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ORIGINAL PAPER

A Pilot Study Examining Activity Participation, Sensory Responsiveness, and Competence in Children with High Functioning Autism Spectrum Disorder

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Abstract This pilot study explored activity patterns in children with and without ASD and examined the role of sensory responsiveness in determining children's level of competence in activity performance. Twenty-six children with high functioning ASD and twenty-six typically-developing children 6–12 years old were assessed using the Sensory Profile and the Child Behavior Checklist. Results reflect differences in the types of activities and jobs/chores engaged in by children with ASD compared to children without ASD. Significant differences were seen in overall level of competence in activities, social, and school performance. Children demonstrating more frequent Sensory Sensitivity and Sensory Avoiding had significantly lower competence scores than children with fewer behaviors in these domains, suggesting that sensory responsiveness may impact the ability to participate successfully.

Keywords Autism · Sensory processing · Sensory responsiveness · Participation · Competence · Occupational therapy

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Autism Spectrum Disorder (ASD) is a diagnostic condition familiar to many rehabilitation professionals. Due to impairments in social skills, language and behavior, families often seek therapy to ameliorate deficits which impact their child's ability to perform meaningful activities (Green et al. 2006). While research has shown differences in levels of participation (Hilton et al. 2008; Orsmond et al. 2004; Solish et al. 2010), few studies have explored differences in the types of activities children with high functioning ASD engage in compared to typically developing peers. Further, the role of sensory responsiveness has not been fully explored as a contributor to overall competence in this population of children. The aims of this study were therefore to explore activity patterns (i.e. play/leisure pursuits and home chore performance) in children with and without ASD and to investigate the role of sensory responsiveness in determining children's level of competence in their participatory roles.

Literature Review

Participation in Autism Spectrum Disorders

Participation in meaningful activities provides the context in which children acquire the physical and social competencies needed to develop and flourish in their homes and communities (Brown and Gordon 1987; King et al. 2003; Kinney and Coyle 1992; Lyons 1993). Impairments in social and motor skills have been hypothesized to interfere with a child's ability to participate in meaningful activities (Kopp et al. 2010; Orsmond et al. 2004). Within the autism spectrum, limitations in imaginative play, the ability to make friends or learn new motor skills, as well as sensory-based impairments are often associated with the disorder

(For review see Hughes 2009). Therefore a cyclical pattern may exist where social, motor, and sensory deficits associated with the autism spectrum limit participation, and restrictions in participation further exacerbate underlying ASD symptomatology.

Deficits in social interactions and the development of social relationships are often extensive and profound in ASD. Failure to seek out or develop typical peer relationships compromises opportunities to engage in and learn from social activities. Research on children with ASD has described the direct effect limited social skill acquisition has on play interactions and participation in functional and symbolic play (Loftin et al. 2008; Orsmond et al. 2004; Harper et al. 2008). These difficulties are observed early in development (Naber et al. 2008) and often continue to increase as the child ages (Wimpory et al. 2007; Hilton et al. 2008). Orsmond et al. reported on the factors that influence participation in social and recreational activities for adolescents and adults with ASD. Based on their study of over 180 adolescents, limited participation in socializing activities and attending social events was reported. Numerous individual and environmental factors, such as greater functional independence, reciprocity skills and maternal participation, along with school inclusion were reported to predict participation. In children with higher functioning ASD, it has also been reported that circumscribed interests or intense preoccupations interfere with the development of social relationships and limit participation (Boyd et al. 2007; South et al. 2005). Solish et al. (2010) found that children with autism participated in fewer social and recreational activities than their typical peers, and their participation tended to involve parents or caregivers, rather than peers. Hilton et al. (2008) focused on social impairment in relation to participation, but noted that competence may also have a role, especially in social and physical activities, and that children with autism may choose to limit engagement in these types of activities because of their social and motor deficits. To our knowledge, no authors have actually focused on the relationship between competence and participation in children with ASD.

While not as frequently reported as social deficits, motor impairments have been widely identified in children with ASD (Fournier et al. 2010; Ming et al. 2007). Early-life studies suggest that motor deficits may be evident in very young children with ASD, and may serve as early markers of the disorder (Teitelbaum et al. 2004; Baranek 1999). These impairments in gross and fine motor coordination, postural instability, and performance on tests of motor proficiency may be important to consider in relation to the child's ability to participate in a range of developmentally appropriate tasks. Few studies, however, have examined how impairments in motor skills translate to participation in meaningful activities. Jasmin et al. (2009) found significant correlations between areas of motor performance and daily living skills in a group of preschoolers with ASD. Similarly, Kopp et al. (2010) found a relationship between motor coordination and ability to perform daily life skills in school-age girls with ASD. These studies, though preliminary, suggest that motor skill and coordination may be important to consider when examining successful participation in self-care activities at home. Successful participation in school tasks is also often dependent on motor skills, specifically fine motor skills used for written communication. Children with ASD have been shown to perform worse on handwriting tasks than age and IQ matched controls and motor skills have been shown to significantly predict handwriting performance in this population (Fuentes et al. 2009). Therefore, the ability to participate in school and household tasks in a competent manner may be influenced by underlying abilities in motor coordination and fine and gross motor skill.

Participation in household tasks is important for promoting family cohesion, social participation, and responsible behavior, all vital areas for childhood development and independent living (Larson 2004; Hofferth and Sandberg 2001). Unfortunately little information is available in the literature regarding children with ASD and their participation in household tasks. Participation in household chores requires physical and cognitive skills, including joint attention, imitation, safety awareness and compliance in following instructions. These are skills with which children with ASD typically have difficulty (Ducharme and Drain 2004; Hume et al. 2009). The requirement of constant parental support, redirection and structure necessary for children with ASD to initiate, maintain and complete requested chores may also limit their participation. Moreover, oppositional behaviors often seen in children with ASD may increase when challenging or demanding conditions are place on them.

Sensory Responsiveness- Role in Participation and Competence

While sensory symptoms are not currently identified as core features of autism spectrum disorders, there is research to suggest that sensory symptoms may contribute to some of the academic difficulties and functional delays often seen in this population (Ashburner et al. 2008; Jasmin et al. 2009). Jasmin et al. (2009) examined the relationship between sensory responsiveness and daily living skills in children with autism aged 3–4 years old. In this study an atypical pattern of sensory responsiveness, specifically the tendency to avoid certain sensations, was inversely related to a child's ability to perform such self-care skills as dressing, bathing and toileting. Ashburner et al. (2008)

identified associations between cognitive problems/inattention and sensory domains of tactile sensitivity, auditory filtering, and under-responsivity/sensation seeking in children with autism. Overall academic performance was also associated with auditory filtering and under-responsivity/sensation seeking. The collective results of these studies suggest that children with ASD may have a difficult time filtering out unimportant sensory information, such as unpleasant tactile input or background noise, and registering or prioritizing the more salient information needed to participate effectively in school-based tasks.

According to the Dunn Model of Sensory Processing, atypical responses to sensory stimulation can be sub-classified based on neurological threshold and corresponding behavioral responses to stimuli (Dunn 1999). Based on this model, individuals with a low neurological threshold will be more sensitive to sensation and will either have an exaggerated behavioral response when faced with unpleasant stimuli (Sensory Sensitive) or attempt to avoid sensations or environments deemed noxious (Sensory Avoiding). Conversely, individuals with a high neurological threshold may require either a higher intensity or frequency of input to register the sensation (Low Registration), or seek out additional sensory input in order to maintain optimal levels of arousal (Sensation Seeking). Both Sensation Seeking and Sensory Avoiding are seen as *active* strategies used to change tonic threshold levels; this is in contrast to Sensory Sensitive and Low Registration patterns which are believed to be *passive* approaches to dealing with stimuli in the environment.

Based on parent report, children with ASD demonstrate behaviors associated with both high and low sensory thresholds, sometimes in combination (Baranek et al. 2006; Leekam et al. 2007; Tomchek and Dunn 2007). Individuals whose inability to generate appropriate behavioral responses to sensory stimuli which significantly impacts their ability to participate in meaningful and developmentally appropriate tasks are believed to have a Sensory Modulation Disorder (SMD) (Miller et al. 2007). While SMD and ASD are considered separate conditions (Reynolds and Lane 2008; Schoen et al. 2009), the rate of co-occurrence has been estimated between 60–90% (Baranek et al. 2006; Leekam et al. 2007). This is supported by Lane et al. (2010), who found that 87% of children with autism exhibited sensory processing challenges, and that general sensory modulation dysfunction was predictive of maladaptive behaviors.

Study Aims and Hypotheses

The first aim of this study was to explore activity patterns in children with and without ASD. It was hypothesized that children with ASD would show different patterns of activity participation and chore performance compared to typically developing children. We further hypothesized that children with ASD would show an overall lower level of competence compared to children without ASD. A second aim of this study was to investigate the role of sensory responsiveness in determining children's level of competence. It was hypothesized that greater deficits in Low Registration and Sensory Sensitivity would be characteristic of an overall lower level of competence. These quadrants were selected since they are considered passive methods in Dunn's model, and it was hypothesized that children who used more active strategies would 1) be more likely to participate in activities and 2) be more successful in their attempts to participate.

Methods

Sample

A cross-sectional design was used to explore activity participation and competence in children with high functioning ASD between the ages of 6 and 12 years. All aspects of the study were approved by the sponsoring university's Institutional Review Board prior to initiating participant recruitment. Children with ASD were recruited via flyers and e-mail blasts sent out through the Interactive Autism Network. Typical children were recruited via flyers and word of mouth. All potential participants were screened by phone prior to enrolling in the study. Phone interviews with parents were conducted to ensure that children met inclusion criteria; for the ASD group, phone interviews were used to verify that the ASD diagnosis had been given by a licensed psychologist or psychiatrist using standardized tools (i.e. the Autism Diagnostic Interview [ADI] or the Autism Diagnostic Observation Schedule [ADOS]) (Lord et al. 1994, 2002). These tools are considered the gold standard for diagnosing ASD and provided us with assurance that the child had been given a thorough evaluation. Parents of children with ASD were asked to provide researchers with a copy of documentation verifying ASD diagnosis. A total of 27 children with ASD met the inclusion criteria and were enrolled in the study. A control group of 28 children aged 6–12 years, without either ASD or SMD, were recruited through informational flyers and via word of mouth. Siblings of children with ASD were excluded from the control group as were children with identified psychological disorders (e.g. ADHD, bipolar disorder, or anxiety disorder). For both groups, children with significant motor impairments such as cerebral palsy, history of seizures, or any known endocrine or metabolic dysfunctions were excluded. Further, children with IQ scores below 70 were excluded from the study. The cut

point of 70 was used because (1) the goal was to examine children with only high functioning ASD, and (2) this was part of a larger study which examined physiological levels of sensory responsiveness, and children with IQ levels below 70 have been shown to have variations in their sympathetic nervous system response to stressful stimuli (Fernhall and Otterstetter 2003; Nomura et al. 1997). All children were screened by the examiners for normal intelligence using the Leiter-R non-verbal scale of intelligence (Leiter-R).

Procedures

Upon determining eligibility to participate, parents were mailed a Sensory Profile (Dunn 1999), the Child Behavior Checklist (CBCL) (Achenbach and Rescorla 2001), the informed consent and assent, and a short form requesting demographic information such as the child's age, gender, and race. All forms were delivered by the parents during a visit to our lab where the IQ testing was completed. At that time the consent/assent forms were signed and parents had the opportunity to ask additional questions. The researchers also reviewed the completed Sensory Profile and the CBCL with the parents during this visit, and attempted to clarify any missed items or items in which parents were unsure how to respond.

Measures

Child Behavior Checklist: Competence Scales

The school-age Child Behavior Checklist (CBCL) is part of the Achenbach System of Empirically Based Assessments and was designed for children ages 6–18 years (Achenbach and Rescorla 2001). The CBCL is completed by parents or caregivers who observe the children in their natural environments. Overall, the CBCL has been shown to significantly ($p < .01$) discriminate between referred and non-referred children and has been deemed acceptable to use across groups of different race, ethnicity, and socio-economic status (Achenbach and Rescorla 2001). For this study only the Competence Scales of CBCL were used. Parents were asked to answer questions related to the child's participation in the areas of *activities, social, and school* performance. For the activities domain, parents were asked to list specific activities and chores their child participated in, and then indicate how often *and* how well their child performs the activity compared to other children their age. A score of "0" was assigned to "less than average or below average"; a score of "1" was given for a response of "average", and a score of "2" was given for "more than average or above average". A similar method of scoring was utilized for the areas of social and school competence. A competence score was calculated for each domain (activities, school, and social competence) and a total competence score was calculated using scores from all three areas of performance.

Sensory Profile

The Sensory Profile (Dunn 1999) is a parent report questionnaire, designed to measure and record a child's behavioral responses to sensory stimulation. The Sensory Profile was normed on a sample of 1,037 children without disabilities between the ages of three and ten representing four major regions of the United States. Cut-point scores for the Sensory Profile were based on this national sample and resulted in the development of three categories of scores based on standard deviation (SD): Typical Performance (at or above 1 SD below the mean), Probable Difference (between 1 and 2 SD below the mean), and Definite Difference (more than 2SD below the mean). The original scoring mechanism used for the Sensory Profile identified deficits in sensory systems (auditory, visual, tactile) and general responsiveness to sensory input. These scores, however, did not reflect the four general patterns of sensory responsiveness outlined in Dunn's Model of Sensory Processing. Therefore, standardization data was reanalyzed to identify Quadrant Scores for the Sensory Profile consistent with Dunn's Model: Low Registration, Sensory Seeking, Sensory Sensitivity, and Sensory Avoiding (Dunn 2006). Cut scores were further modified to reflect a continuum of sensory processing abilities: Much Less Than Others (more than 2SD above the mean), Less Than Others (between 1 and 2 SD above the mean), Similar to Others (within 1 SD of the mean), More Than Others (between 1 and 2 SD below the mean), and Much More Than Others (more than 2SD below the mean). For the current study, quadrant scores were utilized. Performance scores, however, were re-coded into three vs. five categories due to the small sample size and number of subjects per group. The three recoded categories of performances were: Less than Others (Definite or Probable Difference Less than Others), Similar to Others, and More than Others (Definite or Probable Difference More than Others).

Results

A total of 55 children were originally enrolled in the study, however three (2 ASD, 1 TYP) presented with incomplete CBCL forms and therefore were excluded from further analysis. The demographic data for the final sample of 52 children is presented in Table 1. There was no significant difference in age between the ASD and control (TYP) groups. While groups did differ significantly ($p = .000$) on

Table 1 Demographic data for sample of ASD and TYP children

	μ age in months/SD	μ IQ/SD	Gender	Race	Ethnicity
TYP	105.9/23.4	111.5/12.8	12- male	19- Caucasian	0- Hispanic or Latino
($N = 26$)			14- female	4- African American	25- Non-Hispanic or Latino
				3- Mixed Race	1- Other
ASD	106.5/20.5	94.7/17.0	23-male	19- Caucasian	4- Hispanic or Latino
($N = 26$)			3-female	3- Asian	22- Non-Hispanic or Latino
				1- African American	
				1- American Indian/Alaska Native	
				2- Mixed Race	

TYP typical group, *ASD* autism spectrum disorder group, *IQ* non-verbal intelligence quotient, μ mean, *SD* standard deviation

Table 2 Comparison of sensory responsiveness quadrant scores between groups

	Low registration	Sensation seeking	Sensory sensitive	Sensation avoiding
Less than Others	TYP = 56%	TYP = 60%	TYP = 60%	TYP = 60%
	ASD = 0%	ASD = 0%	ASD = 0%	ASD = 0%
Similar to Others	TYP = 36%	TYP = 28%	TYP = 32%	TYP = 32%
	ASD = 32%	ASD = 52%	ASD = 32%	ASD = 20%
More than Others	TYP = 8%	TYP = 12%	TYP = 8%	TYP = 8%
	ASD = 68%	ASD = 48%	ASD = 68%	ASD = 80%

TYP typical group, *ASD* autism spectrum disorder group

non-verbal IQ scores, both groups had mean IQ scores within a normal range (>70). A higher percentage of children in the ASD group were males compared to the TYP group, which is typical of the ASD population as a whole.

As expected the two groups differed in terms of their sensory responsiveness. Children in the TYP groups tended to have scores in the "less than others" or "similar to others range", while children in the ASD group had no scores in the "less than others range" and a higher percentage of scores in the "more than others" range on the Sensory Profile. A comparison between groups is presented in Table 2. When examined in an analysis of variance (ANOVA) model, these differences were found to be statistically significant ($p = .000$) for all quadrants of the Sensory Profile.

The first aim of this study was to explore leisure/play and home chore activity patterns in children with and without ASD. To examine the types of activities and chores parents listed on the CBCL, parents were asked to list their child's favorite hobbies, activities, and games other than sports. Three blanks were provided for parents to fill in, with an option to check "none". For this analysis all responses were written down, by hand, on a blank sheet of paper. The activities were then reviewed independently by two researchers (authors 1 & 3) and potential categories were drafted. To arrive at consensus for categorization the researchers compared drafts and discussed similarities and differences; common themes emerged, were compiled and further characterized. For example, Lego's and Building Blocks were categorized together as "Constructive Materials" while playing with trains and cars were categorized as "Transportation Vehicles". Once both researchers had agreed on the number and description of each category, a code sheet was developed (Table 3). The CBCL forms for both the ASD and TYP group were then reviewed separately, and tallied according to the category into which the subjects' activities fell. The total number of activities for each child was also recorded to calculate the total number of activities per group. Once all activities and hobbies had been tallied, percentage scores were calculated per category and compared across groups (Fig. 1). In the TYP group, 77% of parents listed 3 activities for their child, while 23% listed only 2. In the ASD group, 61.5% of parents listed three activities for their child, 30.8% listed 2, and 7.7% listed only one activity. Overall, this analysis suggests that children with ASD in this sample had more involvement in Video Games, Transportation Vehicles, and Reading/Books categories, and less involvement in Dramatic Play, Play with Dolls or Action Figures, and Arts and Crafts activities.

A similar procedure was adopted for examining the chores engaged in by this sample of children with and without ASD. Part IV of the CBCL asks parents to list any

Table 3 Hobbies and activities category code sheet

Category name	Inclusion examples
Video games	Wii, Play Station, Nintendo DS
Computers	Computer, Internet Searchers, Research on Computer
Musical interests	Musical Instruments, Singing, Dance
Reading/books	Reading, Looking at Books, Writing Books
Board/card games	Board Games, Card Games
Arts & crafts	Coloring, Drawing, Crafts, Painting
Dolls/action figures	Barbie's, Stuffed Animals, Army Guys, Super Hero Guys
Transportation vehicles	Cars, Trains, Planes
Construction or manipulative play	Lego's, Blocks, Puzzles
Outdoor riding	Bikes, Horses, Scooters, Skateboards, Roller Coasters
Science/nature	Finding Insects, Fishing, Science Experiments
Card collecting	Pokemon, Sports Cards
Dramatic play	Playing School, Playing Army Men, Playing Star Wars

jobs or chores assigned to their child. Three blanks are provided for parents to fill out; there is also an option to check "none". For this analysis, all items written on the blanks were written down by hand on a blank sheet of paper. Jobs and chores were then reviewed by two researchers (authors 1 & 3) to enable categorization. For example, watering grass and mowing lawn were categorized together as "Lawn Care". Once both reviewers agreed on the number and description of each category a

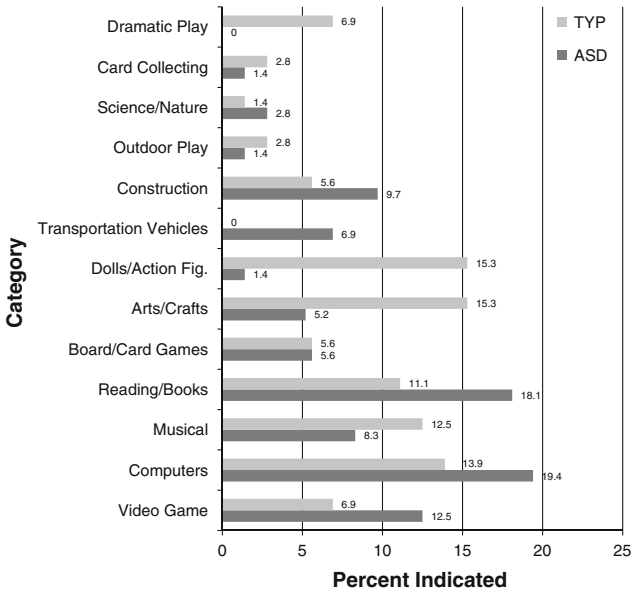

Fig. 1 Comparison of activity choices in children with and without ASD

Table 4 Jobs and chores category code sheet

Category name	Inclusion examples
Animal care	Feeding/walking dog, feed cat, feed chickens
Lawn care	Sweeping grass cuttings, mow lawn, watering grass
Trash/recycling	Recycle cans, take out trash, composting, recycle paper
Kitchen/meal prep	Set/clear table, load/unload dishwasher, help with dinner, dishes, clean eating area
Laundry	Help with laundry, fold clothes, put away clothes
General cleaning	Tidying up, vacuum/dust, sweep floors, clean up, help around the house, clean bathroom, bring in newspaper.
Babysitting	Babysitting
Personal cleaning/ organization	Make bed, clean room, pick up toys, shoe organization

code sheet was developed (Table 4). CBCL forms for each group were then reviewed separately and tallied according to which category their jobs or chores best fit. The total number of jobs and chores for each child was also recorded to calculate the total number of chores per groups (i.e. TYP vs. ASD). Once all chores and jobs had been tallied, percentage scores were calculated per category and compared across groups (Fig. 2). In the TYP group, 77% of parents listed 3 chores for their child, while 7.6% listed 0, 1, or 2 chores. In the ASD group, 31% of parents listed 3 chores for their child, 35% listed 2 chores, 7% listed 1 chore, and 27% listed that their child had no jobs or chores. Overall, this analysis suggests that children with ASD in this sample had fewer jobs and chores overall, and that most chores were in the categories of Kitchen and Meal Prep. Children with ASD had less involvement in chores such as animal care, babysitting and general cleaning.

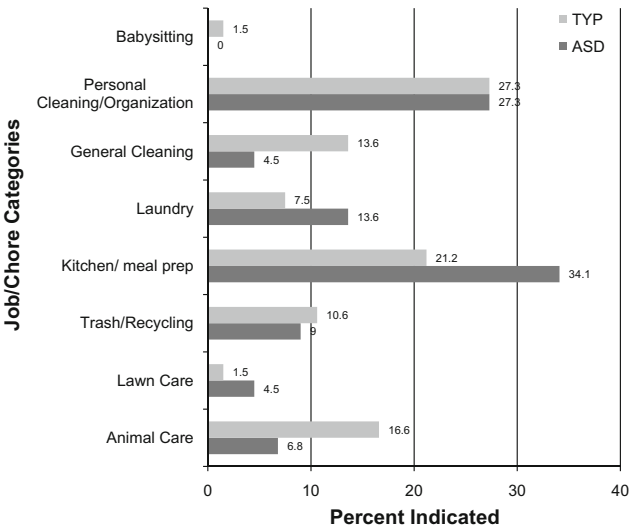

Fig. 2 Comparison of jobs/chores in children with and without ASD

As part of our initial aim of exploring activity patterns in children with and without ASD we wanted to know if children with ASD would show an overall lower level of competence compared to TYP children. As noted previously, competence on the CBCL is assessed in three domains: activity participation, social skills, and school competence. All three areas of competence were included in the analysis since all three areas have been implicated as potential areas of difficulty for children with ASD. A multivariate analysis of covariance (MANCOVA) was conducted to explore differences in the three areas of competence with cognition (non-verbal IQ) and gender entered into the model as covariates. The overall MANCOVA model was found to be significant ($p = .000$) with a moderate effect size of $p\eta^2 = .465$ (partial eta squared). In this analysis, neither cognition nor gender significantly influenced group differences and their effect on the overall model was insubstantial ($p = .709/p\eta^2 = .003$, $p = .150/p\eta^2 = .046$). Subsequent univariate analyses found significant differences between groups in each of the three subdomains (activity $p = .000$; social $p = .000$; school $p = .000$) with typical children demonstrating higher levels of competence in each area.

The second aim of the study was to investigate how sensory responsiveness contributed to children's level of competence; for this aim all children in the study (TYP and ASD) were included in the analyses ($n = 52$). MANCOVA models were utilized to examine if children with different patterns of sensory responsiveness showed differences in competence levels for areas of activity participation, social skills, and school performance. A separate MANCOVA model was initially run for each domain of sensory responsiveness (i.e. low registration, sensation seeking, sensory sensitive, sensation avoiding); cognition and gender were entered into all models as covariates. If the initial MANCOVA model was found to be significant, Bonferroni post-hoc analyses were conducted to examine between group effects for children demonstrating response patterns "more than others", "similar to others", and "less than others". MANCOVA models were found to be non-significant for the sensory quadrants of Low Registration ($p = .188$, $p\eta^2 = .101$) and Sensation Seeking ($p = .418$, $p\eta^2 = .071$); therefore, no further analyses were conducted. The overall MANCOVA model for the quadrants of Sensory Sensitivity and Sensory Avoiding were found to be significant ($p = .013$, $p = .041$), and effect sizes were modest ($p\eta^2 = .179$, $p\eta^2 = .148$). Neither cognition nor gender was found to contribute significantly to any of the models.

Post-hoc analyses indicated significant differences in activity competence, with children who were Sensory Sensitive "more than others" showing lesser activity competence than children who were Sensory Sensitive "less than others" ($p = .026$). Similarly, children who were scored as Sensory Avoiding "more than others" had significantly lower activity competence than children who were scored as "less than others" ($p = .019$). In the area of social competence, children who were Sensory Sensitive "more than others" scored significantly lower than children who were either Sensory Sensitive "less than others" ($p = .003$) or "similar to others" ($p = .005$); children who were Sensation Avoiding "more than others" scored lower in social competence compared to children who were either Sensation Avoiding "less than others" ($p = .004$) or "similar to others" ($p = .069$, borderline). This overall pattern also emerged in the area of school competence. Children who were Sensory Sensitive "more than others" scored significantly lower than children who were either Sensory Sensitive "less than others" ($p = .000$) or "similar to others" ($p = .003$); and children who were Sensation Avoiding "more than others" scored lower in school competence compared to children who were either Sensation Avoiding "less than others" ($p = .000$) or "similar to others" ($p = .005$). Stated more globally, for each of these comparisons, children who had more sensory behaviors demonstrated lower levels of competence.

Discussion

The finding that children with ASD differ from typical children in what they do, and the tasks in which they participate, comes as no surprise. Children with high functioning ASD were reported by caregivers to engage more frequently than typical children in solitary leisure tasks such as play with transportation vehicles, construction activities, reading or writing books, video games and using the computer. Children with ASD were not reported to engage in dramatic play activities such as "playing school" or "playing army", activities that were reported in a high percentage of typical children. Similarly, fewer children with ASD played with dolls or action figures, which often involve dramatic, imaginative, or imitative play. These differences are likely due to the complex nature of role playing and social imitation that these activities require; many children with ASD, despite having normal IQ, may not be able to engage in these complex social imitation tasks (White 2002). That social play and imitation present challenges for children with ASD is well established (Beyer and Gammeltoft 2000; Lord 1984; Lord and Magill 1989). Children with ASD have been noted to have difficulty with the underpinnings of social interaction in that they are challenged by activities requiring such things as shared attention and the ability to communicate in ways that supports continued interaction (White 2002). Imaginative play requires these skills; without them play is

not 'fun'. It has been noted that children with ASD are not considered attractive playmates by other children, likely due to their difficulties with social give and take. And, because social give-and-take is crucial to imaginative play, children with ASD would not be expected to engage in this type of interaction.

Orsmond and colleagues had suggested that participation in leisure and play activities for children with ASD could be predicted by skills such as functional independence and social abilities, along with environmental factors such as availability of options and maternal involvement in the activity. In fact, social requirements in play have been suggested to be non-motivating for children with ASD and potentially anxiety provoking (Brown and Murray 2001). These factors were likely influential in our findings as well. Leisure participation in the current study was most likely in tasks that did not require social skills, and required little in the way of functional independence. Our results thus support those of other investigators in finding that not only did children with high functioning ASD participate in fewer play/leisure activities than typical children, but choice of activities appears to be influenced by individual abilities in social interaction, and the social requirements of the task itself.

Jobs/chores in which children with ASD engaged involved self-care activities such as cleaning their plate after dinner, picking up their toys, or putting away their clothes. In contrast, jobs/chores for TYP children were more likely to involve caring for others (e.g. feeding the dog, babysitting). This difference may again reflect the child's difficulties with social interaction, or their perceived inability to perform more complex tasks. In general our findings demonstrate that parents require less work from their child with ASD since 27% of children with ASD had no chores or jobs compared with only 7.6% of the typical group. Taking on responsibilities within the family may be important for enhancing self-esteem, practicing social roles, and building bonds between family members. There are several possible explanations for this finding. It may be that parents of children with ASD do not want to add additional burdens to their child who is already over-scheduled with therapy sessions, doctor's appointments, and the ever increasing amount of homework. It may also be that children with ASD take longer to perform certain tasks, and require more support, making it simply just faster for a parent or sibling to complete the job themselves. There is also the possibility that children with ASD may be more resistant to participating in the performance of chores, so these requirements are not placed upon them as a means of avoiding tantrums, anxiety or family conflict. It is worth considering, however, that by excusing the child with ASD from family chores, they are missing an opportunity to learn and practice important life skills. This is an area that merits further study.

In addition to social deficits, sensory and motor challenges often found in children with ASD have been suggested to play a role in activity choice. The data collected here does not allow us to determine if sensory and motor demands drive participation choice, but information acquired in this study adds weight to these issues. Children with ASD have been noted to have difficulty with fine motor skills and motor control (Fournier et al. 2010; Ming et al. 2007). Thus it is likely that they will resist participation in leisure activities requiring high levels of motor skill. Some tasks of choice for typical children, such as arts and crafts activities (e.g. painting or model building), require good fine motor skill and motor coordination for success. In the absence of such skill, children with ASD may simply choose not to participate. Further, tasks such as those noted above require the use of materials such as paint, glue, or modeling clay; these materials convey sensory features which themselves may present challenges to children who have a low tactile threshold. If the child has sensory sensitivities, as many of the children in this study did, they may simply avoid activities rich in the sensation they find troublesome.

While not an explicit aim of this investigation, we did examine sensory processing in this study. As has been shown in other investigations, children with ASD demonstrate sensory processing that differs from that of typical children. The exact nature of the sensory processing differences identified has been relatively broad; children with ASD demonstrate both over and under-responsivity, as well as low registration and sensory seeking and they have been noted to use either passive or active strategies to counter this responsivity threshold (Baranek et al. 2006; Leekam et al. 2007; Tomchek and Dunn 2007). Our findings support previous work in that children in the ASD group were considerably more likely to have Sensory Profile scores in the "more than others" range for all Sensory Profile quadrants. The complexity of sensory processing challenges demonstrated by children with ASD is likely to be a reflection of differences in individual preferences within sensory systems.

A second aim of this pilot study was to investigate the role of sensory responsiveness in contributing to children's level of competence. We had hypothesized that greater deficits in Low Registration and Sensory Avoiding would be characteristic of an overall lower level of competence, irrespective of diagnosis. This hypothesis was only partially supported in this study. Based on our findings, lower competence levels were associated with having more frequent behaviors reflective of Sensory Sensitivity or Sensation Avoiding. Sensory Sensitivity and Sensation Avoiding are both considered to be reflective of low neurological thresholds according to Dunn's Model of Sensory Processing, and are grouped together as "sensory

over-responsiveness" according to the proposed nosology for sensory processing disorders (Miller et al. 2007). Thus, as a group, children who show sensory over-responsiveness may be less likely to engage in activities that require the processing of self-perceived noxious sensory inputs (e.g. sights, smells, textures that the child finds unpleasant). Similarly, children with sensory over-responsiveness may not perform such tasks as successfully when they do attempt to engage in these activities.

Other factors may mediate the relationship between sensory over-responsivity and participatory competence. For example, sensory over-responsivity has been associated with motor stereotypies and repetitive behaviors in children with ASD (Baranek et al. 1997; Gal et al. 2009; Liss et al. 2006). Among the more commonly seen stereotypies and repetitive behaviors are observable actions such as turning on/off lights or electronics, hand or object flapping, lining up toys, body rocking, skin picking and finger flicking. It is possible that the presence of these atypical motor behaviors interferes with the development of competence in activity performance. Similarly, sensory over-responsivity has been associated with anxiety, and children who are anxious may be less likely to engage in certain tasks or activities (Pfeiffer et al. 2005; Reynolds and Lane 2009). They may also be less competent or attentive to tasks they are engaged in if they are hypervigilant about sensations in their surrounding environment. Because we examined the relationship between sensory processing and participation in all children, we were unable to differentiate the role sensory processing challenges may have played for each group individually. These relationships require further exploration as they relate to overall participation in children with ASD.

Children with ASD have been reported to experience both over- and under-responsiveness to sensory stimuli (this study and see Ben-Sasson et al. 2009 for review). It was therefore interesting that, in this study, we were able to show a link between competence in task accomplishment and sensory over-responsivity but not in areas of sensation seeking or low registration (under-responsiveness). Children who seek out sensation may engage in activities more frequently or for a longer duration. By engaging, they may naturally get practice in performance of social, motor and sensory skills leading to increased competence over time. The area of low registration is more difficult to explain. Children with low registration are those who do not appear to take in environmental sensation and use it towards the production of adaptive environmental interaction; they do not appear to engage with the environment (Dunn 1999; Miller et al. 2007). It follows then that children with low registration might also show limited participation competence. In this study we saw a trend in this direction, with children more often showing low registration also showing lower competence scores, but this relationship failed to reach significance. The relationship warrants further investigation.

Our findings both confirm the findings of others relative to the limited participation of children with ASD in daily occupations, and add to this a link between participation and sensory processing disorders. Children with sensory over-responsiveness have less competence in both play/leisure and jobs/chore activities. We suggest that addressing challenges in sensory responsiveness should be considered as part of an overall program designed to increase participation for children with ASD.

Limitations

This pilot study is limited by a small sample size and a disproportionate number of female subjects in the typical group. While this distribution of males and females may have influenced the child's choice of activity, in that gender (rather than diagnostic category) could have been driving activity choice, it appears that the categories generated from our analysis were broad enough to encompass activities that may be gender limiting. For example, dramatic play might be initially interpreted as a category that more females would engage in if it were limited to tasks such as "playing house" or "playing school". However, our category encompassed dramatic play such as "playing army men" and "playing star wars" which were reported by our male participants. A similar method of categorization was used for the category "Dolls and Action Figures" which was represented by both male and female participants. When possible, gender was controlled for in our statistical models; in these instances, gender did not have a significant effect on levels of competence.

Another potential limitation was the significant cognitive difference between the ASD and TYP group. While all children included in this study had a non-verbal IQ in the typical range (>70), factors related to cognition, attention, or executive functioning may influence the quality or type of activities in which children in our sample engaged. When possible, cognitive differences were accounted for in our statistical models, and again, were found to be non-significant.

Finally, we must consider the tools used to measure both sensory responsiveness and participation/competence. The child's level competence, as well as the types of activities in which they engaged was reported by the parent. While we made attempts to clarify parents rating and reporting of these items, they are potentially less valid than performance measures of competence in the specified areas. In the area of sensory responsiveness, parent report was also used. Further, the Sensory Profile Caregiver Questionnaire

(Dunn 1999) which was used in this study is recommended for children aged three to ten, while our sample extended to children aged twelve. While this must be considered a potential limitation, we are not the first researchers to extend the use of the caregiver questionnaire to children aged 12 (Cheung and Siu 2009) and the research to develop the tool, in fact, included children, with and without disabilities, between the ages of 3 and 14 years (Dunn 2006).

Conclusion

These results indicate that children with high functioning ASD differ from typically developing peers in both the quantity and type of activities in which they participate. Further, children with ASD show differences in sensory responsiveness and associated behaviors (passive or active) that differentiate them from their typical peers. These are not new findings for children with ASD, but rather they support the work of other investigators. Of great interest in this study was the finding that patterns of sensory processing impairment influence the frequency and competence of *all* children to participate successfully in childhood activities across various areas of performance. The implication of this later finding is that we need to look carefully at sensory processing impairment as a driver for limited and/or unskilled activity participation. Previous work in the area of participation for children with ASD has focused on social and motor deficits as primary indicators of children's level of competence. Our work suggests that we need to look at other factors. Future studies should examine the inter-relationship of sensory processing impairments and autistic symptoms influencing participation. Further, research should address the impact participation deficits have on the development of social, motor and sensory processing skills as the relationship is likely to be reciprocal.

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