.15 (SD=16.40), with a range from 1 to 65 (see Table 4). The child who scored at the 65^{th} percentile was more than 3 standard deviations from the mean for the sample and could be considered an outlier (Munro, 2001). Therefore, the regression was run with this child included and excluded. On the MABC, scores at or below the 5^{th} percentile are considered to indicate a definite motor problem. Scores between the 5^{th} and 15^{th} percentile indicate a 'borderline' degree of motor difficulty. Scores at or above the 15^{th} percentile indicate adequate movement competence. Half of the children in this study have definite motor problems, based on the MABC scores, as shown in Table 3. In addition, means and standard deviations for scaled scores were calculated for Manual Dexterity, Ball Skills, and Balance, and are shown in Table 4. Children had the most difficulty with the manual dexterity items (higher scores indicate more impairment), followed by balance items. In terms of the qualitative rating scale results, children demonstrated the highest rating for therapist's concerns in the one leg balance item. The mean rating for this item on a scale from 1 to 4 (4 indicates major concerns) was 2.42, with a standard deviation of 1.17.

***Table 3:* Movement ABC Categories for Total Score (N=20)**

MABC Category	Frequency	Percentage
Definite Motor Problem (1st to 5th Percentile)	10	50.0
Borderline Motor Difficulty (6th to 15th percentile)	5	25.0
Adequate Movement Competence (16th percentile and above)	5	25.0

***Table 4:* Mean and Standard Deviation for Movement ABC components, scaled scores (N=20)**

MABC Component	Mean	SD
Manual Dexterity	7.15	2.82
Ball Skills	2.90	3.11
Balance	5.68	4.57

Five children in the sample scored in the typical range for motor skills, as measured on the MABC. To explore whether the scores of these 5 children had similar patterns of relationships, their scores and those of the children with atypical motor skills are described in Table 5 and 6. The 5 children did have higher scores on their daily living skills, as measured on the PEDI; however the scores are significantly higher. The proportion of children with scores in the definite difference category of the SSP are identical. Therefore, it appears that having typical versus atypical motor skills does not markedly alter the relationships with daily living skills for this small sample of children. A significant relationship might emerge with a larger sample of children with typical motor skills.

Table 5: **Daily Living Skills in Children with Typical vs. Atypical Motor Ability (n=20)**

Motor Ability	Mean M-ABC percentile rank	PEDI[a] standard score
Typical Motor (n=5)	36.4	35.78
Atypical Motor (n=15)	5.4	28.01

[a]Normative mean= 50, SD=10

Table 6: **Sensory Processing in Children with Typical vs. Atypical Motor Ability (n=20)**

	Short Sensory Profile category Frequency (%)		
Motor Ability	Typical	Probable Difference	Definite Difference
Typical Motor (n=5)	40.0%	20.0%	40.0%
Atypical Motor (n=15)	6.7%	53.30%	40.0%

Sensory Processing

On the Short Sensory Profile, 3 of the children scored in the 'typical performance' range (15.0 %), 9 in the 'probable difference' range (45.0 %), and 8 in the 'definite difference' range (40.0%) for the total score. Thus, with the exception of three children, these children with ASD were under or over responsive to sensory input from their environment in comparison to the responses of typical children. SSP scores were further examined in terms of category scores on seven factors. Frequency distribution of these category scores is shown in Table 5. Seventy percent of children scored in the typical performance category for movement sensitivity and visual/auditory sensitivity factors, indicating minimal differences from typical peers. The highest frequency for definite differences occurred on the auditory filtering factor, followed by under-responsive/seeks sensation and low energy/weak.

Table 7: **Frequencies for SSP factor category scores (N=20)**

SSP factor	Typical performance		Probable difference		Definite difference	
	Freq	(%)	Freq	(%)	Freq	(%)
Tactile sensitivity	6	(30%)	7	(35%)	7	(35%)
Taste/smell sensitivity	9	(45%)	5	(25%	6	(30%)
Movement sensitivity	14	(70%)	4	(20%)	2	(10%)
Under-responsive/seek sensation	6	(30%)	6	(30%)	8	(40%)
Auditory filtering	4	(20%)	5	(25%)	11	(55%)
Low energy / weak	10	(50%)	2	(10%)	8	(40%)
Visual / auditory sensitivity	14	(70%)	2	(10%)	4	(20%)

Daily Living Skills

On the PEDI Self Care scale, the mean normative standard score was 29.96 (SD=9.63), with scores ranging from 13.6 to 50.8. There were no scores that could be considered outliers. On the PEDI Self Care scale, the mean standard score is 50, with a standard deviation of 10. Scores less than 30, or 2 standard deviations below the mean, are considered to indicate a significant degree of difficulty. Therefore, this sample of children demonstrates below average daily living skills, based on the PEDI Self Care skill measure. The frequency of children's scores in terms of standard deviations from the mean is shown in Table 6.

Table 8: **PEDI Self Care Skill Standard Scores (N=20)**

PEDI Self Care Score*	Frequency	Percentage
41 and above	2	10
30- 40 (-2 SD to -1.0 SD)	8	40
0 to 29.9 (>-2.0 SD)	10	50

* PEDI Self Care normative standard score mean= 50; SD= 10

Correlations and Regressions

To explore relationships amongst variables and sample characteristics, Pearson's *r* correlations were calculated. Correlations are shown in Table 7. There was only a fair relationship (Colton, 1974) between the PEDI Self Care normative standard score, and the MABC percentile rank, $r\ (20) = .29$. Given these correlations, there was no concern about multicollinearity between the independent variables. A fair relationship was noted between non-verbal IQ and SSP category, $r\ (20) = .41$.

Table 9: **PEDI, SSP, & MABC Correlations (N=20)**

	SSP category	MABC percentile rank	Non-verbal IQ
PEDI Self Care standard score	-.23	.29	- .04
SSP category		-.12	.41
MABC percentile rank			.14

A multiple regression analysis was performed to determine whether motor ability (as measured by the Movement ABC percentile rank) and sensory processing ability (as measured by the Short Sensory Profile category into which the total score fell) are significant predictors of the outcome variable of daily living skill (as measured by the PEDI Self Care Functional Skill standard score). The variables were entered in two steps. Motor ability was entered first as it was felt to have the most direct link to self care skills. Motor ability accounted for 8% of the variance (p= .22). Sensory processing was entered in the next step and accounted for an additional 4% of the variance but the model was not significant (R^2 = .12, p = .34). The results of this analysis are shown in Table 8. Neither variable explained a significant portion of the variance in the PEDI Self Care standard score. MABC percentile rank scores accounted for more variance when entered first in the regression analysis than did SSP category scores. When SSP category scores were entered in the regression analysis first, they accounted for 5% of the variance.

***Table 10:* Summary of Hierarchical Regression Analysis of Motor Ability and Sensory Processing predicting Daily Living Skills (N=20)**

	Variable	Daily Living Skills (PEDI standard score)		
		B	*SE* B	β
Step 1	Motor Ability MABC percentile rank	0.17	0.13	.29
Step 2	Motor Ability MABC percentile rank	0.15	0.14	.26
	Sensory Processing	-2.64	3.08	-.20

Note. Adjusted R^2 = .04 for Step 1. ΔR^2 = .04 for Step 2

The analysis was re-run with the child whose MABC was markedly different from the scores of the other children in the sample. In this case, motor ability accounted for 7% of the variance (*p*= .29). Sensory processing was entered in the next step and accounted for an additional 4% of the variance. The model was not significant (*p*= .42).

The lower than expected relationship between motor skills, sensory processing, and daily living skills, prompted additional data analyses in order to better understand the results. First, the relationship between the MABC scores and daily living skills was examined in more depth. The MABC total score includes three components and use of the total score may obscure a relationship between specific components (manual dexterity, ball skills, and balance) and the PEDI self care scale standard scores. The relationship of MABC component scores and the PEDI has also been examined by Volman, Visser and Lensvelt-Mulders in children with Down's Syndrome (2007). In the current study, this relationship was explored by calculating

Pearson's r correlations. These results are shown in Table 9. The relationship between these motor components and overall self care skills continued to be weaker than expected.

Table 11: **The relationship between PEDI scores and MABC components (N=20)**

	PEDI self care standard score	Ball Skills	Balance
Manual Dexterity	-.24	.36	.44
Ball Skills	-.27		.47*
Balance	.21		

*Correlation is significant at the 0.05 level (2-tailed).

Further reflection on the nature of the motor skills and daily living skills evaluated raised the question of whether specific types of motor skills might be related to more specific self care items. For example, would the manual dexterity component score be related to self care skills which appear to require more specific manual dexterity skills rather than general motor skills? On the PEDI, these skills might include using utensils while eating, managing shoes and socks, or doing/undoing fasteners (buttons, snaps, zippers). As indicated in Appendix E, PEDI self care item scores were grouped into like items. Standard scores are not provided for these groupings. In the current study, a mean was computed for each of the three relevant grouping of items and Pearson r correlations were calculated with the manual dexterity scaled scores. As shown in Table 10, slightly stronger correlations were noted for these scores in the expected direction. Higher scores on the MABC components indicate more difficulty, while higher scores on the PEDI self care items indicate more proficiency.

Table 12: **The Relationship of MABC Manual Dexterity and PEDI items (N=20)**

	Manual Dexterity	Fasteners	Use of utensils
Shoes & socks	-.42	.33	.70*
Fasteners	-.18		.45
Use of utensils	-.51*		

*Correlation is significant at the 0.05 level (2-tailed).

This additional analysis indicates that although there is a minimal relationship between overall motor skills and overall self care skills for children with ASD, the relationships between specific motor components and discrete self care skills, such as between utensil use and manual dexterity, is stronger. However, it is clear that for this small sample of children with ASD the development of self care skills is not primarily dependent on motor skills.

Secondly, the relationships between discrete sensory factors on the SSP and self care skills were explored in more depth through additional data analysis using Pearson's *r* correlations. These correlations are shown in Table 11. It is clear that some SSP factor categories (movement sensitivity and visual/auditory sensitivity) have minimal relationship to self care. Although a slightly stronger relationship is noted between 'under-responsive/seeks sensation' and PEDI self care scores, the relationship is in an unexpected direction. Children who seek more sensation or who are more under responsive to sensation have higher scores on self care. None of the correlations are significant, indicating a minimal relationship between impairments on specific sensory factors and overall self care skills.

Table 13: **Correlations for SSP factor categories and PEDI Self Care Standard Score (N=20)**

	PEDI Self Care Standard Score
Tactile Sensitivity	-.27
Taste/Smell Sensitivity	-.27
Movement Sensitivity	.01
Under-responsive/ seeks sensation	.35
Auditory filtering	-.19
Low energy/ weak	-.21
Visual/ auditory sensitivity	-.05

To look at more specific relationships, PEDI self care item groupings were selected based on clinical experience and compared with the sensory factors that were most likely related to impairments in these self-care items. The PEDI item groupings were food textures, toothbrushing, hairbrushing, handwashing, and washing face and body as these are often targeted during treatment when working with children with ASD. Theoretically, tactile sensitivity and taste/smell sensitivities are viewed as related to impairments in these areas. As shown in Table 12, the correlations are stronger but none reach significance.

***Table 14:* Correlations between selected SSP factors and PEDI item groupings (N=20)**

	Tactile Sensitivity	Taste /Smell Sensitivity
Toothbrushing	-.15	.21
Hairbrushing	-.30	
Handwashing	-.14	
Washing face & body	-.42	
Food texture	-.11	-.42

The additional analyses provide a clearer understanding of the relationships between items on the three measures used in this study. The results indicate that expected relationships are present only at the level of specific items and factor scores or subscales. However, factor scores or subscales are less reliable than the total scores for the measures used. These additional analyses were exploratory only especially given the small sample size and the number of comparisons.

CHAPTER 4: DISCUSSION

Children with ASD have a variety of challenges that may affect their ability to manage their daily self care needs in a variety of contexts. This study considered two areas of challenges, sensory processing abilities and motor skills, and their relationship to self care for children who scored in the typical range for nonverbal intelligence. Very little variance in the daily living skills as measured by the PEDI Self Care scale was explained by the children's motor skills as measured on the MABC and sensory processing as measured on the SSP. Motor skills were expected to be most related to self-care skills based on the literature for children with other disabilities (Summers, Larkin, & Dewey, 2008). The relationship with sensory processing was less straight forward. These results lead to several interesting questions, as well as some intriguing implications for occupational therapy practice. However, first, the representativeness and the limitations of the sample and the measurement tools are considered.

Sample considerations

The small sample size is a key limitation and the results can only be described as suggestive and applied with caution. The sample size met the minimum required for a regression (10 participants per predictor variable; Munro, 2001). It is preferable to have a larger sample size so that the results are more likely to provide a stable prediction equation (Munro, 2001) and be less subject to the impact of individuals in the sample as well as to allow consideration of additional predictors. Power is low with a small sample and significant relationships may not be apparent. However, the magnitude of the correlations between variables was low, suggesting that an increased sample size would not alter the results of the regression analysis if indeed the sample is representative of children with ASD.

It is important to examine the composition of the study sample to determine the extent to which the sample is similar to or different from other samples of children with ASD. The distribution of gender (markedly more boys than girls) and age of diagnosis for the sample are consistent with other population samples (APA, 2000; Chakrabati & Fombonne, 2005). The sample does not represent the range of cognitive abilities typical of children with ASD as the children were screened to control for the possible effect of cognitive abilities on the outcome variable and to make the sample more homogeneous. Therefore, the results cannot be applied to children with ASD who have below average cognitive abilities. For example, Jasmin et al. (in press) noted that 71% of the children in their sample of children with ASD 3 to 4 years of age were delayed cognitively.

The sample also needs to be considered in terms of how the children's motor, sensory processing, and daily living skills compare to other samples of young children with ASD. As described in the literature review, studies consistently indicate the presence of significant motor difficulties in children with ASD. Manjiviona and Prior (1995) reported that 50% of their group of 12 older children with Asperger Syndrome, and 67% of their group of 9 children with autism showed significant motor impairment (age range 7 to 17 years). This is similar to the proportion of motor difficulties reported in the current study, where 50 % of the children displayed definite motor impairments. Green et al. (2002) described motor difficulties in all 11 of the older (age 6-5 years to 10-6 years) children with Asperger Syndrome they tested using the MABC. This result contrasts with the current study in which 25% of the children had adequate motor abilities. Green et al. (2002) also described the children with Asperger Syndrome in their sample as having particular difficulty with ball skills. In the current study, children struggled most with manual dexterity, and least with ball skills (see Table 4).

In terms of sensory processing, the literature supports the presence of sensory processing difficulties in children with autism, as does the current study sample. Tomcheck and Dunn (2007) reported that 95% of the 281 preschool children with Autism Spectrum Disorder in their sample in the United States showed definite or probable differences in their sensory processing using the Short Sensory Profile total score. Baker, Lane, Angley, and Young's (2008) study of 22 children with autism reported 82% of the children in the same range, also using the SSP. In the current study, 85% of children showed definite or probable differences in their sensory processing. Adamson, O'Hare, and Graham (2006) report significant differences in sensory processing (based on SSP scores) in a sample of 44 young children with ASD in Scotland. Rogers, Hepburn, and Wehner (2003) noted significant differences in sensory processing in their sample of 26 very young children with ASD. In addition, the current study found that the children most often displayed probable and definite differences on tactile sensitivity, under responsive/seek sensation, and auditory filtering factors. This is similar to Rogers, Hepburn, and Wehner's (2003) study in which children with autism were more impaired in their tactile sensitivity, auditory filtering, and response to taste/smell. In their study of 22 children with ASD, Baker, Lane, Angley, and Young (2008) also reported the greatest impairments for under responsive/seek sensation, and auditory filtering factors, as well as more typical performance on movement sensitivity (73%) and visual/auditory sensitivity (55%), similar to the current study.

The daily living skills of the participants in this study appear comparable to the limited results described in other studies. Szatmari, Archer, Fisman, Streiner, and Wilson (1995) report below average adaptive behavior scores using the Vineland Adaptive Behavior Scales in children with autism aged 4 to 6 years. Similar results were reported by Baker, Lane, Angley, and Young (2008), with low levels of performance across VABS domains. The PEDI was not reported as a measure of daily living skills in children with autism in other studies. Most studies reported daily living skills for older children.

In summary, although the sample size of the current study is small, it appears similar in many respects to other samples of young children with ASD. Therefore, the results are suggestive of trends within the population of young children with autism.

Measurement tools

It is also important to consider qualities of the measurement tools used in this research. As noted, the SSP has been used with many children with ASD (Adamson, O'Hare, & Graham, 2006; Rogers, Hepburn & Wehner, 2003; Tomchek & Dunn, 2007). The MABC has also been used with children with ASD (Green et al, 2002; Hilton, et al., 2007;). The accuracy of the MABC as a measurement of motor skills in children with ASD could be affected by some of their unique behaviors. For example, children can occasionally become 'stuck' on performing motor actions in particular ways rather than performing these actions according to standardized instruction. In this case, their low score may reflect a behavioral tendency rather than a motor skill. This would be a limitation in any standardized motor assessment with these children. The MABC was selected because it allows for extra instruction and demonstration to ensure that children understand what is expected of them, allowing accommodation for challenges with communication and behavior. In this study, only 3 of the children appeared to become stuck on performing some of the motor actions in particular ways, while the remainder of the children performed the actions as requested. Therefore, it appears that the behavior of the children did not interfere substantially with the accuracy of the MABC in measuring the motor skills of most of the children in this sample.

The PEDI has not been widely used with children with ASD. It is possible that this particular instrument does not accurately capture the functional daily living skills of children with ASD. The results are generally consistent with those of other comparable measures with this population of children. Jasmin et al. (in press) measured the daily living skills of young children with ASD using both the Functional Independence Measure for children (WeeFIM System) and Vineland Adaptive Behavior Scales. They noted that 49% of their sample scored more than 2 standard deviations below the mean on the WeeFIM, while the Daily Living Skills standard score on the Vineland was between 1 and 2 standard deviations below the mean. The self care domain of the WeeFIM and the DLS scale of the VABS were significantly correlated. Although the PEDI has not been used frequently with children with ASD, the results of the current study using the PEDI are similar to those reported in studies using other measures with 50% of the children scoring more than 2 standard deviations below the mean. Therefore it is likely that the PEDI provides a reasonable measure of the self care skills of children with ASD.

The scores on all of the measures were relatively low resulting in some skewing of the distributions. However, there was variability in the scores indicating that the lack of relationship between variables was not simply due to limited variation in the scores.

The accuracy of measures based on parent report is sometimes called into question because of the possibility of parents' bias in reporting. Streiner and Norman (2003) state that "questionnaires may end up over- or under-estimating the prevalence of a symptom or disease; or the validity of the scale may be seriously jeopardized." (p. 80) Caregiver rating scales are vulnerable to a variety of types of bias, including, 'faking good', 'faking bad', or central tendency bias (the tendency to avoid choosing responses at the extreme ends of a scale). They also depend on the respondent accurately understanding the questions and response alternatives, which may be affected by the person's literacy or level of education, thus introducing the possibility of socioeconomic bias (Streiner & Norman).

Despite the possibility of these sources of bias, other authors emphasize the reliability of parent report. Wilson, Kaplan, Crawford, Campbell and Dewey (2000) describe that "parent report of children's skills and deficits has consistently been shown to be a sensitive, reliable, and valid source of information" (p. 485). It can also be a time effective method offering the advantage of obtaining qualitative, accurate information from the child's natural environment.

In this study, the possibility of parent bias on the PEDI is lessened through its administration by the PI, allowing for clarification of both questions and responses through providing and eliciting examples. The possibility of parent bias on the SSP exists, as described previously. Still, this particular measurement tool has been well researched and used extensively.

Relationship between Motor Skills, Sensory Processing, and Daily Living Skills

Another question to consider is the nature of the relationships discovered amongst the variables. The small correlation (r=.29) between the MABC percentile scores and the PEDI self care scores provides little support for the hypothesis that motor skills are directly related to daily living skills. More age appropriate motor skills are somewhat related to more age appropriate daily living skills. The strength of the relationship is smaller than expected based upon earlier research (Haley, Coster, Ludlow, Haltiwanger, & Andrellos, 1992) for children with other disabilities. For 3 and 4 year old children with ASD, Jasmin et al. (in press) report a significant relationship (r= .45) between fine motor skills and daily living skills. Their sample had a significant proportion (71%) of the children with cognitive delays and they used the Peabody Developmental Motor Scales (Folio & Fewell, 2000), a measure that allows fine and gross motor skills to be separated. In this study, the total impairment score for the MABC was used as there is no direct equivalent for fine motor and gross motor skills on the MABC. However, Case-Smith (1995) found little relationship between fine motor skill and functional performance in preschool children with delayed motor skills. This leads to the question of what other factors are important to consider when targeting the daily living skills of young children with ASD and why the relationship might be different for children with different disabilities.

As stated in the literature review, the relationship between sensory processing and daily living skills has been examined on a limited basis for children with ASD. Baker, Lane, Angley, and Young (2008) reported a correlation of .43 between the total score on the SSP and the Vineland Adaptive Behavior Scales daily living skills for a similar sized sample of children ages 2 years- 9 months to 8 years- 5 months which is higher than the relationship in this study ($r = .23$). Their sample was not limited to children with typical cognitive development. Baranek et al. (2002) examined the connection between sensory processing and occupational performance in Fragile X children, concluding that multiple factors played a role, with sensory processing factors an insufficient explanation for the children's difficulties with occupational performance. The current study corroborates the findings of Baranek et al. (2002) in a sample of young children with autism. Similarly, Jasmin et al. (in press) found no significant relationship between sensory processing as measured on the SSP and daily living skills as measured on the Vineland Adaptive Behavior Scales but a significant relationship with self care on the WeeFIM ($r = .32$). Even for the Baker and colleagues study, the correlation was significant but indicated that there were still other factors related to daily living skills.

Additional analysis of the current study's results indicated that there is some relationship between more discrete motor components and specific self care skills. For example, the manual dexterity component score correlated more strongly with managing shoes and socks, and utensil use, than the MABC overall score did with the

PEDI overall score. Similar analysis of sensory factors did not reveal stronger relationships between discrete sensory factors and specific self care skills. Therefore, it is important to consider what other variables may have more impact on how children with ASD learn and perform daily living skills when cognitive impairments are not present.

Relationship of self care skills and other variables

The smaller than expected relationship noted amongst the independent and dependent variables leads us to the question of what other variables might be important. The person (child)-environment-occupation (task) model used in occupational therapy practice suggests some other factors within the child, environment, and task which may affect the individual's ability to perform daily living activities (Baum & Baptiste, 2002). In the case of children with ASD, a factor within the child that warrants consideration is their behaviour, which was not measured in the current study. Children with ASD, by definition, have "restricted repetitive and stereotyped patterns of behaviour, interests, and activities" (p. 71) which may include an intense interest, inflexible adherence to routines, repetitive motor mannerisms, or preoccupation with parts of objects (APA, 2000). These characteristics could significantly influence the actions of children with ASD while performing activities of daily living. Rogers, Hepburn, and Wehner (2003) found that the total sensory score on the SSP was correlated with a measure of repetitive/restricted behavior in children with autism. Baker, Lane, Angley and Young (2008) also found that poor sensory processing ability was associated with higher levels of behavioral/emotional problems. Since the current study did not indicate a strong relationship between overall sensory processing and daily living skills, exploring a more direct relationship between repetitive or restricted behavior and daily living skills may be helpful. Gabriels, Cuccaro, Hill, Ivers, and Goldson (2005) found that the presence of repetitive behavior and a high level of hyperactivity were associated with lower adaptive functioning, as measured by overall adaptive behavior on the VABS. The relationship specifically with daily living skills was not examined.

Impaired development of communication and social interaction are typically considered primary features of ASD (APA, 2000). These factors may also be important in developing the daily living skills of children with ASD. Communication and social skills were not measured in the current study although the higher non-verbal cognitive ability of the participants in the current study could be expected to be associated with stronger language abilities. Stronger communication skills can affect daily living skills as children are better able to understand directions, or communicate their preferences and challenges in learning or completing tasks. As described in the literature review, Liss et al. (2001) reported that language and verbal memory were strong predictors of adaptive behavior (based on the DLS of the VABS) in a higher functioning group of children with ASD.

Other additional factors within the child that are not specifically part of the diagnostic criteria for ASD include attention and motivation. Motivation can be an important factor, in that self-care skills may not necessarily be inherently rewarding to children with ASD especially if some self care skills are particularly challenging. Typically developing children are motivated to push for autonomy and a desire to perform tasks on their own even when their skills are just developing. There is pride associated with achieving self care skills such as tying shoe laces. Children with ASD may be less motivated by this sense of accomplishment, or by social approval. Attentional issues can affect the child's ability to start and/or complete tasks such as daily living skills. Children with ASD often struggle with focus and attention.

Environmental factors were not addressed directly in this study. There is a large amount of variation in the environment of each of these children, where daily living skills are practised in the context of their home. Each home varies in terms of the distractions or time constraints, parent expectations of the child, or presence of other caregivers (e.g., grandparents, nanny). This study did not specifically measure the amount or type of caregiver assistance provided to the children. It may be that parents typically do tasks for the child because it is easier in light of the other challenges within the family. The presence of other older siblings may affect these skills, either in providing an appropriate model of self care skills, or in having an additional person to help the child.

Factors within the tasks were also not addressed. These could include the type of garment for dressing activities, the amount of structure provided to the child (for example, laying out clothes as opposed to leaving them within drawers), or the exposure and experience the child has had with the task. Within occupational performance models, many factors are thought to contribute to the performance of complex occupational behaviors, with the relative importance of the factors not necessarily specified. Exploring other factors within the child, environment or task that may also affect the child's ability to successfully perform daily living tasks is an important direction for future research.

Implications for Practice

In occupational therapy practice with children with ASD, it is common to ask parents to complete a SSP or a full Sensory Profile. Motor skills are also frequently addressed. The current study supports the need for therapists to consider factors within the person, environment, and task when focusing on treatment goals related to improving children's daily living skills. The study results imply that assessing and addressing the child's overall motor skills and overall sensory processing may improve motor skills and identify ways to accommodate sensory aversions but addressing these areas will likely have minimal direct impact on the development of the child's daily living skills. As Hillier states, "there is evidence to support the idea that what is trained is what is improved, whether that be sensory based or motor skill based" (Hillier, 2007, p. 9). In other words, treatment needs to be focused on the specific tasks that comprise the treatment goal and not the underlying skills. If the goal of intervention is to ensure that the child can manage the daily living skills that are required in a kindergarten or elementary school setting then these skills need to be directly addressed. If the goal is to improve specific motor skills (e.g., ball skills), then motor skills need to be addressed.

The additional exploratory data analysis in this study indicated that there may be a link between specific fine motor components (e.g., manual dexterity) and specific self care skills (e.g., use of utensils, managing shoes which includes tying shoe laces). The link between specific sensory processing factors and specific self care skills was more limited (e.g., tactile sensitivity and washing face/body) in this study. It may be useful to address the specific motor skills associate with specific tasks. For example, to improve utensil use, strengthening or improving the precision of specific hand and finger muscles may be valuable. However, given the challenges that children with ASD have with generalization of skills, it will be important to also focus on the specific self-care skill that is challenging.

A complementary treatment approach has been growing within the field of occupational therapy and warrants consideration in light of the current study's results. This treatment framework was developed for use with children with a diagnosis of Developmental Coordination Disorder (DCD) between 7 and 12 years of age (Taylor, Fayed, & Mandich, 2007). The Cognitive Orientation to daily Occupational Performance (CO-OP) is a "task-orientated problem solving approach which uses cognitive skills to improve the child's motor performance during daily occupations" (Ward & Rodger, 2004, p.257). Within this approach, children (and their parents) identify specific tasks and goals to target, and apply cognitive strategies in learning these tasks. Key elements in this approach include the child's attention, motivation, and ability to evaluate his or her own performance (Ward & Rodger, 2004). This approach has not been applied to children with ASD to date. Ward and Rodger (2004) applied this approach to two young boys aged 5 to 7 years with DCD. They used the approach successfully, improving their task performance including a task of daily living (dressing, cutting food with a knife). The children in their study displayed significant motor difficulties, and fell within 1 standard deviation of the mean based on the K-BIT. In the field of children with DCD, intervention using the CO-OP has been found to be effective (Taylor, Fayed, & Mandich, 2007; Ward & Rodger, 2004), while research on the efficacy of other treatment approaches is inconclusive to date (Hillier, 2007; Sugden, 2007).

Application of such an approach to the population of children with ASD warrants exploration for two reasons. First, this approach may be particularly well suited to those ASD children with approximately average cognitive ability, such as those within the current study. This approach may capitalize on these children's cognitive strengths, allowing them to master daily living skills which may be challenging. The benefit of such an approach is its 'top-down' orientation, rather than a 'bottom-up' approach that focuses initially on components such as motor ability and sensory processing, which were found to contribute to daily living skills less than expected in the current study. Secondly, this approach supports a focus on specific tasks, rather than on global skill development. This connects well with the findings regarding task specific relationships noted in the current study (e.g., manual dexterity and utensil use).

Directions for Future Research

This study points to the need for additional research to better understand the relationships between the motor skills, sensory processing ability, and daily living skills of young children with ASD. A larger sample size would increase the reliability and power of the results. Measurement is a challenge in working with children with ASD, due to their difficulty understanding language and instructions, and their difficulty responding in requested ways due to their tendency toward restricted repetitive behavior. To address this challenge, using a variety of measures may be helpful. For example, combining a standardized motor assessment with a caregiver checklist of motor skills may provide corroboration of children's functional motor skills. In addition, using a measure of motor skills which allows gross and fine motor skills to be delineated would be helpful.

The relationship between discrete motor and sensory factors and specific daily living skills warrants further exploration. In addition, the relationship between other factors within the child, such as the primary features of ASD (social interaction and communication; repetitive, restrictive behavior,) and children's daily living skills requires investigation. The role of executive function in tasks such as daily living skills may also be a promising factor to consider in future research.

CHAPTER 5: CONCLUSION

Within the occupational performance model, factors within the person, or child, are described as contributing to the performance of daily occupations. In this study, the relationship of the motor and sensory processing skills of children with ASD with their daily living skills was explored. Although minimal relationship between overall motor and sensory processing skills, and overall daily living skills was apparent, some specific relationships were noted. The role of other factors within the child must be considered in addressing the development of daily living skills in this group of children. Specifically, the role of cognitive ability and the repetitive and restricted behaviors that are unique to ASD, as well as the social and communication difficulties of these children warrant consideration when addressing self care skill treatment goals. These factors should also be considered in designing future research.

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APPENDIX A: INFORMATION LETTER

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Sensory Motor Factors and Daily Living Skills of Children with Autism Spectrum Disorder

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Purpose of this study

The purpose of this study is to see if the motor and sensory skills of children with Autism Spectrum Disorder are important factors in their daily living skills. This information will help therapists provide better services for children with Autism Spectrum Disorder.

What will happen?

If you agree to be in the study, your child's occupational therapist will interview you about your child's daily living skills at your home or at the LEAD office. The interview takes about 20-30 minutes. You will also complete a questionnaire concerning your child's ability to deal with sensory information. This takes about 30 minutes. Your child will complete an assessment of his/her motor skills at the LEAD office. This assessment takes about 30-40 minutes. It will be done in 1 or 2 sessions depending on your child. You will also be asked to give some information about your child and family. If you agree, we will obtain information about your child's cognition and language from the LEAD file. This will help us describe the children. For children without a cognitive assessment, we will do a short cognitive screening task with your child that takes about 5 to 10 minutes. The interview, questionnaire, and motor assessment are part of your child's typical occupational therapy program. The results of the motor, sensory, and daily living skills assessments will be discussed with you and will be part of your child's file at LEAD. The only difference from your child's usual program is that the results will also be seen by me. The results from several children's assessments will be analyzed together.

Confidentiality

Your answers on the interview and questionnaire and your child's assessment results will be kept confidential by removing all names. The exception is when professional codes of ethics or the law require reporting. In that case we cannot uphold your right to confidentiality and privacy. By signing the consent form you give permission to the study staff to access any personally identifiable health information which is under the custody of other health care professionals as deemed necessary for the conduct of the research. We will keep the forms and questionnaires in locked file cabinets separate from the consent forms for at least five years. We might look at the information again in the future. If so, the ethics board will review the study to ensure we use the information ethically.

Risks and Benefits

There may or may not be any direct benefits for you or your child by being in this study. We hope that other parents and children will benefit from what we learn from you. There are no risks that differ from the usual assessment and treatment of your child.

It's your choice

You can choose not to participate in the study. If you decide not to participate, this will not affect your child's treatment. If you do participate, you have the right to refuse to answer any question. You are free at any time to withdraw from the study. We would be happy to give you a summary of the findings when we are finished the study.

If you have any concerns about any aspect of this study, you may contact the Associate Dean of Research, Faculty of Rehabilitation Medicine at (780) 492-9674 by calling collect. This office has no affiliation with the study investigators.

APPENDIX B: CONSENT FORM

UNIVERSITY OF ALBERTA

Department of Occupational Therapy
Faculty of Rehabilitation Medicine

2-64 Corbett Hall
Edmonton, Alberta, Canada T6G 2G4
www.ot.ualberta.ca
Tel: 780.492.2499
Fax: 780.492.4628

CONSENT FORM

Project Title: **Sensory Motor Factors and Daily Living Skills of Children with Autism Spectrum Disorder**

Principal Investigator: Susan Robinson, B.Sc.O.T., O.T.(C)
Occupational Therapy, University of Alberta
403 270-7912

Co-Investigator: Joyce Magill-Evans, Ph.D.
Professor, Occupational Therapy, University of Alberta
403 492-0402

Do you understand that you and your child have been asked to be in a research study?	Yes	No
Have you read and received a copy of the attached Information Letter?	Yes	No
Do you understand the benefits and risks involved in taking part in this research study?	Yes	No
Have you had an opportunity to ask questions and discuss this study?	Yes	No
Do you understand that you are free to refuse to participate or withdraw from the study at any time? You do not have to give a reason and it will not affect you or your child's care.	Yes	No
Has the issue of confidentiality been explained to you? Do you understand who will have access to your records/information, including personally identifiable health information?	Yes	No
Would you like a report of the research findings when the study is done?	Yes	No

This study was explained to me by: ______________________ Date: __________

I agree to take part in this study.

______________________ ______________________
Signature of Parent Witness (if available)

______________________ ______________________
Printed Name Printed Name

I believe that the person signing this form understands what is involved in the study and voluntarily agrees to participate.

______________________ ______________________
Signature of Researcher Printed Name

APPENDIX C: INFORMATION QUESTIONNAIRE

UNIVERSITY OF ALBERTA

Department of Occupational Therapy
Faculty of Rehabilitation Medicine

2-64 Corbett Hall www.ot.ualberta.ca
Edmonton, Alberta, Canada T6G 2G4

Tel: 780.492.2499
Fax: 780.492.4628

Information Questionnaire

Information about your child:

Gender: ☐ Male ☐ Female

Diagnosis:
- ☐ Autism
- ☐ Pervasive Developmental Disorder, Not Otherwise Specified (PDD NOS)
- ☐ Asperger's Syndrome
- ☐ Other: (please specify) ____________________

Who diagnosed your child ________________________________

Age at diagnosis: _______ years

Number of years in treatment or intervention: _______ years

Medication:
- ☐ yes (please specify__________________)
- ☐ no

Information about parent and family:

Level of education:
- ☐ some high school
- ☐ completed high school
- ☐ specialized training (e.g., SAIT; apprenticeship)
- ☐ some college/university
- ☐ undergraduate degree
- ☐ graduate degree

Ethnic background:
- ☐ First Nations
- ☐ Asian
- ☐ East Indian
- ☐ Hispanic
- ☐ African American
- ☐ Caucasian
- ☐ Other (please specify) ____________________

Number of children:

Date: ____________

APPENDIX D: M-ABC QUALITATIVE RATING SCALE

M-ABC: Age Band 4-6 years QUALITATIVE SCORING SCALE

POSTING COINS
Please circle the appropriate number regarding the quality of performance:

1	2	3	4
No concerns	A few minor concerns	Several minor concerns	Some major concerns

THREADING BEADS
Please circle the appropriate number regarding the quality of performance:

1	2	3	4
No concerns	A few minor concerns	Several minor concerns	Some major concerns

BICYCLE TRAIL
Please circle the appropriate number regarding the quality of performance:

1	2	3	4
No concerns	A few minor concerns	Several minor concerns	Some major concerns

CATCHING BEANBAG
Please circle the appropriate number regarding the quality of performance:

1	2	3	4
No concerns	A few minor concerns	Several minor concerns	Some major concerns

ROLLING BALL INTO GOAL
Please circle the appropriate number regarding the quality of performance:

1	2	3	4
No concerns	A few minor concerns	Several minor concerns	Some major concerns

ONE-LEG BALANCE
Please circle the appropriate number regarding the quality of performance:

1	2	3	4
No concerns	A few minor concerns	Several minor concerns	Some major concerns

JUMPING OVER CORD
Please circle the appropriate number regarding the quality of performance:

1	2	3	4
No concerns	A few minor concerns	Several minor concerns	Some major concerns

WALKING HEELS RAISED
Please circle the appropriate number regarding the quality of performance:

1	2	3	4
No concerns	A few minor concerns	Several minor concerns	Some major concerns

M-ABC: Age Band 7-8 years QUALITATIVE SCORING SCALE

PLACING PEGS
Please circle the appropriate number regarding the quality of performance:

1	2	3	4
No concerns	A few minor concerns	Several minor concerns	Some major concerns

THREADING LACE
Please circle the appropriate number regarding the quality of performance:

1	2	3	4
No concerns	A few minor concerns	Several minor concerns	Some major concerns

FLOWER TRAIL
Please circle the appropriate number regarding the quality of performance:

1	2	3	4
No concerns	A few minor concerns	Several minor concerns	Some major concerns

ONE-HAND BOUNCE AND CATCH
Please circle the appropriate number regarding the quality of performance:

1	2	3	4
No concerns	A few minor concerns	Several minor concerns	Some major concerns

THROWING BEAN BAG INTO BOX
Please circle the appropriate number regarding the quality of performance:

1	2	3	4
No concerns	A few minor concerns	Several minor concerns	Some major concerns

STORK BALANCE
Please circle the appropriate number regarding the quality of performance:

1	2	3	4
No concerns	A few minor concerns	Several minor concerns	Some major concerns

JUMPING IN SQUARES
Please circle the appropriate number regarding the quality of performance:

1	2	3	4
No concerns	A few minor concerns	Several minor concerns	Some major concerns

HEEL-TO-TOE WALKING
Please circle the appropriate number regarding the quality of performance:

1	2	3	4
No concerns	A few minor concerns	Several minor concerns	Some major concerns

APENDIX E: PEDI ITEM GROUPINGS

PEDI item groupings

Use of utensils
- finger feeds
- scoops with a spoon and brings to mouth
- uses a spoon well
- uses a fork well
- uses a knife to butter bread, cut soft foods

Fasteners
- tries to assist with fasteners
- zips and unzips, doesn't separate or hook zipper
- snaps and unsnaps
- buttons and unbuttons
- zips and unzips, separates and hooks zipper

Shoes and Socks
- removes socks and unfastened shoes
- puts on unfastened shoes
- puts on socks
- puts shoes on correct feet; manages Velcro fasteners
- ties shoelaces

Toothbrushing
- opens mouth for teeth to be brushed
- holds toothbrush
- brushes teeth; but not a thorough job
- thoroughly brushes teeth
- prepares toothbrush with toothpaste

Hairbrushing
- holds head in position while hair is combed
- brings brush or comb to hair
- manages tangles and parts hair

Handwashing
- holds hands out to be washed
- rubs hands together to clean
- turns water on and off, obtains soap
- washes hands thoroughly
- dries hands thoroughly

Washing body & face
- tries to wash parts of body

- washes body thoroughly, not including face
- obtains soap (and soaps washcloth, if used)
- dries body thoroughly
- washes and dries face thoroughly

Food texture

- eats pureed/blended/strained foods
- eats ground/lumpy foods
- eats cut up/chunky/diced foods
- eats all textures of table food