HOME AND COMMUNITY ACTIVITIES: DIMENSIONS AND ASSOCIATIONS WITH PATTERNS OF SENSORY RESPONSE AMONG CHILDREN WITH AUTISM SPECTRUM DISORDERS

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ABSTRACT

LAUREN M. LITTLE: Home and Community Activities: Dimensions and Associations with Patterns of Sensory Response Among Children with Autism Spectrum Disorders
(Under the direction of Grace T. Baranek)

Activity participation is integral to the study of occupational science. Children's participation in activities provides them with learning opportunities that positively impact their development; however, children with autism spectrum disorders (ASD) experience decreased activity participation as compared to children with typical development. Among children with ASD, four sensory response patterns (hyporesponsiveness, hyperresponsiveness, sensory seeking, enhanced perception) characterize the extreme behavioral responses to the sensory elements of activities, which potentially impact the frequency of activity participation. Research has not yet investigated the home and community activities in which children with ASD participate, or examined the differential effects of sensory response patterns on activity participation. The purpose of this study was to empirically derive dimensions of home and community activities that characterized the participation of a large sample of school-aged children with ASD (n=713). This study also examined the link between the sensory response patterns and dimensions of activity participation among children with ASD, as moderated by child characteristics (i.e., chronological age, developmental age, autism severity). In order to derive dimensions of activity participation, exploratory factor analysis was utilized on a measure of children's activity participation, the Home and Community Activities Scale (HCAS; adapted from Dunst, Hamby, Trivette, Raab, & Bruder, 2002). The associations with dimensions of activity participation and children's sensory response patterns, as moderated by child characteristics, were analyzed using mixed model regression. The results suggested that a six factor model characterized the activity participation among school-aged children with ASD, and included: Parent-Child Household Activities; Community Activities; Routine Errands; Neighborhood Social Activities; Outdoor Activities; and Faith-based Activities. Hyperresponsiveness was negatively associated with each dimension of activity participation, while enhanced perception supported participation in each activity dimension. Hyporesponsiveness and sensory seeking differentially impacted activity participation based on children's chronological age. The findings have implications for an occupational science conceptualization of how activities are categorized, as well as demonstrate that the sensory response patterns among children with ASD play a key role in their home and community activity participation. Implications for occupational therapy research and future research directions are discussed.

DEDICATION

To my Father, who told me that if it were easy, everyone would do it.

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My mother, the picture of resilience, and my sister, thank you. You always bring me back to myself and believe in me. I also found a lifelong friend in the course of this program, who helped me walk it off. Thank you, Ashley. Of course, to my partner, Dwight, thank you for always listening to my concerns and my fears, and sharing my accomplishments.

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Chapter 1

INTRODUCTION

The purpose of this chapter is to provide an overview of the literature on the activity participation as well as sensory features among children with autism spectrum disorders (ASD). This overview provides the rationale for pursuing the current study, as well as the statement of the problem, and concludes with the study purpose.

Overview

Activity participation is integral to the study of occupational science. The activities in which children participate include meal times with family members, playing with peers at playgrounds, visiting grocery stores with caregivers, and attending special events, such as birthday parties. Participation in activities structure the everyday lives of children, and provide them with learning opportunities in a diversity of environments and tasks with caregivers and peers, which in turn positively affects their development (Dunst, Bruder, Trivette, Raab, & Mclean, 2001; Humphry & Wakeford, 2006; Segal, 1999). Children with developmental disabilities, however, are at risk for limited activity participation (Dunst, Bruder, Trivette, & Hamby, 2006; Law, 2002; Law & King, 2000). They less frequently engage in activities with caregivers and peers, which results in fewer opportunities to learn and practice skills, and may negatively impact their development (Law, 2002; Dunst et al., 2006). Research has shown that children with autism spectrum disorders (ASD) are at higher risk for decreased participation compared to children with other developmental disabilities (Marquenie, Rodger, Mangohig, & Cronin, 2011), which suggests that the study of their participation is a particularly important area for occupational science research.

Recent estimates suggest that 1 in 110 children will be diagnosed with an autism spectrum disorder by the age of 8 (CDC, 2009). Autism spectrum disorders are characterized by deficits in social interaction and communication as well as the presence of restricted interests and repetitive behaviors (APA, 2000). In addition to the triad of core symptoms, sensory features are highly prevalent among children with ASD (Baranek, David, Poe, Stone, & Watson, 2006; Ben-Sasson et al, 2009), with research suggesting that prevalence rates range from 69% to 87% (Baranek et al., 2006; Lane et al., 2010). Sensory features among children with ASD are characterized by four patterns of response: hyporesponsiveness (lack of behavioral orienting and/or attenuated reactions to stimuli), hyperresponsiveness (exaggerated or aversive responses to sensory stimuli), sensory seeking (craving and perseveration on the sensory components of objects or body mannerisms), and enhanced perception (hyper-awareness and/or discrimination of sensory aspects of objects or environments) (Ausderau, Sideris, Little, & Baranek, in preparation). The sensory features of children with ASD have been linked with their decreased participation in small qualitative studies and anecdotal reports (e.g., Bagby, Dickie, & Baranek, 2012; Dickie, Baranek, Schultz, Watson, & McComish., 2009; Schaaf, Toth-Cohen, Outten, Johnson, & Madrid, 2011); however, very little large-scaled empirical research has investigated the differential associations between sensory features and dimensions of activity participation among children with ASD.

Statement of the Problem

A limited number of studies have investigated the activity participation of children with ASD, and previous research has been focused on: 1) time use among children and families with ASD; 2) the perspectives and experiences of mothers' daily lives with a child with ASD; and 3) self-reports of participation among high functioning children with ASD. Moreover, studies on how children's sensory features impact daily life have largely focused on caregiver experiences and accommodations to their child's sensory features (Dickie et al., 2009; Schaaf et al., 2011; Bagby et al., 2012; Little, Ausderau, Freuler, & Baranek, in preparation). Empirical investigation into the home and community activities of school-aged children with ASD, as well as differential effects of sensory response patterns on activity participation, has been largely overlooked.

Study Purpose

The primary aim of this study was to characterize the dimensions of activity participation among school-aged children with ASD in a large sample. This study investigated the extent to which sensory response patterns (hypo, hyper, seek, EP) differentially impact dimensions of activity participation among children with ASD. In addition, the moderating effects of child characteristics (i.e., chronological age, developmental age, autism severity) on the associations between sensory response patterns and activity participation were examined. Findings from this investigation illuminate the extent to which specific sensory response patterns can both support as well as inhibit activity participation, which provides a novel perspective on the impact of sensory response patterns on the activity participation among children with ASD.

Chapter 2

LITERATURE REVIEW

This chapter is divided into five sections and devoted to a discussion of: (a) an occupational science approach to the study of activity participation among children with ASD; (b) measurement of activity participation; (c) a theoretical model of sensory response patterns among children with ASD; (d) associations of sensory response patterns with other child characteristics; and (e) research on the relation between sensory features and activity participation. This literature provides a foundation for the current study as well as creates an understanding of how the activity participation among children with ASD both shapes and is shaped by their sensory response patterns.

Activity Participation: An Occupational Science Approach

An occupational science perspective presupposes that children's activity participation is essential to their health and wellbeing (Humphry, 2002, 2005; Law, 2002). Humphry (2005) described children's occupations as "activities children find interesting or pleasurable and want to do or do because others manifest value in their so doing" (p.38). Activities, especially for children, are laden with sensory components. For example, a meal time experience for a child is characterized by tactile interaction with caregivers, the taste and smell of food, the bright colors and contrasts of food on a plate, and the sounds of voices. Clearly, this seemingly mundane activity of mealtime involves sensory components, and children demonstrate a range of behavioral responses to the sensory components of activities. Sensory features are behavioral responses to sensory components of activities, and are theorized to reflect underlying sensory processing capacities. Sensory features cluster into various sensory response patterns, which contribute to what activities are considered pleasurable, motivating, or aversive for children (Baranek, 1999; Dunn, 2007). Children with ASD exhibit extreme sensory response patterns (Baranek et al., 2006; Ben-Sasson et al. 2007), which may interact with the sensory components of activities, and result in limited or enhanced participation (Dunn, 2007).

Hocking's (2000) approach to the study of occupation may shed light on the process of how components of activities (e.g., sensory elements) interact with children's capacities (e.g., sensory response patterns). Hocking suggested that an occupational science investigation should focus on essential elements of occupation, which encompass the nature, substrates, structure, features or characteristics of occupation. Many studies have focused on the relationships between occupation and other phenomena; however, the study of occupational elements is focused on "the phenomenon of occupation itself" (Hocking, 2000, p.58). For the purposes of this investigation, two essential elements of children's occupations were considered: 1) the structure (i.e., type & frequency) of their home and community activity participation; and 2) the sensory response patterns that reflect children's individual capacities. An understanding of the impact of children's sensory response patterns on their home and community activity participation could contribute to future studies regarding how this relationship plays out over time to impact children's health and wellbeing.

Occupational science presupposes that children's health is related to and perpetuated through participation in activities. Children's health is related to their individual capacities, and the interplay between individuals' capacities and other elements of occupation is an iterative process. Children's characteristics both shape and are shaped by opportunities to engage with caregivers, peers, and siblings, over time and in many contexts (Humphry, 2002; 2005). Children's capacities are fostered by activity participation over time and in many contexts, and increased child capacities often lead to increased participation. Specifically, when children are given opportunities to participate in home and community activities, they gain experiences and coping skills, which in turn contribute to their increased participation. Perhaps the increase in activity participation over time contributes to a decrease in the severity of sensory features among children with ASD, as they are able to gain such experience through their participation in multiple contexts and with multiple partners.

If the link between activity participation and children's health outcomes are to be addressed by occupational science research, the extent to which children with ASD participate in activities must be investigated. Therefore, this study sought to characterize the home and community activity participation among school-aged children with ASD. Although this study was cross sectional, it nonetheless considered the developmental nature of how children's sensory features differentially impact their participation in home and community activities through the inclusion of maturational variables. This study begins to create some understanding into the structure of home and community activities for children with ASD, and how activity participation over time may impact and be impacted by children's sensory features and maturational variables.

Activity Participation among Children with ASD

The activity participation among children with ASD has been found to differ from that of typically developing children with regard to frequency, types of activities, and the individuals with whom the participation occurs. The purpose of this section is to provide a description of the evidence that suggests preschool and school-aged children as well as adolescents with ASD participate in home and community activities less frequently than typically developing children and children with developmental disabilities (DD). Moreover, the evidence suggests children with ASD participate in different types of activities than children with typical development and developmental disabilities.

The decreased frequency and variety of home and community activity participation among children with ASD as compared to typically developing children has been reported in a number of studies. Specifically, preschool-aged children with ASD have been found to participate less frequently in self-care, community mobility, vigorous leisure, sedentary leisure, social interaction, chores, and education as compared to children with typical development (LeVesser & Berg, 2011). Special event activities such as birthday parties and family vacations have also been reported as less frequent among preschool and school-aged children with ASD (Rodger & Umaibalan, 2011; Schaaf et al., 2011).

The difficulty associated with activity participation most likely contributes to the decrease in frequency and diversity among preschool-aged children with ASD, and may perpetuate the lack of activity participation over time. Interviews revealed that parents experienced difficulties when opportunities for participation were offered to their children, such as children's tantrums in public places or lack of following directions

(LeVesser & Berg, 2011; Lam, Wong, Leung, Ho, & Au-Yeung, 2011). The decline of activity participation among families of children with ASD over time was described by DeGrace (2004), whose findings revealed that "families have learned over the years that occupations that bring the family together (birthdays, holidays) are not worth the hassle" (p. 548). Caregivers of preschool children with ASD report less frequent and less diverse activity participation, as well as increased difficulty, which may contribute to and perpetuate a decrease in activity participation over time, and into children's school-aged and adolescent years.

Research suggests that the home and community activity participation among school-aged children with ASD is less frequent, less diverse, and occurs with fewer peers than both typically developing children and those with DD. High functioning school-aged children with ASD have self-reported that they participate in a fewer number of activities, in a fewer variety of environments, and with less diversity of peers as compared to typically developing peers (Hilton, Crouch, & Israel, 2011). Specifically, the participation of school-aged children with ASD appears to occur less frequently than that of typically developing children in unstructured activities, social activities, and hobbies, such as recreational and after school activities (Hochhauser & Engel-Yeger, 2010; Reynolds, Bendixen, Lawrence, & Lane, 2011). Similarly, adolescents with ASD have been found to participate less frequently in recreational activities and community activities such as after school clubs and organizations (e.g., girl/boy scouts, 4H) as compared to both typically developing children and those with other developmental disabilities (Lee, Harrington, Louie & Newshcaffer, 2008; Orsmond, Krauss, & Seltzer, 2004; Solish, Perry, & Minnes; 2010). Thus, there is growing evidence that school-aged children and adolescents with ASD participated in fewer activities with a fewer variety of individuals as compared to typically developing peers.

Increasing evidence suggests that school-aged children and adolescents with ASD experience increased time in solitary activities, such as frequently watching television, playing video games, or using a computer (Mazurek, Shattuck, Wagner, & Cooper, 2011; Orsmond & Kou, 2011). In addition to screen time use (i.e., computer, video game, television), school-aged children with ASD have been found to participate more frequently than children with TD in solitary leisure activities, such as play with transportation vehicles, construction activities, and reading or writing books (Reynolds et al, 2011). The lack of activity participation with peers or siblings among school-aged children with ASD has been reported in a number of studies (Hilton et al., 2011; Hochhauser & Engel-Yeger, 2010), and the findings of one study suggest that adolescents spend the majority of discretionary time use watching television or using a computer, either alone or with their mothers (Orsmond & Kuo, 2011). Clearly, school-aged children and adolescents with ASD are participating less frequently in home and community activities, and most likely spending increased time in solitary activities such as computer use, video game playing, and television watching.

Although methods such as child self-report data (Hilton, et al., 2011), questionnaires with follow up caregiver interview data (DeGrace, 2004; LeVesser & Berg, 2011; Orsmond et al., 2004), and time diaries (Orsmond & Kuo, 2011) have a number of benefits for describing the participation of children with ASD, the abovementioned studies present with limitations. Research on the activity participation of school-aged children with ASD have utilized self-report data (Hilton et al., 2011;

Hochhauser & Engel-Yeger, 2010), which among children with ASD is clearly limited, as communication is a core impairments of the disorder and low functioning children are excluded from research utilizing this method. Qualitative approaches utilizing interview data require extensive time on behalf of families and researchers, which limits possible sample sizes. The study that utilized caregiver report data (Rodger & Umaibalan, 2010) was focused on family routines and did not directly address the activities in which the children were involved. Further, most of the above studies have utilized a comparison group of typically developing children, which does not provide specific knowledge about the activity participation of children with ASD and does not provide additional insight into the heterogeneity associated with the disorder.

These limitations have resulted in a lack of large scale research on the home and community activities of school-aged children with ASD, and child specific characteristics that may be associated with various dimensions of activity participation. Therefore, a necessary area of occupational science inquiry is to empirically validate dimensions that characterize the activity participation of a large sample of school-aged children with ASD, and link these dimensions with child characteristics (i.e., sensory features, maturational variables).

The Measurement of Activity Participation

In order to describe the activity participation of a large sample of children, it is necessary to utilize a caregiver report instrument that measures the frequency of children's participation in a variety of activities. The objective measurement of participation has been argued as a vital area of research for occupational science and occupational therapy (Coster & Khetani, 2008); however, few parent report measures are available to capture children's participation in a variety of activities (Coster, 2008). There are a number of advantages associated with caregiver report instrument administration over other methods. Caregiver report methods have been argued as ecologically valid (Baranek et al., 2006; Sbordone, 1996), and are considered important for measuring outcomes for children over time, intervention planning, and intervention assessment (Kramer, Coster, Kao, Snow, & Orsmond, 2012). Moreover, caregiver report methods allow for the comparison of participation among groups of children with differing diagnoses and allow researchers to assess the participation on large samples, contributing to the generalization of findings. For the purposes of this investigation, nine measures of participation were reviewed and evaluated for use with school-aged children with ASD. The larger study from which extant data was drawn for the current investigation was an online survey study, so an important criterion for the reviewed measures of participation was that the questionnaire be available or easily translated into an online questionnaire. The primary aim of this study was to characterize the participation in home and community activities in a large sample of school-aged children. Therefore, the frequency of children's participation in a variety of activities was considered in reviewing measures, and preliminary evidence of the appropriateness of administration with children with ASD was evaluated.

Of the nine measures reviewed, six measures were designed to be caregiver report and available for use in an online format (Bourke-Taylor, Law, Howie, & Pallant, 2009; Boyce, Jensen, James, & Peacock, 1983; Dunst et al., 2002; Dunn, 2004; Systma, Kelley, & Wymer, 2001; Varni, Seid, & Kurtin, 2001), while the remaining three were intended for self-report or required a follow up interview (Fiese & Kline, 1993; King et al., 2004; Noreau et al., 2007). Five dimensions of home and community participation were addressed across instruments, including: household tasks; family events; solitary activities; physical / outdoor activities; and social / community activities. Only four of the nine measures included the frequency ratings of participation (Boyce et al, 1983; Dunst et al., 2002; King et al., 2004; Systma et al., 2001). Six of the measures had been previously utilized with samples of children with ASD (Bourke-Taylor et al., 2009; Boyce et al., 1983; Dunst et al., 2002: Fiese & Kline, 1993; King et al., 2004; Systma et al., 2001). Each of the nine measures addressed activity participation in the home; however, only six of the measures addressed also community activity participation (Bourke-Taylor et al., 2009; Dunst et al., 2002; Fiese & Kline, 1993; King et al., 2004; Noreau et al., 2007; Varni et al., 2001). Refer to Table 2.1 for an overview of these criteria. From the findings of this review of measures of activity participation for use with school-aged children with ASD, the Home and Communities Activities Scale (HCAS; adapted from Dunst et al., 2002; Refer to Appendix A) was the only to tap each of the five dimensions of activity participation, include frequency of participation, have evidence of utility among children with ASD, and measure participation in both home and community activities.

Table 2.1 Criteria for Measures of Participation for Children with ASD

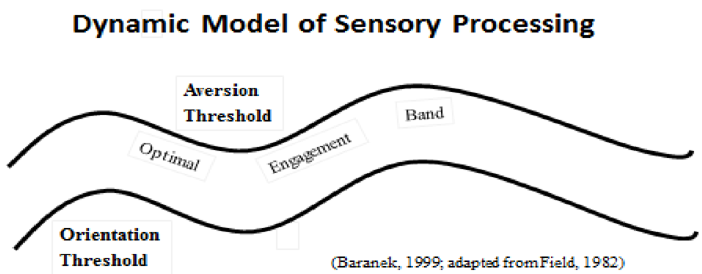
Instrument	# of items	Caregiver report	Online Administratio	Frequency of Participation	Utilized with children with ASD	Home activities	Community Activities
The Assistance to Participate Scale (Bourke-Taylor, Law, Howie, & Pallant, 2009)	8	X	X		X	X	X
Children's Assessment of Participation and Enjoyment (King et al., 2004)	55			X	X	X	X
Child Routines Questionnaire (Systma, Kelley & Wymer, 2001)	30	X	X	X	X	X	
The Children Helping Out: Responsibilities, Expectations, and Supports (Dunn, 2004)	33	X				X	
Family Ritual Questionnaire (Fiese & Kline, 1993)	56				X	X	X
Family Routines Inventory (FRI; Boyce, Jensen, James & Peacock, 1983)	28	X	X	X	X	X	
Home and Community Activities Scale (HCAS; adapted from Dunst et al., 2002)	83	X	X	X	X	X	X
The Assessment of Life Habits for Children (LIFE-H; Noreau et al., 2007)	69					X	X
Pediatric Quality of Life Inventory (PQoL; Varni et al., 2001)	23	X				X	X

There is preliminary evidence to suggest that the HCAS may be useful in characterizing the activity participation of children with ASD. Holtzclaw and colleagues (2006) administered the HCAS to a small sample of preschool-aged children with ASD (n=62) and typical development (n=65), and found that eleven factors characterized the participation of the combined sample: home / family; church; holidays; alone; errands/ shopping; outdoors; story / music groups; friends; play; community events; and school. The results of this study demonstrate that the HCAS may have utility in characterizing the activity participation among children with ASD; however, this study had methodological limitations. Holtzclaw and colleagues (2006) utilized principal components analysis, a method of data reduction that does not uncover underlying latent factors associated with the measure as factor analysis does. Moreover, the sample of children with ASD was small (n=62) and preschool-aged, and the HCAS items may be more appropriate for school-aged children (e.g., after school care, basketball). Additionally, the factor structure of the HCAS was tested utilizing the children with typical development and ASD combined, which does not fully reveal the activities that characterize the participation of children with ASD. The findings of this study, however, contribute to evidence that suggests the HCAS may capture the functional impairments of children with ASD. The current study built on this evidence through analyzing the factor structure of the HCAS, as well as analyzed how sensory features, often prevalent among children with ASD, in combination with other child characteristics, may inhibit and enhance activity participation.

Sensory Response Patterns of Children with ASD: A Conceptual Model

One model of sensory processing that provides insight into how sensory features are associated with activity participation among children with ASD is the Dynamic Model of Sensory Processing (Baranek, 1999; adapted from Field, 1982). The Dynamic Model of Sensory Processing provides a way to conceptualize how children's thresholds for orientation and aversion interact with environmental sensory stimuli necessary for optimal engagement in occupation. In this model, two thresholds are important for a child's engagement and are based on children's arousal levels: the orientation threshold and the aversion threshold. Orientation is the point at which children become aware of the sensory stimuli of an activity, and "tune-in"; thus engaging in that activity. The aversion threshold is the point at which children become over-aroused and "tune-out", thus exhibiting distress or avoidant behavioral responses. Behavioral manifestations of alterations in these thresholds contribute to a narrower band of optimal engagement and may result in various sensory features and accommodations. Figure 2.1 depicts the model.

Figure 2.1. Dynamic Model of Sensory Processing



A confirmatory factor analytic study on the Sensory Experiences Questionnaire 3.0 (SEQ 3.0; Baranek, 1999, 2006), a caregiver report measure of children's behavioral responses to sensory stimuli based on the Dynamic Model of Sensory Processing, revealed that four independent factors most succinctly characterize the sensory response patterns of children with ASD in a large sample (n=1307): hyporesponsiveness, hyperresponsiveness, seeking, and enhanced perception (Ausderau et al., in preparation). Refer to Appendix B for results of the factor analytic model of the SEQ 3.0.

Four patterns of sensory response (hyporesponsiveness, hyperresponsiveness, seeking, enhanced perception) can be explicated by the orientation and aversion thresholds as described by the Dynamic Model of Sensory Processing. Children who demonstrate hyporesponsiveness require repeated or increasingly intense sensory stimuli during activities in order to reach orientation thresholds; however, children that demonstrate hyperresponsiveness more quickly reach the aversion threshold and may require less intense sensory stimuli during activities. Findings from the empirical investigation into the interrelationships between these factors showed that enhanced perception is associated with hyperresponsiveness (r=.74), which suggests that children who are hyper aware and able to very quickly or intensely discriminate properties of sensory stimuli in their environments may reach the aversion threshold. Sensory seeking is associated with both hyporesponsiveness (r=.64) and hyperresponsiveness (r=.44), which suggests that children demonstrating this pattern of response have arousal levels that greatly fluctuate between aversion and orientation, and may use seeking strategies to modulate arousal (Ausderau et al., in preparation; Boyd et al., 2010).

A number of theorists have argued that sensory features promote or inhibit participation (Dunn 2001, 2007; Miller et al., 2007), because it is the interplay between children's sensory preferences and aversions that promote engagement, serve as motivation for engagement, or constrain engagement. Children's individual intrinsic capacities interact with the contextual, sensory aspects of activities, which consequently results in successful or unsuccessful participation in home and community activities. Sensory response patterns are the behavioral responses to the sensory components of everyday activities in the home and community, and these behavioral responses have been found to be more extreme among children with ASD. For the purposes of this project, the Dynamic Model of Sensory Processing was used as a conceptual model of children's sensory response patterns, and the SEQ 3.0 was used to empirically measure sensory response patterns.

In summary, two conceptual models were used to guide the current analysis. In the current study, the elements of occupation (i.e., structure of activity participation) and individual capacities (i.e., sensory response patterns) were investigated (Hocking, 2000). Moreover, the Dynamic Model of Sensory Processing (Baranek, 1999) provides a conceptual framework of how sensory response patterns contribute to optimal engagement in activity participation. These two conceptual models have different foci, which converge to shape the current occupational science investigation into the activity participation and sensory response patterns of school-age children with ASD.

Sensory Response Patterns: Associations with Child Characteristics

A number of studies have demonstrated that children with ASD exhibit more extreme sensory features than typically developing children (Kientz & Dunn, 1997; Watling, Dietz, & White, 2001) and those with developmental delay (Baranek et al., 2006). The patterns of sensory response among children with ASD are not mutually exclusive and often co-occur (Baranek et al., 2006; Ben-Sasson et al., 2009). Specific studies offer insight into the associations between the four patterns that describe the sensory processing of children with ASD and their characteristics. The purpose of this section is to describe the research on how the sensory response patterns among children with ASD have been associated with child characteristics (i.e., developmental age, chronological age, autism severity).

Developmental age. The sensory response patterns among children with ASD have been associated with their developmental age, and it is hypothesized that as children age developmentally they gain maturity and coping skills through experience which lessens the severity of their responses to sensory stimuli (Baranek et al., 2006). Evidence suggests that hyperresponsiveness is associated more with lower developmental ages than diagnosis per se (Baranek et al., 2006; Baranek et al., 2007). Sensory seeking and hyporesponsiveness have been found to be significantly negatively associated with developmental age among children with ASD (Little et al., 2010; Liss et al., 2006). Research to date has not examined the link between enhanced perception and developmental age.

Chronological Age. Evidence suggests that sensory features decrease with increasing chronological age (Kern et al., 2007). Specifically, children over the age of nine years exhibit lower hyporesponsiveness, hyperresponsiveness, and sensory seeking patterns (Ben-Sasson et al., 2009). Behavioral observation research suggests that infants with ASD demonstrate increased rates of sensory seeking (Baranek, 1999); however, parent report data suggests that sensory seeking occurs less frequently among toddlers with ASD as compared to children with typical development (Ermer & Dunn, 1998; Ben-Sasson et al., 2007). As children with ASD reach preschool-aged, parent report data has shown that they demonstrate increased rates of sensory seeking (Watling, Dietz, & White, 2001). The literature on the sensory seeking behaviors among school-aged children with ASD is sparse; although, it may be that as children age, sensory seeking behaviors become more apparent and reported by caregivers, as the unusual nature of these features diverges with typically developing children (Honey, Leekam, Turner, & McConachi, 2007).

A majority of the research on enhanced perception among individuals with ASD has been conducted with high functioning adults. Such research has found that adults with ASD exhibit enhanced visual perception of static targets and dimensions (Mottron, Dawson, Soulières, Hubert, & Burack, 2006), enhanced pitch recognition (Bonnell, 2003), and enhanced perception of certain types of tactile input (Cascio et al., 2008).

Autism Severity. Sensory features have been linked with autism severity as well as core impairments of ASD (social interaction, communication, restricted and repetitive behaviors). The severity of sensory symptoms is associated with levels of autism severity (Ben-Sasson et al., 2009; Kern et al., 2007). Few studies have linked differential sensory response patterns with autism severity; however, Liss and colleagues (2006) suggested that it is specifically the presence of sensory seeking that is associated with autism severity. The severity of children's sensory features has been linked with social communicative symptom severity (Hilton et al., 2007), as well as specifically to the presence of hyporesponsiveness (Watson et al., 2011). Moreover, the severity of sensory symptoms is associated with the severity of restricted and repetitive behaviors among children with ASD (Boyd, McBee, Holtzclaw, Baranek, & Bodfish 2009; Gabriels, Cuccaro, Hill, Ivers, & Goldson, 2008). Hyperresponsiveness has been associated with stereotypies, compulsions, and rituals, and the presence of sensory seeking has been linked with ritualistic / sameness behaviors (Boyd et al., 2010). In summary, research is beginning to uncover the relations between sensory features and child characteristics (MA, CA, autism severity).

Sensory Response Patterns: Impact on Home and Community Activities

Sensory response patterns are often at the periphery of the studies that have investigated the occupations, or activity participation, of children with ASD. Findings from these studies provide insight into the possible interplay between sensory response patterns and activity participation, and inferences can be made to inform the current investigation. The purpose of this section is to describe the research that provides insight into the how sensory response patterns impact the activity participation among children with ASD.

The severity of sensory features may contribute to the limited activity participation among children with ASD. Specifically, children that demonstrate hyperresponsiveness may experience decreased community activity participation. Research has found that caregivers attribute children's hyperresponsiveness to sensory stimuli as a reason for not visiting restaurants (Larson, 2006; LeVesser & Berg, 2011). Schaaf and colleagues (2011) found that caregivers of children with ASD restrict activity participation to familiar spaces, as the sensory stimuli associated with unfamiliar spaces may be unexpected and children's responses are unpredictable. Hyperresponsiveness and sensory seeking have also been associated with decreased social, school, and activity competence among school-aged children with ASD (Ashburner, Ziviani, & Rodger, 2008; Reynolds et al., 2011), which may be partially due to the unpredictability of stimuli in these contexts.

There is emerging evidence that caregivers' difficulty associated with monitoring and accommodating activities due to children's sensory features contributes to decreased participation. In order to monitor children's responses to sensory stimuli of participation in community activities, parents have reported utilizing "back up plans" in case children demonstrate aversive behavioral responses during community activities (Bagby et al., 2012). Caregivers' vigilance regarding the unpredictability of sensory stimuli as associated with community activities was also reported by Larson (2010), who stated, "These mothers vigilantly oversaw social and physical environments to mitigate social and sensory features that were troublesome and could lead to severe behavioral problems" (p.19). Research suggests that in unfamiliar environments (e.g., community activities such as sporting events), caregivers do not have the tools or strategies readily available to cope with children's responses to unexpected sensory stimuli (Schaaf et al., 2011). This interplay between the unpredictability of sensory stimuli and social aspects associated with community activities, as reported by caregivers, provides insight into how children's sensory features interact with the severity of autism symptoms, which may result in decreased participation.

Evidence suggests that activities in the home environment may be more predicable than those in community settings for children and more easily controlled by caregivers. Research on household activities among families of children with ASD sheds light onto how children's sensory features may both inhibit and support participation. Caregiver descriptions of home activities, such as meal times, bed times, and cuddling with their children, are impacted by the children's responses to the sensory stimuli associated with those activities (Marquenie et al., 2011). For example, Dickie and colleagues (2011) reported that one mother of a child with ASD stated, "Anytime he has a hug, I think he gets a stim because he likes the deep pressure" (p.176). Activities such as cuddling and roughhousing may be pursued more frequently due to children's sensory response patterns. Conversely, sensory features may constrain children's participation in home activities. Meal times and self-care activities have been discussed in the literature as challenging for caregivers of children with ASD, which may partially be due to children’s sensory responses (Marquenie et al., 2011; Nadon, Felman, Dunn, & Gisel, 2011).

Research suggests that it is not merely the severity of children’s sensory features that impact participation; instead, it may be that sensory response patterns differentially impact home and community activity participation. A recent study found that caregivers implement differential accommodations to both community and home activities based on their children’s sensory response patterns (Little et al., in preparation). This mixed methods analysis revealed that caregivers implement qualitatively different types of accommodations based on children’s hyperresponsiveness, hyporesponsiveness, and sensory seeking. For example, the findings showed that some caregivers of children with ASD utilized a “remove and avoid” strategy when children demonstrated hyperresponsiveness. Moreover, hyperresponsiveness elicited a higher number of accommodations from caregivers as compared to hyporesponsiveness and seeking.

One study that has measured the impact of sensory response patterns on the activity participation, as self-reported by school-aged children with ASD, found that sensory symptom severity was associated with less frequent activity participation (Hochhauser & Engel-Yeger, 2010). Specifically, hyperresponsiveness was associated with decreased frequency in physical activities and sensory seeking was associated with increased in-home activities, such as doing puzzles. The association between seeking and participation in in-home activities was unexpected, and authors attributed this finding to the possibility that caregivers provide increased opportunities for children to participate in activities to improve children’s skills in certain areas.

The impact of enhanced perception on the activity participation among school-aged children with ASD has not been previously investigated, and previous research on this sensory response pattern has focused on high-functioning adults with ASD (Ashwin, Ashwin, Rhydderch Howells, & Baron-Cohen, 2009; Bonnell, 2003; Cascio et al., 2008). Enhanced perception is characterized by hyper acuity and hyper awareness of the elements of activities (Mottron et al., 2006), which may aid participation in certain activities. For example, individuals that demonstrate enhanced perception may perform better on puzzles or block design tasks, as they are successful at processing sensory information at the local level. The over-focus and hyper-systemizing approach that enhances local level processing, however, may also be at the expense of the interpretation of the global meaning (Dakin & Frith, 2005), which may ultimately detract from activity participation. Moreover, enhanced perception is theorized to be highly associated with hyperresponsiveness, which has been shown to negatively impact activity participation (Baron-Cohen et al., 2009). It is unknown how enhanced perception will impact the activity participation in the current study; there is evidence, however, that it could either be positively or negatively associated with children's activity participation.

While research has provided insight into how overall sensory severity and differential patterns may impact children's home and community activity participation, many of the abovementioned studies utilized qualitative methods with small samples. The study that has addressed associations between sensory response patterns and activity participation utilized a small sample (n=25) of high-functioning children with ASD as compared to children with typical development, and did not address the role of enhanced perception as it may impact activity participation (Hochhauser & Engel-Yeger, 2011).

The descriptions and meanings of caregivers' experiences with children with ASD that were revealed in the abovementioned studies influence understandings around the interplay between children's sensory features and activity participation. Nonetheless, there is a lack of empirical research that has examined the extent to which the frequency and variety of home and community activities may be both negatively and positively associated with different sensory response patterns in a large sample of children with ASD.

In summary, this chapter reviewed the literature that supports the occupational science approach to studying elements of occupations (i.e., dimensions of activity participation) and the individual capacities interacting with those elements (i.e., sensory response patterns). Literature on the activity participation among children with ASD has been described, as well as the limitations that exist in this literature. The number of instruments available to measure activity participation were reviewed and highlighted specifically for use in the current study. Moreover, the evidence that sensory response patterns are associated with other child characteristics (i.e., CA, PEDA, autism severity) was discussed. The few studies which showed that activity participation may be linked with children's sensory features were discussed, and methodological limitations of these studies were addressed.

Gap in Literature

Research on the home and community activity participation of children with ASD has largely utilized methods such as caregiver interview data, time diaries, and self-reports, which are insufficient for large scale empirical studies. Findings associated with the small sample, primarily qualitative studies inform understandings of the meanings associated with the activity participation among children with ASD; however, a large-scale study of the frequency and types of activity participation has not yet been conducted, which would contribute to a generalization of findings. A limited amount of research has addressed the participation in home and school activities among school-aged children with ASD specifically. Research with preschool-aged and adolescent aged children with ASD has provided insight into their activity participation; however, very little is known about the activity participation among school-aged children with ASD.

Children's sensory response patterns have been negatively associated with activity participation, and research has largely overlooked the possibility that children's patterns of sensory response may differentially, even positively, impact dimensions of participation in the home and community. Further, evidence suggests that child characteristics (i.e., developmental age, CA, and autism severity) are associated with children's sensory features. These maturational variables have not yet been considered in the investigation into the interplay between sensory response patterns and the activity participation of children with ASD. The link between children's sensory features, other child characteristics, and activity participation has remained unexamined in the literature.

Research Questions

This study addressed the following research questions:

Research Question 1: What empirically derived dimensions characterize the participation of school-age children with ASD on the HCAS?

Hypothesis: I hypothesized that the HCAS would tap five dimensions of activity participation, including: 1) household tasks; 2) family events; 3) solitary activities; 4) physical / outdoor activities; and 5) social / community activities. Previous research has not examined the range of activities in which school-aged children with ASD participate utilizing factor analysis; therefore, this was an exploratory factor analysis. This hypothesis, however, was based on the shared commonalities between dimensions of activity participation across measures as explicated above.

Research Question 2: To what extent are sensory response patterns (hypo, hyper, seeking, EP) associated with dimensions of participation among children with ASD?

Hypotheses: First, I hypothesized that hyperresponsiveness would be negatively associated with frequency in household tasks, family events, physical/ outdoor activities, and social / community activities. Research suggests that caregivers attribute children's hyperresponsiveness or the potential for aversive responses as a reason for a lack of participation (Bagby et al., 2012; Larson, 2010; LeVesser & Berg, 2011). There is also evidence that caregivers implement the highest number of accommodations in the presence of children's hyperresponsiveness (Little et al., 2011).

Second, I hypothesized that hyporesponsiveness will be negatively associated with the frequency of participation in social events / community activities. Emergent research on the associations between sensory features and social-communication development suggests that children demonstrating hyporesponsiveness do not orient to social stimuli and thus miss opportunities to engage with caregivers and peers (Watson et al., 2011). Therefore, activities that are based on interaction with others such as social events and community activities will be particularly negatively impacted by the presence of hyporesponsiveness.

Third, I hypothesized that sensory seeking would be positively associated with participation in solitary activities, in addition to negatively associated with the frequency of social activities. There is limited evidence on sensory seeking of children with ASD; however, research suggests that sensory seeking is negatively associated with social interaction and communication skills (Watson et al., 2011), and anecdotal evidence shows that children exhibiting sensory seeking behaviors often do so alone (Spitzer, 2003).

As earlier explicated, the evidence on enhanced perception has suggested that certain skills of individuals that exhibit this sensory response pattern may contribute to successful participation in certain activities (e.g., puzzles); however, other research suggests that an over-focus on details may detract from activity participation. Therefore, this aspect of research question two (i.e., the impact of enhanced perception on dimensions of activity participation) was exploratory in nature.

Research Question 3: To what extent do child characteristics (i.e., CA, MA, autism severity) moderate the associations between sensory response patterns and dimensions of activity participation?

Hypothesis 3: I proposed that CA, MA and autism severity moderate the associations between sensory response patterns and dimensions of participation. Specifically, the association between sensory features and participation was hypothesized to be increasingly negative for older children with ASD than younger children. Next, I hypothesized that the negative association between sensory features and participation would differ based on children's developmental ages and levels of autism severity, with the magnitude of the association between sensory features and participation to be larger for younger and lower functioning children.

CHAPTER 3

METHOD

Design

This cross-sectional, online survey study utilized a factor analytic approach to derive an empirical model of home and community activity participation in a large sample of school-age children with ASD (n=713). Questionnaire data utilized for the current study were administered to the sample at one point in time, concurrently. This design allowed for the examination of the associations between sensory response patterns (hypo, hyper, seek, EP) and derived factors of home and community activity participation, as moderated by child characteristics (i.e., parents' estimated developmental age, chronological age, autism severity).

Data Collection

This study utilized extant data drawn from a larger, longitudinal study: The Sensory Experiences Project – ARRA Supplement Grant (R01 HD042168-06S1). The aims of this larger, national survey study were to identify subtypes of children as defined by specific sensory response patterns from a large heterogeneous ASD sample and determine the stability of these subtypes in children ages 1-13 years. As part of the larger study, caregivers of children with ASD completed online questionnaires regarding various aspects of their child's development at two time points, approximately one year apart. The current study primarily used questionnaire data from the second time point, with the exception of a measure of autism severity (SRS; Constantino & Gruber, 2005), which was administered to the sample at the first time point.

Procedures

As part of the larger study, participants were recruited through autism organizations across the United States, including the Interactive Autism Network, an online research registry for caregivers of children with ASD. Recruitment began in May 2010 and was conducted through December 2010 solely through online recruitment material. Before completing the full battery of online questionnaires, potential participants completed a short screening questionnaire that determined eligibility for full participation based on inclusion/exclusion criteria. Once determined eligible, participants were sent an electronic invitation to participate, and sent at least 3 electronic follow up contacts to complete the surveys if needed. The sample was contacted at two time points, approximately one year apart. Participant consent was obtained electronically at the first time point, between May 2010 and December 2010, as well as the second time point, between May 2011 and December 2011.

At both time points of the larger study, questionnaires were available through Qualtrics, which is a survey collection tool made available through the University of North Carolina at Chapel Hill. Qualtrics allows users to make questionnaire data available through a secure website, and confidentially download participant data onto secure servers in SPSS 21.0 or excel formatted files. Participants were given the option to request, complete, and return paper copies of the surveys. Following completion of the surveys at the first time point, all online survey data was downloaded onto a secure server, and participants were assigned identification numbers. Confidential identifying information was then removed from survey data. Participants that completed questionnaire data at the first time point in data collection were contacted approximately one year later, and invited to complete another battery of surveys. At both time points, families were offered a $5.00 gift card as an incentive for completing the questionnaires. The Sensory Experiences Project – ARRA Supplement Grant study (including the aims of this dissertation) was approved by University of North Carolina at Chapel Hill's Institutional Review Board.

The current study primarily utilized questionnaire data from the second time point, which was collected between May 2011 and December 2011. At the second time point of data collection, questionnaire completion required approximately 1.5 hours of time from participants. Data that were downloaded from Qualtrics into SPSS 21.0 files went through a series of data cleaning steps to ensure that questionnaires were matched across participants, assigned accurate identification numbers, and demographic information collected from the first time point was accurate. Additionally, data were checked for errors through data management core at University of North Carolina at Chapel Hill.

Participants

The sample included in the factor analysis of the HCAS included 713 caregivers of children with ASD ages 5-12 years 11 months (mean=105.93 mos.; SD=26.02 mos.; range=60-155). Children included in the current study had a caregiver reported diagnosis of an autism spectrum disorder, including autism or autistic disorder, Asperger's Syndrome, and Pervasive Developmental Disorder-Not Otherwise Specified (PDD-

NOS). A subsample of caregivers reported that their children had concurrent ASD diagnoses (e.g., autism and PDD-NOS). A subsample of participants (n=686), aged 5-12 years 11 months (mean=106.12 mos.; SD=25.85 mos.; range=60-155 mos.) was utilized to address the second research question due to missing data (n=26). Among the subsample (n=686), child characteristics included in the current study were parents' estimated developmental age (PEDA) (mean=83.9 mos.; SD=31.86 mos.; 6.50-161.50 mos.) and autism severity as a measure of the Social Responsiveness Scale (SRS; Constantino & Gruber, 2004) total raw score (mean=106.69; SD=27.51; range=14-174). Table 3.1 provides demographic and diagnostic information about the sample utilized for the HCAS EFA and subsample utilized for the second set of analyses.

Table 3.1. Sample Demographics

Demographic Variable	Factor Analysis (n=713) n (%)	Subsample (n=686) n (%)
Child gender		
Male	593 (83.2)	571(83.2)
Female	120 (16.8)	115 (16.8)
Child race /ethnicity		
Caucasian	608 (85.3)	587 (85.7)
African-American	16 (2.2)	16 (2.3)
Hispanic	60 (8.4)	55 (2.8)
Asian	9 (1.3)	8 (1.2)
Other	25 (11.1)	46 (6.8)
Unknown	1 (.1)	1 (.1)
Diagnostic category		
Autism/autistic Disorder	365 (51.2)	350 (51.0)
Asperger's Syndrome	157 (22.0)	151 (22.0)
PDD-NOS	127 (17.8)	125 (18.2)
Multiple ASD diagnoses	64 (9.0)	60 (8.7)
Respondent		
Mother	684 (95.9)	657 (95.8)
Father	23 (3.2)	23 (3.4)
Grandmother	3 (.4)	3 (.4)
Other Primary	3 (.4)	3 (.4)

Inclusion / Exclusion Criteria. Children included in the current study were aged 5 years to 12 years 11 months (60 – 155 months) and had a caregiver reported diagnosis of an autism spectrum disorder. Exclusionary criteria were as follows: co-morbid conditions of autism, such as Fragile X Syndrome; significant visual or hearing impairments; developmental disabilities due to a genetic disorder or syndrome; physical impairments; psychiatric conditions such as schizophrenia; seizure activity within the last 12 months; or had lost a diagnosis of an ASD in the previous year.

Measures

HCAS. (15 minutes). The Home and Community Activities Scale (HCAS; adapted from Dunst, Hamby, Trivette, Raab, & Bruder, 2002) is an 83-item parent report instrument that measures the frequency with which children participate in activities of daily life in the home and community. Caregivers rate the frequency of the child's participation in each activity on a scale from never (1), monthly (2), weekly (3), or daily (4). The HCAS is based on research by Dunst, Hamby, Trivette, Raab & Bruder (2000), in which 3300 children with or at risk for developmental delays were surveyed to determine the settings of naturally occurring learning opportunities.

SEQ. (15 minutes). The Sensory Experiences Questionnaire Version 3.0 (SEQ; Baranek, 1999; Baranek et al., 2006) is a 105-item caregiver report tool that characterizes sensory features in children ages 2-12 years with ASD and/or developmental disabilities (DD) in social and non-social contexts. Ninety-seven items on the SEQ 3.0 measure the frequency of child responses to various sensory stimuli in the context of functional activities and daily routines using a 5-point Likert scale ranging from 1 (almost never) to

5 (almost always.) Eight items about the child's sensory behaviors allow the caregiver to elaborate with a qualitative response. Previous studies have shown that the SEQ 2.0 has good internal consistency and test-rest reliability (Little et al., 2010). A confirmatory factor analytic study has shown that the SEQ 3.0 demonstrates good model fit (RMSEA = .050; CFI = .722; SMRR= .065), with factor loadings for the latent sensory factors (hypo, hyper, seeking, enhanced perception) generally strong and all significant ($p < .001$); all were greater than .2 and the vast majority were .4 or greater (Ausderau et al., in preparation).

Background Information Questionnaire. (30 minutes). The Background Information Questionnaire (BIQ; unpublished questionnaire) is a caregiver report measure designed to gain demographic information about the families of children with ASD, child's therapy and treatment history, and child characteristics such as communication ability, IQ, and comorbid diagnoses. This study utilized BIQ data, including basic demographic data (i.e., gender, race, ethnicity), chronological age, and the parents' estimate of the child's developmental age (PEDA).

Social Responsiveness Scale. (20 minutes). The Social Responsiveness Scale (SRS; Constantino & Gruber, 2005) is a 64-item caregiver report quantitative measure of autistic traits in children. The SRS has been found to have a single factor structure (Constantino et al., 2004), and the subscales of the SRS address the three core symptoms of ASD (social deficits, language deficits, and stereotypic behaviors/restricted range of interests). Psychometric studies on the SRS have suggested that the measure has good interrater reliability (0.80) (Constantino et al., 2003) and convergent validity with the Autism Diagnostic Interview-Revised (ADI-R; Lord, Rutter, & Couteur, 1999). The SRS data utilized for the current study were drawn from the first point of data collection, approximately one year prior to the collection of other measures (i.e., HCAS, SEQ, BIQ). Research suggests that SRS has excellent test-retest reliability (0.88 over three months; 0.83 over 27 months) (Constantino & Todd, 2003; Constantino et al., 2003). Therefore, there is strong evidence that the stability of the SRS score as previously gathered to inform the current study is a valid estimate of participants' autism severity. The current study utilized the total SRS score, which is an index of autism severity, and higher SRS total scores indicate increased impairment.

Data Analysis

Exploratory Factor Analysis

In order to address research question 1, "What empirically derived dimensions characterize the participation of school-age children with ASD on the HCAS?", an exploratory factor analysis (EFA) on the HCAS in Mplus (Muthén Muthén, 1998) was conducted. Exploratory factor analysis is a method utilized to explain the variation and covariation in a set of variables (Preacher & MacCallum, 2003), and is appropriate for use when there is limited research on the phenomenon of interest. Limited research exists on the dimensions of activity participation among school-aged children with ASD; therefore, confirmatory factor analysis (CFA) was not used to analyze data. Utilizing a CFA approach would result in hypothesizing parameter estimates that would unnecessarily constrain the data (Costello & Osborne, 2005). However, the current study proposed a hypothesis regarding the structure of the HCAS, which is helpful in conceptually guiding an EFA (Ferguson & Cox, 1993).

Factor analysis requires that the researcher make a number of decisions that guide the analysis, and ultimately, shape the results. Decisions regarding the rotation method as well as the number of factors and items to retain have consequences for the quality and meaningfulness of results (Preacher & MacCallum, 2003). Moreover, the decisions that are made regarding the number of factors and retainment of items represent an interplay between theory and statistical evidence. In order to guide the series of decisions in EFA, the literature on factor analysis often refers to Thurston's (1947) concept of simple structure. Simple structure refers to the case in which the fewest meaningful factors and high item loadings on each factor is the most desirable. There is a multiplicity of possibilities related to the rotation matrices of data, the number of factors that may be kept in the interpretation, and the items that are retained. The solution that presents high item loadings on each factor in conjunction with low inter-factor correlations should be chosen. In sum, simple structure refers to the situation in which the least complex, most meaningful solution is chosen. The factors retained as well as the items that are retained on each factor, therefore, should be most easily interpretable, meaningful, and replicable (Fabrigar, Wegener, MacCallum, & Strahan, 1999; Preacher & MacCallum, 2003).

Exploratory factor analysis demands a number of steps, including: 1) type of EFA; 2) sample size; 3) factor extraction method; 4) rotation; 5) number of factors to interpret; 6) retainment of items on each factor; and 7) naming of factors. The HCAS consists of 83 items measured on a categorical measurement scale from Never = 1, Monthly = 2, Weekly = 3, and Daily = 4. Due to the ordinal nature of the data, a categorical factor analysis was utilized. Regarding sample size, the current study sufficiently meets Goruschs's (1990) recommendation for a 5:1 ratio of number of participants to number of items, as the approximate ratio of participants to items in the current study was 8.5:1.

The choice of a factor extraction method is based on the assumptions regarding the distribution of the data. Assumptions regarding the continuous nature of the data cannot be met, as the HCAS data is based on ordinal response categories. Consequently, the extraction method utilized in the current study was weighted least squares with mean and variance adjustment (WLMSV), as recommended for categorical exploratory factor analysis in Mplus by Muthén, DuToit, and Spisic (1997). The WLSMV approach is recommended for sample sizes 200 or greater, and utilizes polychoric correlations, which estimate the linear relationship within ordinal data (Muthen, du Toit, & Spisic, 1997).

The method of rotation simplifies and clarifies the data structure (Costello & Osborne, 2005), and can have drastic consequences for the results of the anaylsis (Preacher & MacCallum, 2003). Rotation cannot, however, alter the amount of variance extracted for the solution (Costello & Osborne, 2005). Two broad categories of rotation are often explicated in the literature: orthogonal and oblique rotation. Orthogonal rotation methods produce factors that are not correlated, while oblique rotation methods allow for the correlation between factors. The data used in the current study were assumed to be correlated, as is common in social science research (Costello & Osborne, 2005). The default rotation in Mplus for a categorical EFA is geomin (Yates, 1987), as some studies suggest that it yields superior results as compared to other oblique rotation methods (Browne, 2001). However, there are a number of available oblique rotations, oblimin being the most commonly utilized as it is the rotation that most drastically rotates the data structure (Ferguson & Cox, 1993). Both geomin and oblimin rotations were utilized and the results of which were subsequently compared in the current study.

An essential step in exploratory factor analysis is the determination of the number of factors to retain. Although some have argued that any factor with an eigenvalue over 1.0 should be retained (Guttman, 1954), this has been found as the least accurate method of factor retention (Velicer & Jackson, 1990). Visual inspection of scree plot has been suggested as an accurate and acceptable method for determining the number of factors to retain (Costello & Osborne, 2005; Fabriagar et al., 1999). This method allows the researcher to visually examine the plot of eigenvalues, and retain the number of factors above the bend, or break, in the data points.

Following the inspection of the scree plot and detainment of number of factors, the inter-factor correlations and item loadings among each factor were examined. Inter-factor correlations give an estimate of the unique contribution of each factor for the model, and therefore are expected to be minimally correlated (Tabachnick & Fidell, 2007). The decisions regarding which items to keep were based on recommendations in the literature as well as the meaningfulness of items as they loaded on the factors. Although there exist no clear statistical guidelines for retaining items and choosing an arbitrary cut point may be detrimental to the solution (Preacher & MacCallum, 2003), research suggests that items with loadings greater than .32 be examined (Tabachinick & Fidell, 2007) and analyzed with regard to the extent to which they meaningfully contribute to the factor. Item loadings are considered “high” if they load above 0.80 on a factor, although this is rare is social sciences. More commonly, items communalities between 0.40 and 0.70 are likely to occur and considered low to moderate (Costello &

Osborne, 2005). Cross loading of items, or those items that load on more than one factor, may be problematic as they suggest that the variance associated with one item is not necessarily attributable to one factor (Ferguson & Cox, 1993). The magnitude of difference between items should be considered in the deletion of items, in addition to the examination of the factor correlations and item communalities (Worthington & Whittaker, 2006). For the current analysis, items that loaded on two factors within 0.10 of one another were deleted, in conjunction with the consideration of factor correlations. Moreover, solutions from a factor analysis should account for approximately 50% of the variance, as suggested by Streiner (1994). Therefore, the overall accounted variance for each solution was examined.

In order to test the stability of the model chosen to best represent the data, the results of the initial EFA were reanalyzed. Items were deleted based on the results of the initial model, and the second round of analysis of data should produce a scree plot similar to the first, which supports the determination and retainment of number of factors. The eigenvalues associated with the reanalysis with deleted items should be reported and serve as evidence for the stability of the model with deleted items (Costello & Osborne, 2005).

The factors were named trough a two-pronged process adapted from the guidelines described by Ferguson and Cox (1997). First, the hypothesized factor names and associated items were compared with the factors that emerged from the EFA. Each item was hypothesized to load on one of five factors; therefore, each item was assigned a factor name prior to data analysis. Following data analysis, the item loadings that emerged from the EFA were analyzed according to the hypothesized, and subsequently comparing the similarities across the factors that were revealed. The second approach used to name factors included presenting the item loadings on each factor to a panel of a team of scientific investigators (n=7) and doctoral students (n=3), having the judges blindly name the factors, and discussing the names that were applied. Chosen factor names will be discussed in the results section.

Mixed Model Regression Analysis

In order to address research questions 2 and 3: "To what extent are sensory response patterns (hypo, hyper, seeking, enhanced perception) associated with dimensions of participation among children with ASD?" and "To what extent do child characteristics (i.e., CA, MA, autism severity) moderate the associations between sensory response patterns and dimensions of activity participation?", mixed model regression in SAS 9.2 (SAS Institute, 2008) was used. Mixed model regression, also referred to as hierarchical linear modeling or multi-level modeling, allows for fixed and random effects to be included in a model. The repeated administration of questionnaires to each participant introduces dependence in the measurement of outcomes, as responses are nested within individuals (Raudenbush & Bryk, 2002). Therefore, the estimation of random effects accounts for such dependence, and is particularly suited to the current data due to the nesting of outcomes within individuals (Burchinal & Applebaum, 1991; Raudenbush & Bryk, 2002). Additionally, mixed model regression with nested outcomes within individuals allows for specific and direct test of differential model effects for different outcomes (Littell et al., 2006). In other words, the outcomes may be directly compared to one another through one outcome category serving as a reference for other outcomes. Data analysis for the current study utilized a mixed model to test the effects of the independent variables of four sensory response patterns (hyperresponsiveness, hyporesponsiveness, sensory seeking, enhanced perception) on the dependent variables of dimensions of activity participation, which were nested within child. The following covariates were entered into the model: child CA, parents' estimated developmental age, and autism severity. Descriptions of the variables used are explicated below.

Sensory Response Pattern Factor Scores. Factor scores on the sensory patterns (hyporesponsiveness, hyperresponsiveness, sensory seeking, enhanced perception) were derived from the CFA on the SEQ 3.0, and served as independent variables in the model. As earlier explicated, the factor model of the SEQ 3.0 (Baranek, 1999) is described in Appendix B (Ausderau et al., in preparation). The CFA model of the SEQ utilized a larger sample (n=884) with a larger age range (36-168 months) than the sample utilized in the current study. SEQ 3.0 factor scores for participants that met inclusion and exclusion for the current study were imported into an excel file, matched according to each participant's unique identification number, and subsequently used in the analysis.

HCAS Mean Scores. HCAS mean scores were utilized as the dependent variables in the model, as opposed to HCAS factor scores. The dependent variables utilized in the model to address research questions 2 and 3 were derived through an EFA; therefore, factor scores associated with this model reflect the lack of predetermined parameters which characterize an EFA approach (Ford, MacCallum, & Tait, 1986). However, the factor scores derived from an EFA in a CFA framework are highly significantly correlated with mean factor scores (Ford, MacCallum, & Tait, 1986), and will be shown in the results section.

Chronological Age (CA). Child CA was considered as the difference between the child's date of birth and the date of the caregiver's completion of the HCAS.

Parents' Estimated Developmental Age (PEDA). In order to derive the score of estimated cognitive functioning, caregiver response categories (1-21) of six and twelve-month intervals (e.g., 12-17 months; 5-6 years) ranging from less than 12 months to 18.9 years were recoded to reflect the median of each category. For example, the category of 5 to 5.9 years (60 to 71 months) was recoded into 65.5 months.

Autism Severity. The covariate of child autism severity was utilized as the total raw score on the SRS (Constantino & Gruber, 2005). Higher raw scores on the SRS indicate increased symptoms of ASD.

Mixed model regression demands a number of decisions, including: 1) determining random versus fixed effects; 2) the type of covariance structure; 3) the estimation method; and 4) the degrees of freedom method. The independent variables were treated as fixed effects, with the intercept treated as a random effect. There are a number of covariance structure options, which specify the variance-covariance matrix and serves as a starting point to estimate model parameters (Field, 2009). The current analysis utilized an unstructured model, as this approach is applicable to data with repeated measures, and assumes the covariances do not conform to a systematic pattern (Littell et al., 2006). As for the estimation method, restricted maximum likelihood was used in the analyses, as this method is argued to be the most effective for use in mixed models and favored over a maximum likelihood approach which may be biased toward small samples (Littell et al., 2006). Lastly, the Kenward-Roger (1997) method of estimating degrees of freedom was utilized, as it is strongly suggested for use with repeated measures data and applicable to an unstructured model.

Data utilized for the mixed model were screened for normality, which included an examination of the descriptive data and diagnostic information on the data. The normality of the distribution of errors was examined through the inspection of a histogram of the standardized residuals. Further, collinearity, which indicates the presence of linear relationships between predictors and covariate variables (Field, 2009), was screened through bivariate correlations.

Chapter 4

RESULTS

The purpose of this study was to examine the structure of the home and community activity participation as measured by the HCAS in a large, national sample of school-aged children with ASD. In addition, this study examined the extent to which sensory response patterns (i.e., hyporesponsiveness, hyperresponsiveness, seeking, enhanced perception) were associated with dimensions of activity participation as moderated by child characteristics (i.e., autism severity, PEDA, CA). This chapter will be divided into two sections: 1) the results of the exploratory factor analysis of the structure of the HCAS; and 2) the results of the mixed model regression analyzing the associations between dimensions of HCAS and sensory response patterns.

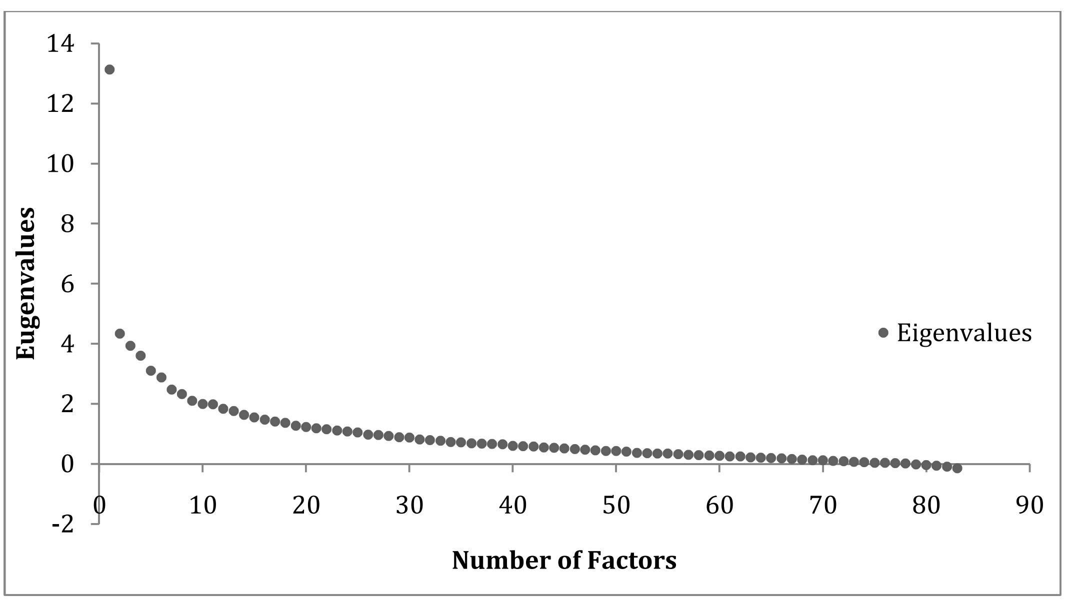
HCAS Factor Structure

In order to determine the empirically derived dimensions that characterize the participation of school-age children with ASD on the HCAS, the results of a categorical exploratory factor EFA utilizing WLMSV were analyzed. One, two, and six factor solutions using both geomin and oblimin rotation were evaluated with regard to statistical evidence and theoretical meaningfulness.

Descriptive data, including counts and percentages for each item are reported in Appendix C. The normality of distribution of data are not considered for a categorical EFA utilizing WLMSV, as it can be used with ordinal data while not assuming multivariate normality (Muthen & Muthen, 2004).

The exploratory factor analysis yield 25 factors with eigenvalues exceeding 1.00. As earlier stated, research has shown that retaining eigenvalues over 1.00 is an inaccurate method of determining number of factors (Fabrigar et. al, 1999); therefore, the results of the scree plot were investigated. The scree plot is shown in Figure 4.1. The “breaks” that characterized the viable solutions were between one and two factors (13.130-4.336), two and three factors (4.336-3.929) and six and seven factors (2.875-2.471); therefore, the one, two, and six factor solutions were investigated with regard to the interplay between statistical evidence and theoretical meaningfulness. The one factor and two factor solutions will be described below; however, the six factor solution was ultimately determined to most succinctly characterize the data.

Figure 4.1. HCAS Scree Plot



HCAS: One Factor Solution

The one factor solution accounted for 10.8% of the variance, and item loadings ranged from .027 to .787. Twenty-six items did not load above .320 on the one factor solution, and the item loadings were quite low, with the highest item loading at .787. Theoretically, these highest loading items did not appear to share a common theme associated with children's activity participation, and the variance explained by the one factor solution was low. Consequently the one factor solution was rejected and results of the two-factor solution were investigated.

HCAS: Two Factor Solution

The two-factor solution was investigated to determine the extent to which it characterized activity participation among children with ASD. The results of the geomin and oblimin rotation methods were compared, and both solutions suggested that the majority of items loaded on factor one, with many fewer items loading on factor two. The two-factor solution accounted for 11.9% of the variance. Table 4.1 shows the comparison of the number of items that loaded on each factor in addition to those items that cross loaded and loaded below .32 between the oblimin and geomin rotation solutions. The results of the item loadings for both the geomin and oblimin solutions are shown in Table 4.1, along with items that did not load above .32 and cross-loaded within a .10 magnitude difference across factors. Refer to Appendix D for the two factor geomin and oblimin solutions.

The geomin and oblimin rotation solutions yielded similar results. Two items on factor two in the oblimin solution (e.g., swimming, water play/swimming) negatively loaded, while the same two items cross-loaded on the geomin solution. As geomin rotation is suggested for use in categorical exploratory factor analysis and the increased negative factor loadings on the oblimin solution were not able to be interpreted, the results of the two-factor geomin rotation solution are discussed. The results of the two-factor geomin rotation solution revealed the majority of items loaded on factor 1 (n=47), while many fewer items loaded on factor 2 (n=6). Five items cross-loaded within a magnitude of .10 difference, while 24 items did not load above 0.32. Factor correlations of the two-factor model were 0.188, which suggested that each factor may make a unique contribution to the model.

Table 4.1. Two Factor Solution Geomin v. Oblimin Rotation Overview

	Factor 1 (n items)	Factor 2 (n items)	Low Loading Items* (n)	Cross loading items** (n)	Factor Correlations (r)
Geomin Solution	47	6	24	5	.188
Oblimin Solution	47	7	24	4	.022

Item loadings above 0.32 on each factor were examined in an attempt to meaningfully interpret the items on each factor. The item loadings from the geomin rotation solution on each factor, ranged from low to moderate on factor one (0.323 to 0.699) and low to high on factor two (0.323 to 0.875).

There was a lack of clarity regarding the interpretation of the items that loaded on the two-factor gemoin rotation solution. The majority of items loaded on factor one, and reflected a lack of meaningful cohesion among those items. Specifically, items that were theorized to tap community activities, outdoor activities, and social activities loaded on factor one, while activities that appeared to tap family events and household tasks (e.g., going to church, religious activities, praying, cleaning up room, picking up toys, household chores) loaded on factor two. The two-factor solution did not provide clear evidence related to the underlying latent structure of the activity participation among children with ASD, and the theoretical meaningfulness was questionable. Therefore, the two-factor solution was rejected and the six factor solution was examined next.

Six Factor Solution

The six-factor solution was investigated in order to determine the statistical evidence and theoretical meaningfulness presented by the data. Six factors accounted for 51.7% of the variance, which aligned with Streiner's (1994) recommendation that factors should account for at least 50% of the variance. The factor correlations, item loadings, and theoretical meaningfulness of items were considered for the geomin and oblimin rotation solutions.

The statistical evidence for both the geomin and oblimin rotation six factor solutions was similar. Factor correlations for the oblimin solution ranged from 0.002 to 0.280, while the geomin solution factor correlations ranged from -0.126 to 0.388. The oblimin solution factor correlations were all positive and somewhat lower. Both the oblimin and geomin factor correlations suggested that factors were minimally correlated, therefore each made a unique contribution to the model.

The item loadings on each solution were investigated, and the geomin rotation presented a higher number of items that more highly loaded as well as meaningfully aligned with one another. For example, the geomin rotation solution presented 15 items that highly and meaningfully loaded on factor one; however, the oblimin solution had 13 items that loaded on this factor. The lack of these two items (i.e., cooking/preparing meals and playing board games) as loading on factor one in the oblimin solution detracted from the overall meaningfulness of the factor. Moreover, 18 items did not highly load (<.32) on the oblimin rotation solution, while 11 items did not highly load on the geomin solution. This statistical evidence and theoretical meaningfulness suggested that the results of the geomin solution best represented that data. Factor correlations for the geomin solution are shown in Table 4.2.

Table 4.2. Six Factor Geomin Rotation Solution Factor Correlations

	Factor 1	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 6**
Factor 1	1.000					
Factor 2	0.388	1.000				
Factor 3	-0.126	0.037	1.000			
Factor 4	0.215	0.279	0.096	1.000		
Factor 5	0.124	0.079	-0.021	0.085	1.000	
Factor 6	0.119	0.130	-0.046	0.117	0.062	1.000

The results of the item loadings on the geomin rotation solution are presented in Table 4.3. Item loadings that were considered (above 0.320) included the following ranges on each factor: Factor 1: 0.343 to 0.711; Factor 2: 0.33 to 0.822; Factor 3: 0.392

to 0.65; Factor 4: 0.334 to 0.828; Factor 5: 0.388 to 0.629; and Factor 6: 0.413 to 0.908. Eleven items did not load above 0.320, sixteen items cross-loaded within 1.0 of one another and one item was a duplicate in the measure (i.e., running errands). Therefore, 28 items were deleted from the solution and 55 items were kept in the subsequent analyses. Refer to Appendix E for the item loadings for the six factor oblimin solution.

Table 4.3. Six Factor Geomin Rotation Solution Item Loadings

HCAS ITEM	F1	F2	F3	F4	F5	F6
Picking up Toys	**0.711**	-0.02	-0.147	0.08	0.094	0.219
Cleaning up Room	**0.612**	0.023	-0.139	0.046	0.206	0.287
Reading/Looking at Books	**0.611**	0.177	-0.103	-0.028	0.034	0.096
Adult/Child Play Times	**0.565**	0.201	-0.036	0.088	-0.163	-0.1
Telling Child Stories	**0.492**	0.246	-0.064	0.111	0.075	0.09
Bedtime Stories	**0.482**	0.324	-0.086	0.06	-0.071	0
Dancing/Singing	**0.445**	0.19	0.017	0.119	-0.323	-0.046
Family Talks	**0.437**	0.249	-0.032	0.21	0.221	0.332
Playing Ball Games	**0.432**	0.245	-0.165	0.289	-0.108	0.025
Listening to Music	**0.412**	0.208	0.064	0.136	-0.269	-0.04
Cuddling with Child	**0.381**	0.238	-0.046	0.162	-0.119	-0.111
Art Activities/Drawing	**0.37**	0.169	-0.145	0.007	-0.048	0.061
Cooking/Preparing Meals	**0.359**	0.139	0.097	0.138	0.236	0.139
Playing Board Games	**0.343**	0.225	-0.019	0.204	0.095	0.146
Children's Festivals	0.302	**0.822**	0.043	0.24	-0.052	0.269
Community Celebrations	0.171	**0.701**	0.104	0.323	0.037	0.242
County/Community Fairs	0.172	**0.662**	0.041	0.222	0.049	0.184
Hay Rides	0.285	**0.658**	-0.099	0.03	0.075	0.198
Music Concerts/Children's Theater	0.28	**0.62**	0.096	0.254	-0.018	0.169
Community Gardens	0.322	**0.613**	-0.028	0.11	0.107	-0.07

Parades	0.193	**0.611**	-0.088	0.297	0.013	0.162
Nature Centers	0.262	**0.6**	0.06	0.124	0.353	-0.094
Zoo/Animal Reserves	0.186	**0.589**	0.127	0.104	0.057	-0.059
Picnics	0.306	**0.564**	0.039	0.346	0.235	0.083
Animal Farms/Petting Zoos	0.192	**0.55**	0.054	0.048	0.16	0.026
Parks/Nature Reserves	0.292	**0.524**	0.128	0.16	0.313	-0.089
Children's Museums/Science Centers	0.203	**0.514**	0.096	0.195	0.071	0.047
Child Play Groups	0.29	**0.501**	0.016	0.23	-0.03	0.225
Storytellers	0.202	**0.484**	-0.14	0.135	-0.077	0.2
Indoor Playgrounds	0.31	**0.476**	0.03	0.25	-0.223	0.102
Recreation/Community Centers	0.207	**0.47**	0.164	0.308	0.071	0.085
Daycare/Preschool	0.037	**0.372**	0.123	0.023	-0.247	0.024
Family Gatherings	0.255	**0.352**	-0.078	0.285	0.097	0.083
Music Activities	0.279	**0.339**	-0.087	0.008	-0.17	0.206
Car Rides/Bus Rides	0.155	**0.33**	-0.023	0.011	-0.263	0.029
Doing Errands	0.399	0.235	**0.65**	0.228	0.198	0.033
Going Shopping	0.314	0.321	**0.561**	0.229	-0.105	0.037
Food Shopping	0.35	0.238	**0.569**	0.146	0.069	0.001
Eating Out	0.173	0.294	**0.392**	0.246	-0.041	0.143
Swimming	0.093	0.167	0.223	**0.828**	0.026	-0.242
Water Play/Swimming	0.089	0.151	0.202	**0.798**	-0.039	-0.261
Visiting Friends	0.342	0.304	0.025	**0.637**	0.092	0.358
Having Friends Over to Play	0.278	0.193	-0.036	**0.619**	0.162	0.351
Visiting Neighbors	0.268	0.249	0.021	**0.509**	0.171	0.329
Sleepovers	0.175	0.19	0.003	**0.422**	0.139	0.274
Basketball	0.293	0.177	-0.222	**0.334**	-0.006	0.21
Hiking	0.259	0.523	0.016	0.208	**0.629**	-0.162
Doing Yard Work	0.378	0.187	-0.052	0.103	**0.537**	0.123
Growing Vegetable Garden	0.358	0.288	-0.118	0.098	**0.45**	0.056
Camping	0.091	0.295	0.024	0.248	**0.418**	0.07
Caring for Pets/Animals	0.142	0.051	0.121	0.118	**0.388**	0.262
Going to Church	0.08	0.113	0.01	0.113	0.012	**0.908**
Religious Activities	0.116	0.211	0.018	0.1	-0.012	**0.9**
Praying	0.202	0.116	-0.09	0.074	0.034	**0.793**
Children's Clubs (4H, Scouts)	0.08	0.182	0.035	0.108	0.269	**0.413**

Cross Load within 0.10

Planting Trees/Flowers	**0.521**	**0.438**	-0.156	0.103	0.501	0.14
Taking Walks/Strolls	**0.432**	**0.369**	-0.047	0.134	0.055	-0.037
Household Chores	**0.434**	0.011	0.04	0.138	**0.363**	**0.305**
Nature Trail Walks	0.305	**0.56**	0.018	0.155	**0.589**	-0.196
Family Meetings	**0.382**	0.277	-0.138	0.182	0.281	**0.408**
Outdoor Playgrounds	**0.334**	**0.35**	-0.104	0.207	-0.132	0.047
Decorating Home (Holidays)	**0.443**	**0.536**	**-0.454**	0.214	0.224	0.147
Family Member's Birthdays	**0.343**	**0.486**	**-0.472**	0.239	0.121	0.08
Holiday Dinners	**0.402**	**0.547**	**-0.478**	0.275	0.151	0.059
Playing Arcade Games	0.058	**0.347**	0.031	**0.321**	0.118	0.222
Boating/Canoeing	0.101	0.291	0.012	**0.371**	**0.408**	0.085
Rafting/Tubing	0.037	0.154	-0.004	**0.381**	**0.368**	0.067
Fishing	0.102	0.211	0.033	**0.388**	**0.37**	0.082
School	0.059	0.178	-0.21	**-0.174**	**-0.238**	0.085
After School Care	-0.04	**0.318**	0.092	-0.096	**-0.235**	0.072
Riding Bike/Wagon	**0.329**	**0.257**	-0.037	**0.299**	0.107	0.096
Did not load above 0.32						
Playing Alone	0.189	0.035	0.179	-0.007	-0.128	-0.018
Horseback Riding	0.031	0.25	0.024	0.03	0.023	-0.012
Library/Book Mobiles	0.225	0.296	-0.054	0.05	0.111	0.189
Pet Stores/Animal Shelters	0.1	0.303	0.167	0.08	0.181	0.069
Watching TV/Videos/DVDs	0.113	0.02	-0.011	0.14	-0.087	0.043
Rough Housing	0.283	0.173	-0.074	0.156	-0.164	-0.112
Playing Video Games	0.035	0.028	0.075	0.186	0.178	0.231
Karate/Martial Arts	0.064	0.154	0.127	0.223	0.163	0.182
Soccer	0.256	0.174	-0.212	0.226	0.008	0.154
Gymnastics/Movement Classes	0.145	0.291	0.064	0.231	-0.145	0.076
Baseball	0.172	0.167	-0.165	0.312	-0.078	0.079
Duplicate Item						
Doing Errands	0.439	0.294	0.588	0.266	0.139	0.041

In order to test the stability of the six-factor model after the deletion of the low loading items and cross-loading items, the 55-item solution was tested using a categorical EFA in Mplus with geomin rotation. Results of the 55-item EFA scree plot suggested moderate stability, as there was a break in eigenvalues between the sixth and seventh factor solution (2.019-1.82). In order to support the utilization of HCAS mean scores as opposed to factor scores, the results of the EFA were analyzed in a CFA framework in Mplus, as factor scores cannot be derived from an EFA. Mean scores on each factor and factor scores derived from the CFA were tested using spearman correlations, and results are as follows: Factor 1 $r=.970$; factor 2 $r=.944$; factor 3 $r=.983$; Factor 4 $r=.940$; Factor 5 $r=.802$; and Factor 6 $r=.965$. All correlations were highly significant ($p<.001$), clearly lending support for the use of mean score of activity participation as outcomes in the mixed model.

Factor Naming

The process of naming the factors occurred through a two-pronged approach. First, my hypothesized factors as assigned to each item a priori were compared to the factors that emerged from the analysis. Second, a panel of experts on children with ASD ($n=11$) reviewed each factor's item loadings and asked to name each factor without discussion. After individually examining the factor loadings, factor names were discussed and I considered the input of the panel in the final assignment of factor names. The factor names that emerged from this iterative process were: Factor 1: Parent-Child Household Activities; Factor 2: Community Activities; Factor 3: Routine Errands; Factor 4: Neighborhood Social Activities; Factor 5: Outdoor Activities; and Factor 6: Faith-based Activities.

Six Dimensions of Activity Participation:

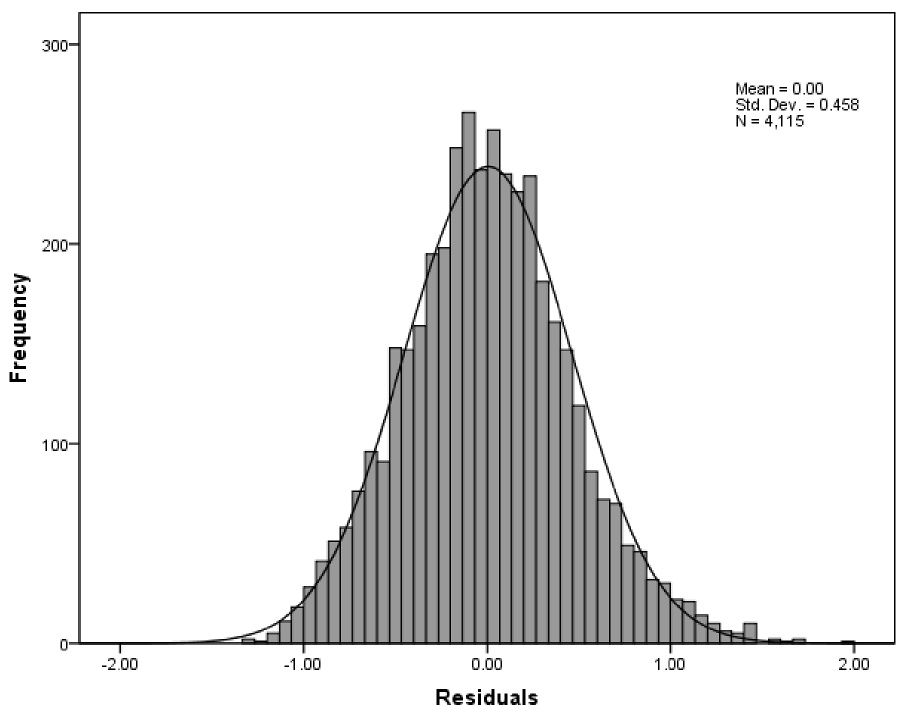
Associations with Sensory Response Patterns

Research questions two and three included: "To what extent are sensory response patterns (hypo, hyper, seeking, EP) associated with dimensions of participation among children with ASD?" and "To what extent do child characteristics (i.e., CA, MA, autism severity) moderate the associations between sensory response patterns and dimensions of activity participation?" Mixed model regression was utilized to address the associations between independent and dependent variables as well as covariates. Independent variables included sensory response patterns (hypo, hyper, seeking, EP), covariates included autism severity, chronological age, and parents' estimated developmental age, and dependent variables included HCAS factors (Parent-Child Household Activities Community Activities, Routine Errands, Neighborhood Social Activities, Outdoor Activities, Faith-based Activities).

Descriptive Statistics

In order to test the normality assumption, the residuals were calculated and the histogram of residuals is shown in Figure 4.2, which supports the assumption of normality in the data. With regard to parents' estimated developmental age, ninety (13.1%) caregivers of children with ASD were unable to provide an estimate. Furthermore, 66 (9.6%) caregivers estimated their child's development age as 12 months greater than the child's chronological age. These responses were considered missing for two reasons. First, extensive research suggests that the developmental age of children with ASD most often does not exceed their chronological age (Mottron, 2004). Second, the majority of available response categories for parents to estimate their child's developmental age were divided into twelve-month increments. Therefore, parents could have estimated their child's developmental age within the same twelve-month range as the child's CA. Consequently, 156 (22.7%) responses of PEDA were not included in the model.

Figure 4.2. Residuals Plot

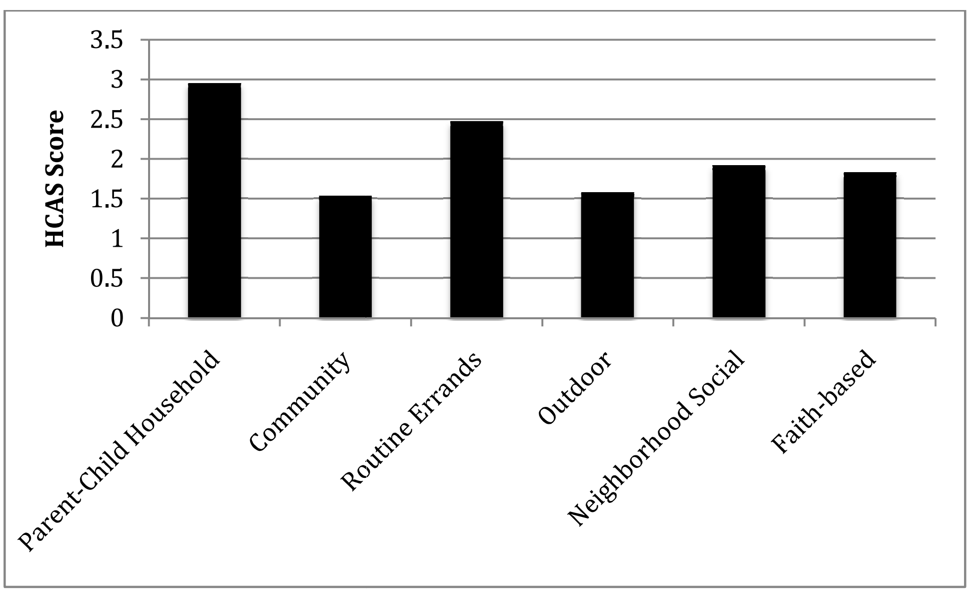


Descriptive statistics for sensory scores, HCAS dimensions and child characteristics are shown in Table 4.4. For sensory response pattern scores, lower scores indicate decreased impairment. Higher scores on the autism severity indicate increased severity, and higher scores on the HCAS dimensions indicate more frequent participation. HCAS Dimension mean scores are shown in Figure 4.3.

Table 4.5. Descriptive Statistics

Variable	N	Mean (SD)	Range
Hypo	686	-.243 (.933)	-1.842-3.453
Hyper	686	-.172 (.954)	-2.394-2.620
Seeking	686	-.276 (.962)	-2.277- 2.316
Enhanced Perception	686	-.127 (.906)	-2.313-2.691
Autism Severity	686	106.69 (27.510)	14-174
PEDA	596	89.51 (35.444)	6.50-221.50
CA	686	106.09 (25.877)	60-155
Parent-Child Household Activities	686	2.95 (.453)	1.50-3.86
Community Activities	686	1.54 (.276)	1.00-3.19
Routine Errands	686	2.47 (.579)	1.00-4.00
Outdoor Activities	686	1.58 (.457)	1.00-3.40
Neighborhood Social Activities	686	1.91 (.474)	1.00-3.57
Faith-based Activities	686	1.83 (.453)	1.50-3.86

Figure 4.3. HCAS Mean Scores



The correlations among mean scores on each factor of activity participation, factor scores of sensory response patterns, and child characteristics are shown in Table 4.5. The variables shown in the correlational analyses were used for subsequent analysis in mixed model data; therefore, the correlations should be interpreted in the context of the mixed model and will not be discussed at length. The correlational data suggested a lack of collinearity between predictor and covariate variables (i.e., CA, PEDA, autism severity, sensory response patterns), as no correlations were above .80 (Field, 2010). The lack of collinearity, particularly between sensory response patterns and autism severity, suggests that each variable is measuring a specific construct and the variance associated with one construct's measurement is not masking the effect of another.

Solution for Fixed Effects

The results of the mixed model regression are shown in Table 4.6 and reflect the final model with the removal of non-significant two and three way interactions. Mixed models require a reference category from which to make comparisons between outcomes (Bryk & Raudenbush, 1992). Parent-Child Household Activities was utilized as the reference category, as it had the highest mean score. The results of the mixed model regression showed significant main effects for the HCAS dimensions, enhanced perception, hyperresponsiveness, autism severity, and PEDA. Two way significant interactions included PEDA by HCAS dimensions. Significant three way interactions included seeking by CA by HCAS dimensions and hyporesponsiveness by CA by HCAS dimensions. Each of these findings will be explicated below.

Table 4.5. Pearson Correlations

	F1	F2	F3	F4	F5	F6	CA	PEDA	SRS	Hypo	Hyper	Seek
F1: Parent-Child	1.000											
F2: Community	.344**	1.00										
F3: Routine Errands	.304**	.269**	1.00									
F4: Neighborhood	.302**	.268**	.268**	1.00								
F5: Outdoor	.220**	.243**	.198**	.227**	1.00							
F6: Faith-based	.171**	.158**	.033	.117**	.153**	1.00						
CA	-.249**	-.115**	.004	-.036	.171**	.065	1.00					
PEDA	-.052	-.067	.046	.093*	.272**	.076	.578**	1.00				
SRS	-.199**	-.006	-.089*	-.126**	.102**	-.007	.031	-.187**	1.000			
Hypo	-.075*	.047	-.108**	-.094*	-.026	-.068	-.139**	-.304**	.584**	1.000		
Hyper	.031	-.006	-.089*	-.126**	.102**	-.007	.042	.030	.545**	.590**	1.000	
Seeking	.048	.086*	-.056	-.056	.014	-.024	-.146**	-.278**	.511**	.732**	.580**	1.000
EP	.135**	.036	-.047	-.047	.166**	.049	.093*	-.187**	.385**	.347**	.839**	.617**

**<.01 *<.05
PEDA=parents' estimated developmental age
SRS=autism severity
CA=chronological age

Table 4.6. Tests of Effects of Sensory Response Patterns and Child Characteristics on HCAS Dimensions

Effect	DF	F Value	*p*
HCAS	5,2945	503.83	*<.0001*
Seek	1,586	0.03	0.7372
Enhanced perception	1,586	12.80	*<0.0001*
Hypo	1,586	2.00	0.1111
Hyper	1,586	9.25	*<0.01*
Autism severity	1,586	19.01	*<.0001*
CA	1,586	3.35	0.0275
PEDA	1,586	6.68	*<0.01*
Seek*HCAS	5,2945	0.57	0.3712
Hypo*HCAS	5,2945	0.54	0.0915
CA*HCAS	5,2945	3.52	*<0.01*
PEDA*HCAS	5,2945	3.05	*<0.01*
Seek*CA	1,586	0.72	0.4371
Hypo*CA	1,586	0.01	0.6903
Seek*CA*HCAS	5,2945	4.33	*<0.01*
Hypo*CA*HCAS	5,2945	3.20	*<0.05*

HCAS Dimensions. The results show that the six HCAS dimensions significantly differed from one another [F(5.2945)=503.83, p<.0001, see Table 4.6]), which provides further support for the uniqueness of each HCAS dimension. A series of post hoc comparisons revealed the extent to which HCAS factors differed from one another, controlling for autism severity, CA, PEDA, and sensory response patterns. Overall, children participated less frequently in every activity dimension compared to Parent-Child Household Activities. Specifically, children participate less frequently in Community Activities (b=-1.4167, SE=.027, p<.001), Routine Errands (b=-1.4167, SE=.027, p<.001), Neighborhood Social Activities (b= -0.5023, SE=.027, p<.001), Outdoor Activities (b=-1.044, SE=.027, p<.001), and Faith-based Activities (b= -1.118, SE=.027, p<.001) than in Parent-Child Household Activities. Refer to Table 4.7 for comparisons between each of the remaining dimensions.

Table 4.7. Planned Contrasts between HCAS Dimensions

Planned Contrasts	b (SE)	*p*
Community v. Errands	-0.91 (.03)	<.001
Community v. Faith-based	-0.30 (.03)	<.001
Community v. Neighborhood	-0.37 (.03)	<.001
Community v. Outdoor	-0.04 (.03)	<.001
Errands v. Faith-based	0.62 (.03)	<.001
Errands v. Neighborhood	0.54 (.03)	<.001
Errands v. Outdoor	0.87(.03)	<.001
Faith-based v. Neighborhood	-0.07 (.03)	<.05
Faith-based v. Outdoor	0.26 (.03)	<.001
Neighborhood v. Outdoor	0.33 (.03)	<.001
Parent-Child v. Community	-1.46 (.03)	<.001
Parent-Child v. Errands	-0.50 (.03)	<.001
Parent-Child v. Neighborhood	-1.09 (.03)	<.001
Parent-Child v. Outdoor	-1.41(.03)	<.001
Parent-Child v. Faith-based	-1.19(.03)	<.001

Hyperresponsiveness. Hyperresponsiveness significantly predicted HCAS scores, controlling for child characteristics and other sensory response patterns, which provided support for the hypothesis that hyperresponsiveness would negatively impact children's participation in a number of activity dimensions. Specifically, hyperresponsiveness was found to negatively impact each of the six dimensions of activity participation [F(1,586)=9.25, p<.01, see Table 4.6]), and demonstrated a small effect size (.20) (Cohen, 1988). These findings suggest that hyperresponsiveness inhibited activities in all dimensions, and for each one point increase in hyperresponsiveness, children demonstrated a .048 decrease in participation across HCAS dimensions.

Enhanced Perception. Enhanced perception positively impacted all dimensions of activity participation [F(1,586)=12.80, p<.001, see Table 4.6]), regardless of child characteristics and other sensory response patterns, and demonstrated a moderate effect size (.40). Enhanced perception supported participation in all dimensions, and for each one point increase in enhanced perception, children demonstrated a .14 increase in participation across HCAS dimensions.

Child Characteristics. The results showed that the child characteristics found to impact activity participation included autism severity and PEDA. Autism severity had a significant, negative main effect on each of the six HCAS dimensions [$F(1,586)=19.01$, $p<.01$, see Table 4.6]), and a minimal effect size ($d=.01$). Autism severity inhibits activity participation across HCAS dimensions, and for each one point increase in autism severity, children demonstrate a .002 decrease in participation across HCAS dimensions. The impact of PEDA significantly differed across HCAS dimensions [$F(1,586)=6.68$, $p<.01$, see Table 4.6]), such that the impact of PEDA is contingent on the HCAS dimension. Comparisons between the effect of PEDA on each activity dimension are shown in Table 4.8. Overall, the significant effect of PEDA was between Outdoor Activities versus Parent-Child Household Activities and demonstrated a small effect size ($d=.01$), such that developmentally older children were reported to participate more in Outdoor Activities than in Parent-Child Household Activities ($p<.05$).

Table 4.8. Planned Comparisons PEDA and HCAS Dimensions

Effect	DF	b (SE)	*p*
PEDA: Parent-Child v. Community	1,2945	-0.001 (.001)	0.222
PEDA: Parent-Child v. Errands	1,2945	-0.001 (.001)	0.561
PEDA: Parent-Child v. Faith-based	1,2945	-0.0004 (.001)	0.681
PEDA: Parent-Child v. Neighborhood	1,2945	0.0005 (.001)	0.595
PEDA: Parent-Child v. Outdoor	1,2945	0.002 (.001)	*<0.05*
PEDA: Parent-Child (reference category)	-	-	-

Two-way Interaction: Hyporesponsiveness by CA. Figure 4.4 shows the significant interactions for hyporesponsiveness by CA across HCAS dimensions [F(5,2945)=3.20, p<.05, see Table 4.6], when controlling for other sensory patterns, PEDA, and autism severity. The hypothesis that CA would moderate the association between hyporesponsiveness and activity participation was partially supported. The results suggest that the impact of hyporesponsiveness on activity participation varies as a function of children's CA. That is, hyporesponsiveness made a significant contribution to children's activity participation, but that association was qualified by a significant hyporesponsiveness by CA interaction. Overall, younger children with high levels of hyporesponsiveness participated more frequently in activities, including Parent-Child Household Activities, Community Activities, Routine Errands, Neighborhood Social Activities, and Outdoor Activities. Older children with high and low levels of hyporesponsiveness demonstrated similar participation scores in Parent-Child Household Activities, Community Activities, Routine Errands, Neighborhood Social Activities, and Outdoor Activities.

The association between hyporesponsiveness, CA, and activity participation differed in the Faith-based Activities dimension, such that older children with high levels of hyporesponsiveness participated more in Faith-based Activities. These results suggest that the presence of high hyporesponsiveness in older children may support their participation in Faith-based Activities, whereas the presence of high hyporesponsiveness in young children inhibits their participation in Faith-based Activities. Differences in high versus low hyporesponsiveness slopes across HCAS dimensions were tested. The low and high hyporesponsiveness groups were based on scores that were above and below 1.5 SD of the mean for hyporesponsiveness. Results (refer to Table 4.9) showed low effect sizes for Routine Errands (d=.31) and Neighborhood Social activities (d=.22), moderate effect sizes for Community Activities (d=.40), Outdoor Activities (d=.44), and Parent-Child Household Activities (d=.54), and a large effect size for Faith-based Activities (d=.69).

Table 4.9. Slope Differences between High and Low Hyporesponsiveness

Effect	DF	b (SE)	*P*	Cohen's d
Faith-based: Low v. High Hypo	1,1668	.539 (.245)	*<.05*	*.69*
Household Low v. High Hypo	1,1668	- 0.248 (.245)	0.3129	.54
Outdoor: Low v. High Hypo	1,1668	-0.199 (.245)	0.4153	.44
Community: Low v. High Hypo	1,1668	-0.111 (.245)	0.6522	.40
Neighborhood: Low v. High Hypo	1,1668	-0.148 (.245)	0.5468	.31
Errands: Low v. High Hypo	1,1668	.126 (.245)	0.6076	.22

Two-way Interaction: Sensory Seeking by CA. Figure 4.5 shows the sensory seeking by CA significant interactions across HCAS dimensions [F(5,2945)=4.33, p<.01, Refer to Table 4.6], when controlling for other sensory patterns, PEDA, and autism severity. The hypothesis that CA would moderate the association between sensory seeking and activity participation was partially supported. Sensory seeking made a significant contribution to activity participation; however, this contribution varied as a function of children's CA. Older children with high levels of sensory seeking participated more frequently in Parent-Child Household Activities, Outdoor Activities, Community Activities, and Neighborhood Social activities. This trend diverged, however, for Routine Errands and Faith-based Activities. Older children with high levels of sensory seeking participated less frequently in Routine Errands and Faith-based Activities than younger children with high levels of sensory seeking. These results suggest that the presence of high sensory seeking in older children may inhibit their participation in Faith-based Activities and Routine Errands. Differences in high versus low sensory seeking slopes across HCAS dimensions were tested, and the groups were based on scores that were above and below 1.5 SD of the mean for hyporesponsiveness. Results (refer to Table 4.10) showed low effect sizes for Neighborhood Social Activities (d=.002), Community Activities (d=.10), and Outdoor Activities (d=.10). Effect sizes for Parent-Child Household Activities (d=.39) and Routine Errands were moderate (d=.53), and that of Faith-based Activities was large (d=.90).

Table 4.10. Slope Differences between High and Low Sensory Seeking

Effect	DF	b (SE)	*P*	Cohen's d
Faith-based: Low v. High Seek	1,1724	-0.743 (.245)	<*.01*	.90
Household Low v. High Seek	1,1724	0.176 (.245)	0.4740	.39
Outdoor: Low v. High Seek	1,1724	-0.113 (.245)	0.6466	*.25*
Community: Low v. High Seek	1,1724	-0.026 (.245)	0.2153	.10
Neighborhood: Low v. High Seek	1,1724	-0.001 (.245)	0.9964	.002
Errands: Low v. High Seek	1,1724	-0.305 (.245)	0.6076	.53

Figure 4.4. The Effect of CA on Hyporesponsiveness and HCAS Dimensions

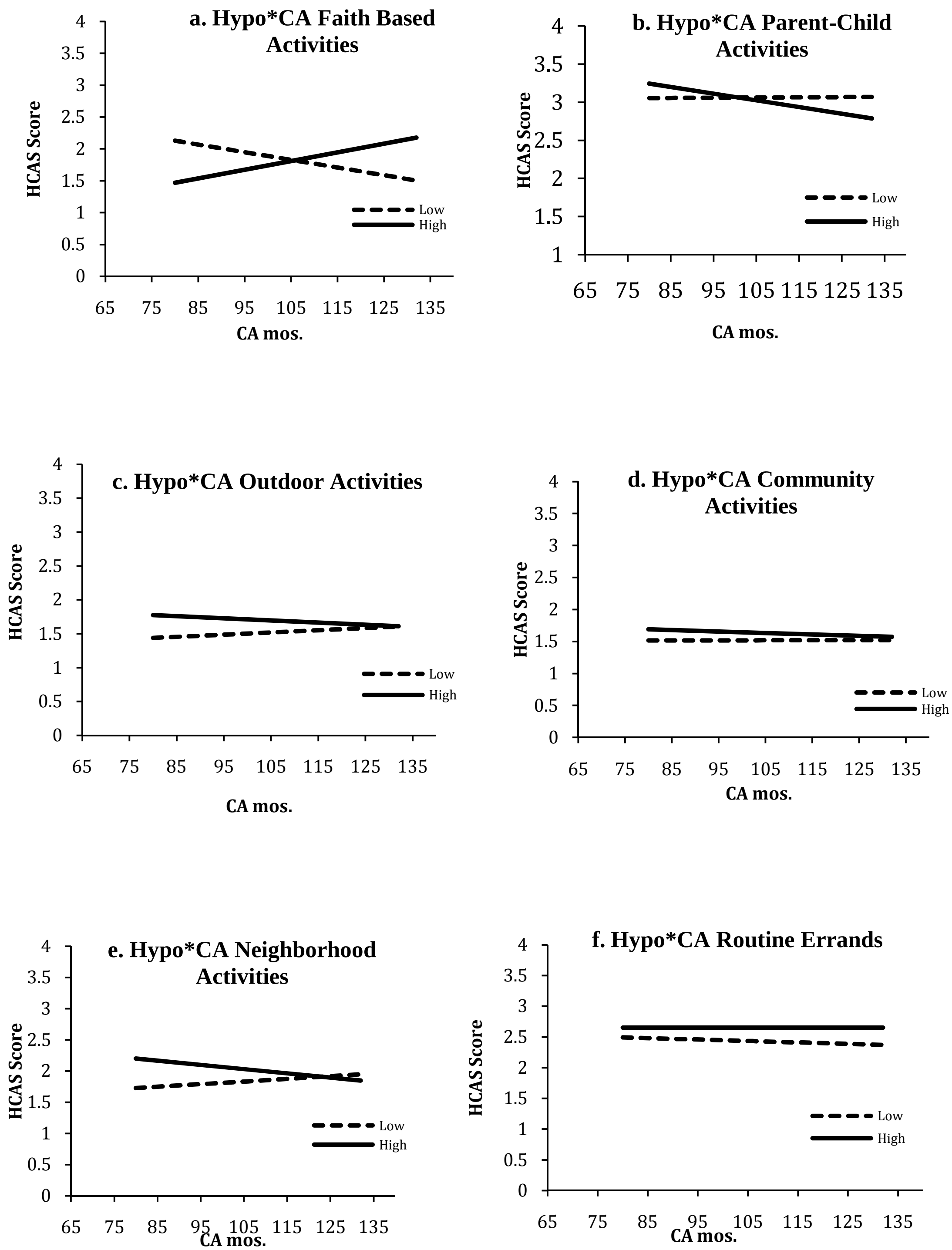
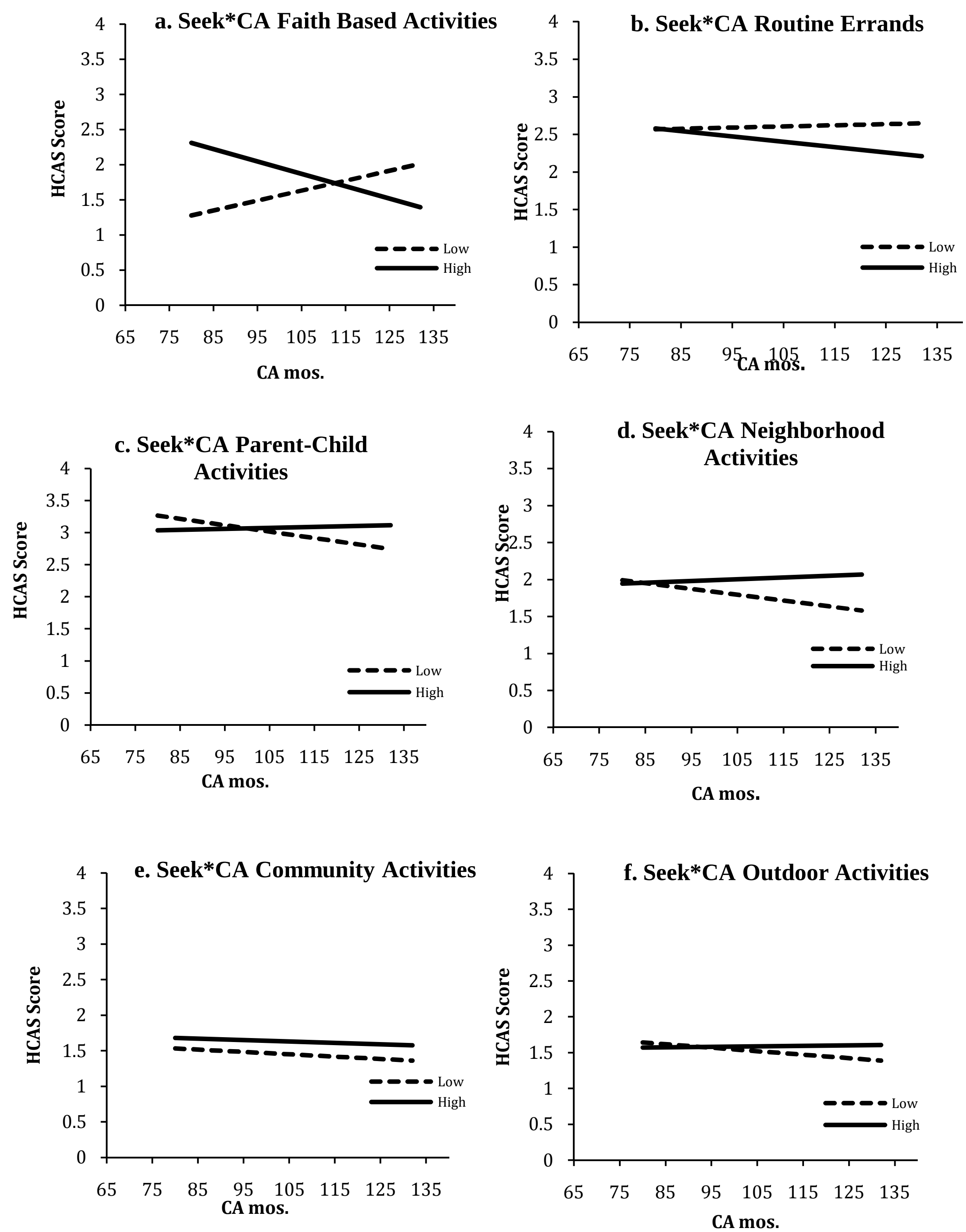


Figure 4.5. The Effect of CA on Seeking and HCAS Dimensions



Results Summary. These findings suggest that hyperresponsiveness negatively impacted children's participation across HCAS dimensions, whereas enhanced perception supported children's participation. Autism severity and PEDA negatively impacted activity participation, such that higher functioning and developmentally more mature children participated more frequently in a number of activities. The results of the interactions between sensory seeking by CA, and hyporesponsiveness by CA, were reversed. These findings clearly suggest that hyperresponsiveness and enhanced perception impacted all dimensions of activity participation similarly, albeit in opposite directions. Hyporesponsiveness and seeking had varying effects according to age across HCAS dimensions.

CHAPTER 5

DISCUSSION

This study examined the dimensions that characterized the activity participation among school-aged children with ASD. Drawing from a large, national sample of school-aged children with ASD, exploratory factor analysis was used to determine a parsimonious model that characterized the dimensions of activity participation as measured by the Home and Community Activities Scale (HCAS; adapted from Dunst et al., 2002). The associations between derived factors of the HCAS and sensory response patterns (hyperresponsiveness, hyporesponsiveness, seeking, enhanced perception) as well as the moderating role of child characteristics (autism severity, CA, PEDA) were examined. The findings of this study suggest that six dimensions characterized children's participation on the HCAS, and sensory response patterns differentially impacted dimensions of activity participation. This section will describe and further explicate the findings of the current study, as well as interpret the findings in the context of previous research and occupational science theory. Finally, this chapter concludes with implications for occupational science, occupational therapy practice, limitations, and future research directions.

Conceptualizing Activity Participation among Children with ASD

The findings of this study showed that the activity participation of school-aged children with ASD as measured by the HCAS is characterized by Parent-Child

Household Activities; Community Activities; Routine Errands; Neighborhood Social Activities; Outdoor Activities; and Faith-based Activities. These results clearly differed from previous studies of the HCAS, which suggested that the measure was characterized by two factors (Dunst et al., 2006) or eleven factors (Holtzclaw et al., 2006).

Based on previous research on the measurement of activity participation among children with disabilities, I hypothesized that the HCAS would consist of five factors. Although four factors from the EFA aligned with those hypothesized, two factors distinctly differed from the hypothesis and offer a new perspective on the activity participation among children with ASD. The Neighborhood Social Factor consisted of items that other tools divide into physical activities and social activities (King et al., 2004). However, the frequency of the activity participation among children with ASD may reflect the activity demands as well as context; therefore, activities that may appear primarily physical in nature possess social demands that impact the participation among children with ASD. For instance, the activity of "swimming" highly loaded on the Neighborhood Social Activities dimension; however, "sleepovers" and "visiting friends" also loaded on this factor, which suggests that physical and social activities possibly involve similar skills among children with ASD. It may be that among school-aged children with ASD, social communication skills are integrally linked with certain physical activities, and vice versa.

These findings align with literature suggesting that physical activity participation is associated with social interaction skills among children with ASD. In a study of the physical activity participation among school-aged children with high functioning ASD, the participants self-reported that the primary barrier to engaging in physical activity was a lack of peer partner, and the highest reported facilitator of physical activities included friends who are supportive or physically active (Obrusnikova & Cavalier, 2011). Caregivers of children with ASD have also been found to report that the primary barrier to their children's physical activity participation was the child's social skills (Obrusnikova & Miccinello, 2012). Swimming loaded most highly on the Neighborhood Social Activities Factor, and one study addressed the potential link between engagement in swimming and social skills among school-aged children with ASD. In a small sample RCT on the effects of a ten-week intervention focused on swimming among children with ASD, those that participated in swimming exercises demonstrated increased social skills (Pan, 2010).

The Faith-based Activity Factor that emerged from the EFA was unexpected, and contributes to the gap in the literature regarding the participation of children with ASD in religious services, religious activities, praying, and structured engagement in children's clubs (i.e., boy/girl scouts, 4H). Previous research on a large sample of children with ASD (n=176) has found that 41.6% of school-aged children with ASD were reported to attend a religious service one time per week (Lee et al., 2008). Similarly, 36.7% of the current sample was reported to attend church one time per week. Additionally, one of the key findings of this study was that structured clubs (e.g., boy/girl scouts; 4H) loaded on the Faith-based Activities Factor. Although this was the lowest loading item on this factor, there are nonetheless similarities in the participation demands of these particular activities. Children are required to attend and follow rules in the activities that specifically loaded on the Faith-based Activity Factor (i.e., attending church, religious activities, praying, scouts/4H); therefore, this study begins to create a descriptive understanding of how the demands of these activities may be related.

Sensory Response Patterns and Activity Participation

This study contributes to growing evidence that the sensory features among children with ASD impact their activity participation. The findings of this study suggest that sensory response patterns do not only differentially impact activity participation, but these associations vary as a function of children's age. Overall, the results of the study can be summarized into four findings: 1) hyperresponsiveness had a negative impact on activity participation across activity participation as measured by the HCAS; 2) enhanced perception had a positive impact on activity participation as measured by the HCAS; 3) the impact of children's levels of sensory seeking varied as a function of children's chronological age; and 4) the impact of children's levels of hyporesponsiveness varied as a function of children's chronological age. This section will further explicate these findings, interpret the results, and relate the findings to the literature.

Hyperresponsiveness: The Negative Association with Activity Participation

As predicted, hyperresponsiveness had a negative impact on each dimension of activity participation (i.e., Parent-Child Household Activities; Community Activities; Routine Errands; Neighborhood Social Activities; Outdoor Activities; Faith-based Activities) regardless of other sensory response patterns, CA, PEDA, or autism severity. By controlling child characteristics (i.e., autism severity, PEDA, CA) and other sensory response patterns, the results point to the particular role that hyperresponsiveness plays in children's participation in activities in the home, in the community, and in structured space such as church and children's clubs. This association demonstrated a small effect size (d=.20); however, the findings align with previous phenomenological accounts and small sample correlational research on ways in which hyperresponsiveness limits children's activity participation across contexts (Ashburner et al., 2008; Bagby et al., 20112; Brown & Dunn, 2010; Dickie et al., 2009).

Although the current study was cross-sectional, the findings related to hyperresponsiveness and a lack of activity participation may reflect a transaction between a child, the context, and interactions with caregivers that occurs over time. These findings may be further elucidated through the lens of the Model of Risk and Prevention (Dawson, 2008). This model suggests that children with ASD that demonstrate risk factors (e.g., hyperresponsiveness) may experience altered patterns of interaction between caregivers in contexts (i.e., risk processes), which iteratively impacts development over time. As an example, children that demonstrate hyperresponsiveness may avoid certain activities that may result in the child having limited exploration and adaptation skills, and consequently limited activity participation. Thus, hyperresponsiveness contributes to limited activity participation, and the lack of activity participation further perpetuates a child's hyperresponsiveness, as he/she does not gain optimal experiences, learning, and coping skills.

Previous research has illuminated the extent to which hyperresponsiveness among children with autism and other developmental disabilities impacts activity participation (Baranek et al., 2002; Bagby et al., 2012; DeGrace, 2004; Larson, 2010; Schaaf et al. 2006). Caregivers of children with ASD have been found to experience great difficulty with orchestrating activity participation for their children, learning over time that the effort may outweigh the possible positive aspects of the experience (DeGrace, 2004). Further, caregivers report constant feelings of vigilance related to the sensory aspects of the environments of the children's activity participation (Larson, 2010; Schaaf et al., 2006), as well as back-up plans due to the unpredictability of their children's responses to sensory stimuli of activities (Bagby et al., 2012). Baranek and colleagues (2002) found that children with fragile X syndrome that demonstrated increased avoidance associated with hyperresponsiveness had lower levels and performance in a number of activities, including self-care, school tasks, and play. However, a subset of the sample that demonstrated avoidance were also proficient in certain tasks in which they could perform independently. Taken together, these findings suggest over time, children's aversive responses to elements of activities perhaps negatively reinforce caregivers' efforts to pursue activity participation, which leads to decreased activity participation. Further, children with hyperresponsiveness may be engaging in more solitary activities, specifically those in which they are able to exert self-regulatory strategies to modulate their hyperresponsiveness. The cumulative effects of stress on caregivers of children with ASD, as they accommodate activities, may lead them to not pursue certain activities in the home or community, and these hypotheses would benefit from more research.

Enhanced Perception: A Potentially Adaptive Sensory Response Pattern

Enhanced perception was found to positively contribute to the activity participation among children with ASD. There were no hypotheses made regarding enhanced perception, as research suggests that it may possibly facilitate participation due to an over-focus on the elements of activities (Motrron et al., 2006) or detract from participation due to the lack of derived meaning from the experience as a whole (Baron-Cohen et al., 2009). The results suggest that regardless of other sensory response patterns, autism severity, CA, or PEDA, enhanced perception demonstrated a positive association with children's activity participation across contexts. Moreover, the findings demonstrated a medium effect size (d=.40), which may illuminate the extent to which this finding may have clinical relevance for children with ASD.

It is unclear how the over-focus or hyper-awareness on the sensory elements of an activity may support children's participation. Emerging evidence suggests that enhanced perception among adults with ASD occurs across modalities, including auditory stimuli (Bonnell, 2003; Mottron et al., 2000), visual stimuli (Ashwin et al., 2009; Mottron et al, 2003; Mottron et al., 2006), and tactile input (Cascio et al., 2008). Further, theorists have suggested that enhanced perception of sensory stimuli among individuals with ASD is associated with a cognitive style of processing (Mottron et al., 2006; Baron-Cohen et al., 2009). Strengths in local processing contribute to the ability among individuals to recognize patterns and may ultimately contribute to success in everyday situations (Mottron et al., 2006). Moreover, enhanced perception may be associated with hyper-systemizing and hyper-attention to details in autism, and may contribute to success in some cognitive tasks (Baron-Cohen et al., 2009). It may be, then, that enhanced perception is somewhat of an adaptive skill or facilitative function of children's participation in home and community activities. The ability to over-focus on the elements of activities, and the accompanying style of over-systemizing, may allow the child to have systematic ways of engagement in or completion of tasks. For example, certain activities may be supported by children's over focus on particular elements of the tasks, such as completing puzzles or art activities / drawing. These findings align with one previous study on the hyper-attention to detail among children with ASD. Liss and colleagues (2006) found that individuals that demonstrated over-focused attention were reported to have higher adaptive skills as compared to other children with ASD, which may be related to the ability of children with enhanced perception to increasingly participate in home and community activities. Enhanced perception, then, may reflect a way in which children with ASD perceive and interpret environmental sensory information that somehow contributes to increased frequency of home and community activity participation.

The interpretation of enhanced perception as a purely adaptive sensory response pattern, however, conceals the link between enhanced perception and hyperresponsiveness, which is supported by previous research (Baron-Cohen et al., 2009; Liss et al., 2006), and is evident by the correlational analysis in the current study (r=.84). Previous research on enhanced perception has suggested that children with enhanced perception may not interpret the gestalt of the experience, as they are over focused on the elements of activities (Dakin and Frith, 2005). In other words, enhanced perception is most likely able to help individuals at the local level, but at the expense of the interpretation of the global meaning. The possibility that children with enhanced perception may not be interpreting the global meaning as associated with activity participation illuminates how this study addressed the frequency of children's activity participation as opposed to the quality of children's activity participation. It may be that the frequency of children's engagement is somehow enhanced by the ability to over-systemize or create rigid order to the ways in which activities are pursued.

Hyporesponsiveness and Sensory Seeking: The Moderating Role of Chronological Age

Hyporesponsiveness. I hypothesized that chronological age would moderate the association between hyporesponsiveness and activity participation such that older children with high hyporesponsiveness would participate less frequently in activities. This hypothesis was partially confirmed, as a significant interaction was found between hyporesponsiveness by CA on activity participation. Overall, the results of the hyporesponsiveness by CA interaction showed that younger children with high hyporesponsiveness participated more frequently in community activities, Parent-Child Household Activities, Outdoor Activities, Routine Errands and Neighborhood Social Activities. For Faith-based Activity participation, however, the findings suggest that older children with high levels of hyporesponsiveness participate more frequently in these structured activities.

Previous research on hyporesponsiveness among children with ASD may help illuminate how young children with ASD participate more frequently in Outdoor Activities, Community Activities, and Neighborhood Social Activities. Hyporesponsiveness has been linked with decreased social communication and adaptive skills among children with ASD (Liss et al., 2006; Watson et al., 2011). Although these previous findings may lead one to conclude that decreased social communication and adaptive skills may be associated with decreased activity participation in young children, it may be that these characteristics do not conflict with activity participation per se. Limited social communication and adaptive skills may not particularly interfere with the frequency of activity participation among children with high levels of hyporesponsiveness. A child that demonstrated high levels of hyporesponsiveness may appear passive and not initiate activities independently (Baranek et al., 2006; Dunn, 2007). Young children with high hyporesponsiveness may not resist caregiver efforts to engage them in activity participation. Therefore, caregivers perhaps do not experience difficulties when engaging young children with high hyporesponsiveness in activities, such as hiking, going to the zoo, or swimming. Moreover, a young child with high hyporesponsiveness may be perceived as benefiting from the caregiver's initiation of activities. Children with high hyporesponsiveness are likely to not object to a number of activities; therefore, engagement among families may occur with ease, and the young child with high hyporesponsiveness may appear to enjoy the activities as they occur.

The findings suggest that the activity participation among older children with high hyporesponsiveness does not differ from that of younger children, except in Faith-based Activities. Previous research has not yet addressed the role of sensory response patterns as they contribute to children's lack of participation in structured contexts; however, it may be that older children with high hyporesponsiveness demonstrate fewer behaviors that interrupt participation in such structured contexts. The lack of initiation and demonstration of passive behaviors may be perceived as compliance during Faith-based Activities. Therefore, older children with high hyporesponsiveness will sit through structured activities, such as going to church or girl/boy scouts. Although children with high hyporesponsiveness may sit through such experiences, the extent to which they are actively engaged in the activities is unknown.

Sensory Seeking. I hypothesized that CA would moderate the association between sensory seeking and activity participation such that older children with high levels of sensory seeking would participate less frequently in activities, which was partially confirmed. The trend among Parent-Child Household Activities, Neighborhood Social Activities, Community Activities, and Outdoor Activities suggested that older children with high sensory seeking participate more frequently than those with low sensory seeking. The difference in that trend was evidenced in Faith-based Activities and Routine Errands, the results of which suggest that older children with high sensory seeking tend to participate in these home and communities activities less frequently.

Caregivers' sense of how sensory seeking influences activity participation most likely differs between young and older children. Research suggests that behavioral measures of sensory seeking are able to differentiate such behaviors among young children with ASD versus typical development (Baranek, 1999; Little et al., 2010; Zwaigenbuam et al., 2005). However, results from parent report measures do not necessarily differentiate the sensory seeking behaviors among young children with ASD from those with typical development (Ermer & Dunn, 1998). It may be that the sensory seeking behaviors among young children with ASD are perceived by caregivers as part of normal exploratory play, and caregivers may not recognize the unusual nature of these behaviors from those of typically developing children. Moreover, young children with high sensory seeking may be perceived as energetic and requiring activity participation to exert energy. Therefore, caregivers of young children with ASD may create increased opportunities for the children to participate in unstructured activities, particularly Parent-Child Household Activities, Neighborhood Social Activities, Community Activities, and Outdoor Activities.

The activity participation of older children with high sensory seeking is decreased in Routine Errands and Faith-based Activities. The social expectations of children's behavior in public contexts possibly limit the participation of older children with high sensory seeking in structured contexts. For older children that demonstrate high sensory seeking behaviors during Routine Errands or Faith-based Activities, caregivers may interpret such behavior as noncompliant or disruptive. Particularly for older children, increased frequency and intensity of sensory seeking behaviors may be perceived as abnormal, which ultimately leads to the decreased participation in Routine Errands and Faith-based Activities.

The interaction between hyporesponsiveness by age and sensory seeking by age may also be interpreted within the context of two sensory processing theories. One interpretation of the interaction results of the current study may be that hyporesponsiveness and seeking have opposite, but complementary effects on the participation among children with ASD in Faith-based Activities. In particular, children with high levels of hyporesponsiveness and associated high levels of sensory seeking participate less frequently in Faith-based Activities. Although this may be a viable explanation given that some models of sensory processing attribute sensory seeking to hyporesponsiveness (Dunn, 2007; Miller et al., 2007), this explanation fails to provide a full picture of the impact of sensory features on activity participation among children with ASD. The current analysis controlled for other sensory response patterns, such that the interaction between seeking by CA is significant regardless of hyporesponsiveness. Therefore, the explanation that the interaction merely represents the group of children engaging in high levels of sensory seeking to counteract high levels of hyporesponsiveness is not supported by the analysis, and further explanation is needed.

The Dynamic Model of Sensory Processing (Baranek, 1999), which guided the current study, postulates that sensory seeking may counteract both hyporesponsiveness and hyperresponsiveness. Therefore, the impact of sensory seeking on Faith-based Activities could potentially be related to both hyporesponsiveness and hyperresponsiveness in different subgroups of children with ASD. This possibility is supported by previous research on the associations between sensory seeking with hyporesponsiveness and hyperresponsiveness (Ausderau et al., in preparation; Baranek, Foster, & Berkson, 1997; Boyd et al., 2010; Gabriels et al., 2009), as well as the correlational data in the current study which links sensory seeking with both hyporesponsiveness (.732) and hyperresponsiveness (.580). Therefore, some high sensory seeking children engage in such behaviors in certain activities in order to modulate increased arousal (i.e., hyperresponsiveness) associated with participation in unfamiliar contexts. On the contrary, another group of high sensory seeking children may engage in such behaviors in certain activities to modulate low levels of arousal (i.e., hyporesponsiveness). The current analysis suggests that children that have high levels of sensory seeking are engaging in such behaviors in certain contexts, but does not necessarily illuminate the extent to which the sensory seeking may serve to modulate hyperresponsiveness or hyporesponsiveness.

Autism Severity and Parents' Estimated Developmental Age: Influences on Activity Participation

Contrary to my hypothesis, autism severity did not moderate associations between sensory features and activity participation. Instead, autism severity demonstrated a main, negative effect on activity participation. This finding demonstrated a very small effect size (d=.01), which suggests that caregivers of children with ASD may be limiting their children's activity participation due to other child and environmental factors as opposed to autism severity per se. Parents' estimated developmental age was found to differentially impact children's participation across activity dimensions. Specifically, developmentally more mature children participated more frequently in Outdoor Activities than Parent-Child Household Activities. Children that are developmentally more mature may have increased opportunities to engage in activities that occur outside of the home and are unstructured, such as hiking and gardening. These findings related to child characteristics may be due to the lack of expectations surrounding autism severity; instead, caregivers and peers may have expectations of children with ASD based on their age and/or developmental maturity. Previous research has suggested that caregivers may structure children's activity participation due to their symptoms of autism (DeGrace, 2004); however, the findings of this study suggest that activity participation may be related to perceptions of what the child is able to and expected to do based on their developmental maturity, which possibly differentially impacts dimensions of activity participation.

Implications for Occupational Science

Taken together, these findings point to the multidimensionality of occupational engagement among children with ASD. As opposed to previously held notions that categories that may encompass specific activities, the findings of this study suggest that there may be underlying aspects of activities, or occupations, that facilitate children's participation. As earlier explicated, categories of occupation are often used to characterize the activity participation among children with disabilities (King et al., 2004; Berg & LeVesser, 2006). However, from the items that loaded on certain activity factors, the evidence suggests that the categorization of participation among children with ASD may be contextual and meaning specific.

Hocking (2009) argued that the generation of knowledge related to occupation itself may be focused on the meanings associated with participation in occupation or the contextual factors that facilitate or inhibit participation in occupation. Further, Humphry (2002, 2005) has argued that the sociocultural context and accompanying meanings influence children's activity participation, which therefore influences development. These ideas of how meaning and context shape the participation of children with ASD are used to conceptualize how the frequency of activity participation emerged in the HCAS factor analysis. While social participation and physical activities are linked, potentially by social demands or context, it may also be the case that Faith-based Activities are shaped by the meanings in which families of children with ASD attribute to participation in such activities. This study has implications for future occupational science research regarding how meanings and context influence the activity participation, and how superficial groups (e.g., physical activities) of activities may be insufficient for characterizing the occupations of children with ASD.

The literature on the occupational engagement of children with disabilities suggests that caregivers create opportunities for their children to engage in occupations based on the child's performance in certain activities as well as the caregiver's goals for the child's development. For example, Kellegrew (2000) found that mothers of children with disabilities purposefully created opportunities for their children to practice self-care skills because they wanted the children to eventually be independent in self-care. The possibility that caregivers purposefully structure their children's environments, such that they provide the children with learning opportunities through occupation as well as match caregivers' sense of contributing to their children's development, has been reported in a number of studies (Donovan, VanLeit, Crow, & Keefe, 2005; Dunst et al., 2000; Harkness et al., 2007). These studies, however, were primarily qualitative and focused on the experience of creating opportunities for children to participate. The results of this study suggest that caregivers may purposefully construct activity participation, as well as consider the meaning of activity participation for children with ASD partially based on the children's sensory response patterns and the child's chronological age.

Implications for Occupational Therapy Practice

The findings of this study have implications for occupational therapy practice with school-aged children with ASD. First, the potential clinical utility of the HCAS may be explored by occupational therapists in order to determine the extent to which it allows for the characterization of the activity participation of clients with ASD. If naturalistic setting intervention approaches are hypothesized to have positive effects on the development of children with ASD (e.g., Shonekoff & Meisels, 2000), occupational therapists must have a method of assessing the activities in which children with ASD participate. The results further suggested that certain activities of children with ASD, as found by the HCAS dimensions, may be more related to the contexts, meanings, and task demands as opposed to superficial categories of activities. For example, physical activities (i.e., swimming, basketball) loaded on the same factor as social activities (i.e., sleepovers). Therefore, when planning intervention approaches specifically focused on increasing children's activity participation, particular skills may be more associated with differing categories of activities than previously conceptualized.

Moreover, the findings of this study may help to illuminate the extent to which specific sensory processing patterns may differentially impact dimension of activity participation. Therefore, occupational therapists working with school-aged children with ASD may have some idea of the way in which children's sensory processing patterns are associated with certain dimensions of activity participation. Although intervention may be highly individualized, a general understanding of how certain sensory patterns may impact certain activities can be a starting point for occupational therapists working with school-aged children with ASD. Additionally, the findings point to the importance of taking a holistic approach to intervention, as impact of sensory response patterns on activity participation should be considered in the context of the child's age, autism severity, and developmental age.

As previously explicated, the transaction between a lack of activity participation and children's hyperresponsiveness may be self-perpetuating over time. Therefore, it may be that intervention focused on decreasing children's hyperresponsiveness is interrelated with increasing activity participation, and occupational therapy services may serve to specifically interrupt the cycle of non-participation due to hyperresponsiveness and hyperresponsiveness due to the lack of participation.

Limitations

This study presented with limitations, which will be explicated here. This analysis was cross sectional, and therefore the impact of sensory features on the activity participation among this sample over time is unknown. The convenience sample utilized in the current study was not stratified, which may limit the generalizability of findings. This study utilized caregiver report data only; therefore, child characteristics that were measured could not be validated by behavioral measures. It is unknown if the sensory response patterns, measure of autism severity, or parents' estimation of developmental age (PEDA) as reported by caregivers would align with behavioral measures of these features. Moreover, the scale of the HCAS limits the variability of activity participation that can be measured. In other words, the specificity (e.g., how may times per week) and intensity (e.g., length of time) of the frequency with which activity participation occurs may be limited by the response scale of the HCAS. Further, a number of HCAS items were not included in the final HCAS factor solution. The excluded items may be associated with children's sensory response patterns; however, the current analysis did not address the associations with these deleted items. Specifically, the current study did not address the extent to which children with ASD participate in solitary activities (e.g., watching television, playing video games), or the associations between sensory patterns and these solitary activities.

Future Research Directions

The findings and limitations of the current study present a number of future avenues for research focused on the activity participation and sensory response patterns among children with ASD. The findings of this study illuminate the complexities associated with activity participation among school-aged children with ASD, as well as the ways in which sensory response patterns and child characteristics serve as both inhibitors and facilitators for activity participation. Moreover, the findings point to the multidimensionality of occupational engagement among children with ASD. Therefore, future research may draw from the findings of this study in order to develop a theoretical model related to activity participation among children with ASD.

Future research is needed on the HCAS, specifically validating and expanding its use in characterizing the activity participation of children with ASD. The extent to which the structure of the HCAS remains stable in an independent sample of school-aged children with ASD should also be addressed. Moreover, the response scale of the HCAS should be expanded to address the frequency, enjoyment, with whom, and difficulty associated with activity participation among children with ASD. The expansion of response categories would contribute to occupational science research through illuminating the multidimensionality associated with the activity participation of children with ASD. The role of enjoyment in activity participation was not addressed in the current study; however, research suggests that this may be an integral aspect of measurement in the activity participation among children with disabilities (King et al., 2004). If different aspects of measurement (i.e., frequency, enjoyment, with whom, and difficulty) could potentially be addressed through one measure, the interrelatedness of different facets of children's occupations could be better described.

The role that solitary activities, as well as other activities that were excluded from the current study (e.g., karate, soccer), play in the lives of children with ASD may be addressed in future studies. Emerging research suggests that the discretionary time use among children with ASD is spent in solitary activities (Orsmond & Kuo, 2011). The research on how children's sensory response patterns impact activity participation, however, has not yet addressed how sensory features play out in the context of children's solitary activities. Future research could utilize caregiver report measures as well as interview data to determine the extent to which solitary activities occur, and may potentially be influenced by children's sensory response patterns.

The findings related to enhanced perception were surprising in the current study, and future research should investigate enhanced perception in children with ASD. Caregivers' descriptions of their children's enhanced perception, as well as how it plays out in activity participation, should be examined in order to better characterize this sensory response pattern. Moreover, the majority of research on enhanced perception has focused on high functioning adults with ASD, but the role of enhanced perception in lower functioning children with ASD is unknown. Future research could address the extent to which enhanced perception and IQ are related.

This study focused on the concurrent interplay between sensory response patterns and activity participation; however, from a transactional perspective, occupations are impacted by and impact a myriad of contextual and child characteristics over time. Future longitudinal research should address the role that sensory response patterns, as well as family composition, geographic location, and family socioeconomic status play in the activity participation of children with ASD over time. Moreover, the findings as they relate to the meanings in which caregivers ascribe to interactions between sensory patterns, age, and activity participation may be illuminated by qualitative research that explores the meaning associated with these child and family experiences.

Appendix A. Home and Activities Scale (adapted from Dunst, Hamby, Trivette, Raab, & Bruder, 2002)

Participant Examiner
ID#_ _ _ _ _.00 Initials: _ _ Initials: _ _ _ Date: _ _ / _ _ / _ _

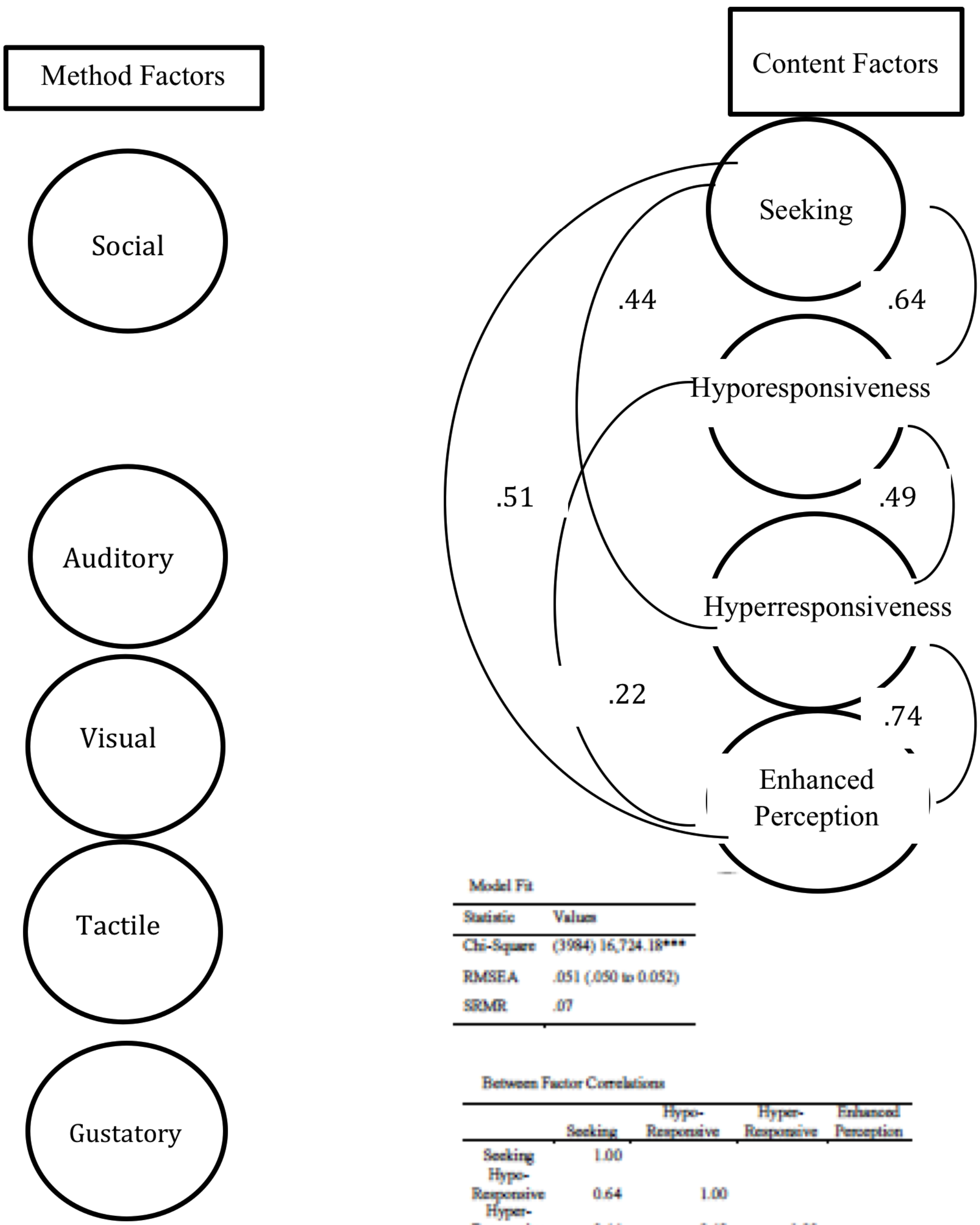
HOME AND COMMUNITY ACTIVITIES

Instructions: Please read each of the following home and community activities and determine how often your son or daughter has participated in the activity over the last month. Use the definitions in the box below to score each item.

N = NEVER	-	has not participated in the activity
M = MONTHLY	-	participated at least once a month, but not every week
W = WEEKLY	-	participates at least once a week, but not every day
D = DAILY	-	participated at least once a day

1	Household Chores	N	M	W	D
2	Cooking/Preparing Meals	N	M	W	D
3	Caring for Pets/Animals	N	M	W	D
4	Doing Errands	N	M	W	D
5	Food Shopping	N	M	W	D
6	Cleaning up Room	N	M	W	D
7	Picking up Toys	N	M	W	D
8	Reading/Looking at Books	N	M	W	D
9	Telling Child Stories	N	M	W	D
10	Adult/Child Play Times	N	M	W	D
11	Taking Walks/Strolls	N	M	W	D
12	Bedtime Stories	N	M	W	D
13	Cuddling with Child	N	M	W	D
14	Riding Bike/Wagon	N	M	W	D
15	Playing Ball Games	N	M	W	D
16	Water Play/Swimming	N	M	W	D
17	Rough Housing	N	M	W	D
18	Art Activities/Drawing	N	M	W	D
19	Playing Board Games	N	M	W	D
20	Playing Video Games	N	M	W	D
21	Dancing/Singing	N	M	W	D
22	Listening to Music	N	M	W	D
23	Watching TV/Videos/DVDs	N	M	W	D
24	Playing Alone	N	M	W	D
25	Family Talks	N	M	W	D
26	Praying	N	M	W	D
27	Family Meetings	N	M	W	D
28	Holiday Dinners	N	M	W	D
29	Family Member's Birthdays	N	M	W	D
30	Decorating Home (Holidays)	N	M	W	D
31	Family Gatherings	N	M	W	D
32	Picnics	N	M	W	D
33	Having Friends Over to Play	N	M	W	D
34	Visiting Neighbors	N	M	W	D
35	Sleepovers	N	M	W	D
36	Doing Yard Work	N	M	W	D
37	Planting Trees/Flowers	N	M	W	D
38	Growing Vegetable Garden	N	M	W	D
39	School	N	M	W	D
40	Daycare/Preschool	N	M	W	D
41	After School Care	N	M	W	D
42	Car Rides/Bus Rides	N	M	W	D
43	Doing Errands	N	M	W	D
44	Eating Out	N	M	W	D
45	Going Shopping	N	M	W	D
46	Visiting Friends	N	M	W	D
47	Outdoor Playgrounds	N	M	W	D
48	Indoor Playgrounds	N	M	W	D
49	Child Play Groups	N	M	W	D
50	Playing Arcade Games	N	M	W	D
51	Community Celebrations	N	M	W	D
52	Children's Festivals	N	M	W	D
53	County/Community Fairs	N	M	W	D
54	Parades	N	M	W	D
55	Hay Rides	N	M	W	D
56	Hiking	N	M	W	D
57	Nature Trail Walks	N	M	W	D
58	Boating/Canoeing	N	M	W	D
59	Camping	N	M	W	D
60	Community Gardens	N	M	W	D
61	Rafting/Tubing	N	M	W	D
62	Fishing	N	M	W	D
63	Recreation/Community Centers	N	M	W	D
64	Swimming	N	M	W	D
65	Horseback Riding	N	M	W	D
66	Animal Farms/Petting Zoos	N	M	W	D
67	Parks/Nature Reserves	N	M	W	D
68	Zoos/Animal Reserves	N	M	W	D
69	Pet Stores/Animal Shelters	N	M	W	D
70	Nature Centers	N	M	W	D
71	Children's Museums/Science Centers	N	M	W	D
72	Music Concerts/Children's Theater	N	M	W	D
73	Library/Book Mobiles	N	M	W	D
74	Storytellers	N	M	W	D
75	Music Activities	N	M	W	D
76	Religious Activities	N	M	W	D
77	Going to Church	N	M	W	D
78	Children's Clubs (4H, Scouts)	N	M	W	D
79	Karate/Martial Arts	N	M	W	D
80	Gymnastics/Movement Classes	N	M	W	D
81	Baseball	N	M	W	D
82	Basketball	N	M	W	D
83	Soccer	N	M	W	D

Appendix B. Confirmatory Factor Analysis of the Sensory Experiences Questionniare 3.0 (Ausderau et al., in prepartation).



Model Fit

Statistic	Values
Chi-Square	(3984) 16,724.18***
RMSEA	.051 (.050 to 0.052)
SRMR	.07

Between Factor Correlations

	Seeking	Hypo-Responsive	Hyper-Responsive	Enhanced Perception
Seeking	1.00			
Hypo-Responsive	0.64	1.00		
Hyper-Responsive	0.44	0.49	1.00	
Enhanced Perception	0.51	0.22	0.74	1.00

Appendix C. HCAS Item Descriptive Data

HCAS Item	Never n (%)	Monthly n (%)	Weekly n (%)	Daily n (%)
Household Chores	92 (12.9)	102 (14.3)	303 (42.5)	215 (30.2)
Cooking/Preparing Meals	291(40.8)	185(25.9)	195(27.3)	4(5.9)
Caring for Pets/Animals	313 (43.9)	81 (11.4)	161 (22.6)	158 (22.2)
Doing Errands	196 (27.5)	105 (14.7)	322 (45.2)	90 (12.6)
Food Shopping	153 (21.5)	211 (29.6)	328 (46.0)	21 2.9)
Cleaning up Room	110 (15.4)	165 (23.1)	317 (44.5)	121 (17.0)
Picking up Toys	38 (5.3)	89 (12.5)	259 (36.3)	327 (45.9)
Reading/Looking at Books	13 (1.8)	21 (2.9)	94 (13.2)	585 (82.0)
Telling Child Stories	215 (30.2)	73 (10.2)	187 (26.2)	238 (33.4)
Adult/Child Play Times	19(2.7)	26 (3.6)	181 (25.4)	487 (68.3)
Taking Walks/Strolls	58 (8.1)	156 (21.9)	346 (48.5)	153 (21.5)
Bedtime Stories	165 (23.1)	85 (11.9)	165 (23.1)	298 (41.8)
Cuddling with Child	66(9.3)	44 (6.2)	86 (12.1)	517 (72.5)
Riding Bike/Wagon	225 (31.6)	181 (25.4)	221 (31.0)	86 (12.1)
. Playing Ball Games	182 (25.5)	178 (25.0)	287 (40.3)	66 (9.3)
Water Play/Swimming	79 (11.1)	200 (28.1)	321 (45.0)	113 (15.8)
Rough Housing	83 (11.6)	96 (13.5)	271 (38.0)	263 (36.9)
Art Activities/Drawing	56 (7.9)	99 (13.9)	309 (43.3)	249 (34.9)
Playing Board Games	196 (27.5)	212 (29.7)	266 (37.3)	39 (5.5)
Playing Video Games	108 (15.1)	78 (10.9)	198 (27.8)	329 (46.1)
Dancing/Singing	129 (18.1)	90 (12.6)	218 (30.6)	276 (38.7)
Listening to Music	35 (4.9)	41 (5.8)	167 (23.4)	470 (65.9)
Watching TV/Videos/DVDs	5 (.7)	11 (1.5)	98 (13.7)	599 (84.0)
Playing Alone	12 (1.7)	10 (1.4)	54 (7.6)	637 (89.3)
Family Talks	93 (13.0)	48 (6.7)	174 (24.4)	398 (55.8)
Praying	303 (42.5)	43 (6.0)	124 (17.4)	243 (34.1)
Family Meetings	370 (51.9)	151 (21.2)	142 (19.9)	49 (6.9)
Holiday Dinners	289 (40.5)	401 (56.2)	14 (2.0)	9 (1.3)
Family Member's Birthdays	176 (24.7)	507 (71.1)	21 (2.9)	9 (1.3)
Decorating Home (Holidays)	382 (53.6)	309 (43.3)	11 (1.5)	11 (1.5)
Family Gatherings	102 (14.3)	411 (57.6)	172 (24.1)	28 (3.9)
Picnics	324 (45.4)	333 (46.7)	51 (7.2)	5 (.7)
Having Friends Over to Play	314 (44.0)	221 (31.0)	155 (21.7)	23 (3.2)
Visiting Neighbors	309 (43.3)	208 (29.2)	167 (23.4)	29 (4.1)
Sleepovers	568 (79.7)	126 (17.7)	18 (2.5)	1 (.1)
Doing Yard Work	376 (52.7)	210 (29.5)	121 (17.0)	6 (.8)
Planting Trees/Flowers	497 (69.7)	180 (25.2)	34 (4.8)	2 (.3)
Growing Vegetable Garden	536 (75.2)	111 (15.6)	51 (7.2)	15 (2.1)
School	118 (16.5)	10 (1.4)	41 (5.8)	544 (76.3)
Daycare/Preschool	614 (86.1)	12 (1.7)	22 (3.1)	65 (9.1)
After School Care	589 (82.6)	12 (1.7)	23 (3.2)	89 (12.5)

Car Rides/Bus Rides	27 (3.8)	7 (1.0)	69 (9.7)	610 (85.6)
Eating Out	59 (8.3)	227 (31.8)	409 (57.4)	18 (2.5)
Going Shopping	40 (5.6)	220 (30.9)	432 (60.6)	21 (2.9)
Visiting Friends	201 (28.2)	255 (35.8)	234 (32.8)	23 (3.2)
Outdoor Playgrounds	66 (9.3)	166 (23.3)	278 (39.0)	203 (28.5)
Indoor Playgrounds	371 (52.0)	214 (30.0)	95 (13.3)	33 (4.6)
Child Play Groups	515 (70.8)	99 (13.9)	90 (12.6)	19 (2.7)
Playing Arcade Games	510 (71.5)	131 (18.4)	46 (6.5)	26 (3.6)
Community Celebrations	409 (57.4)	280 (39.3)	24 (3.4)	0
Children's Festivals	503 (70.5)	199 (27.9)	11 (1.5)	0
County/Community Fairs	481 (67.5)	223 (31.3)	9 (1.3)	0
Parades	569 (79.8)	140 (19.6)	4 (.6)	0
Hay Rides	615 (86.3)	95 (13.3)	3 (.4)	0
Hiking	487 (68.3)	158 (22.2)	67 (9.4)	1 (.1)
Nature Trail Walks	382 (53.6)	237 (33.2)	89 (12.5)	5 (.7)
Boating/Canoeing	569 (79.8)	120 (16.8)	23 (3.2)	1 (.1)
Camping	581 (81.5)	119 (16.7)	11 (1.5)	1 (.1)
Community Gardens	654 (91.7)	53 (7.4)	6 (.8)	0
Rafting/Tubing	661 (92.7)	45 (6.3)	5 (.7)	2 (.3)
Fishing	566 (79.4)	123 (17.3)	24 (3.4)	0
Recreation/Community Centers	534 (74.9)	112 (15.7)	59 (8.3)	89 (1.1)
Swimming	142 (19.9)	181 (25.4)	288 (40.4)	102 (14.3)
Horseback Riding	615 (86.3)	45 (6.3)	52 (7.3)	1 (.1)
Animal Farms/Petting Zoos	522 (73.2)	164 (23.0)	25 (3.5)	2 (.3)
Parks/Nature Reserves	369 (51.8)	245 (34.4)	97 (13.6)	2 (.3)
Zoo/Animal Reserves	490 (68.7)	204 (28.6)	19 (2.7)	0
Pet Stores/Animal Shelters	485 (68.0)	175 (24.5)	53 (7.4)	0
Nature Centers	567 (79.5)	130 (18.2)	16 (2.2)	0
Children's Museums/Science Centers	392 (55.0)	298 (41.8)	23 (3.2)	0
Music Concerts/Children's Theater	599 (84.0)	108 (15.1)	6 (.8)	0
Library/Book Mobiles	232 (32.5)	221 (31.0)	248 (34.8)	12 (1.7)
Storytellers	602 (84.4)	68 (9.5)	33 (4.6)	10 (1.4)
Music Activities	381 (53.4)	119 (16.7)	153 (21.5)	60 (8.4)
Religious Activities	407 (57.1)	73 (10.2)	216 (30.3)	17 (2.4)
Going to Church	383 (53.7)	64 (9.0)	262 (36.7)	4 (.6)
Children's Clubs (4H, Scouts)	601 (84.3)	45 (6.3)	65 (9.1)	2 (.3)
Karate/Martial Arts	647 (90.7)	8 (1.1)	53 (7.4)	5 (.7)
Gymnastics/Movement Classes	628 (88.1)	23 (3.2)	55 (7.7)	7 (1.0)
Baseball	599 (84.0)	49 (6.9)	62 (8.7)	3 (.4)
Basketball	625 (87.7)	40 (5.6)	42 (5.9)	6 (.8)
Soccer	603 (84.6)	44 (6.2)	58 (8.1)	8 (1.1)

Appendix D. Two Factor Geomin v. Oblimin Rotation Item Loadings

	Factor 1		Factor 2	
HCAS ITEM	Geomin	Oblimin	Geomin	Oblimin
Children's Festivals	**0.699**	**0.697**	0.268	0.173
Nature Trail Walks	**0.658**	**0.662**	-0.116	-0.212
Hiking	**0.654**	**0.657**	-0.129	-0.225
Community Celebrations	**0.615**	**0.614**	0.17	0.084
Picnics	**0.587**	**0.587**	0.111	0.028
Holiday Dinners	**0.582**	**0.578**	0.306	0.228
Doing Errands	**0.58**	**0.582**	-0.06	-0.144
Nature Centers	**0.576**	**0.578**	-0.013	-0.096
Decorating Home (Holidays)	**0.569**	**0.565**	0.38	0.305
Music Concerts/Children's Theater	**0.559**	**0.558**	0.17	0.093
County/Community Fairs	**0.556**	**0.556**	0.163	0.086
Planting Trees/Flowers	**0.551**	**0.547**	0.325	0.252
Doing Errands	**0.549**	**0.551**	-0.089	-0.169
Parks/Nature Reserves	**0.538**	**0.539**	-0.02	-0.098
Community Gardens	**0.537**	**0.537**	0.056	-0.02
Parades	**0.535**	**0.534**	0.171	0.097
Hay Rides	**0.525**	**0.522**	0.276	0.206
Visiting Friends	**0.523**	**0.52**	0.298	0.228
Family Member's Birthdays	**0.504**	**0.501**	0.289	0.221
Zoo/Animal Reserves	**0.487**	**0.488**	-0.017	-0.087
Recreation/Community Centers	**0.47**	**0.47**	0.057	-0.009
Child Play Groups	**0.463**	**0.461**	0.236	0.174
Children's Museums/Science Centers	**0.461**	**0.461**	0.061	-0.004
Animal Farms/Petting Zoos	**0.456**	**0.456**	0.066	0.002
Going Shopping	**0.446**	**0.448**	-0.051	-0.116
Food Shopping	**0.446**	**0.449**	-0.074	-0.139
Having Friends Over to Play	**0.441**	**0.438**	0.286	0.227
Indoor Playgrounds	**0.436**	**0.435**	0.139	0.079
Visiting Neighbors	**0.435**	**0.432**	0.272	0.214
Taking Walks/Strolls	**0.415**	**0.414**	0.123	0.066
Growing Vegetable Garden	**0.398**	**0.396**	0.203	0.15
Boating/Canoeing	**0.398**	**0.398**	0.039	-0.018
Family Gatherings	**0.392**	**0.391**	0.121	0.067
Storytellers	**0.374**	**0.372**	0.229	0.179
Riding Bike/Wagon	**0.37**	**0.369**	0.147	0.097
Doing Yard Work	**0.367**	**0.364**	0.236	0.187
Bedtime Stories	**0.362**	**0.36**	0.189	0.141
Outdoor Playgrounds	**0.357**	**0.356**	0.141	0.092

Camping	**0.357**	**0.358**	0.035	-0.015
Telling Child Stories	**0.355**	**0.353**	0.245	0.198
Playing Ball Games	**0.355**	**0.354**	0.156	0.108
Eating Out	**0.352**	**0.353**	0.015	-0.035
Playing Arcade Games	**0.34**	**0.339**	0.12	0.073
Fishing	**0.34**	**0.341**	0.03	-0.018
Playing Board Games	**0.327**	**0.325**	0.194	0.151
Adult/Child Play Times	**0.325**	**0.324**	0.134	0.09
Sleepovers	**0.323**	**0.321**	0.198	0.155
Going to Church	0.123	0.11	**0.875**	**0.872**
Religious Activities	0.182	0.169	**0.87**	**0.858**
Praying	0.149	0.138	**0.74**	**0.731**
Cleaning up Room	0.282	0.275	**0.526**	**0.494**
Picking up Toys	0.28	0.273	**0.506**	**0.475**
Household Chores	0.274	0.27	**0.359**	**0.325**
Cross Load Within .10				
Family Meetings	**0.379**	**0.373**	**0.434**	**0.387**
Family Talks	**0.392**	**0.388**	**0.372**	**0.322**
Reading/Looking at Books	**0.316**	**0.312**	**0.326**	**0.286**
Swimming	**0.506**	**0.516**	**-0.563**	**-0.646**
Water Play/Swimming	**0.482**	**0.492**	**-0.576**	**-0.655**
Did not load >0.32				
Soccer	0.24	0.237	0.21	0.179
Baseball	0.23	0.23	0.091	0.06
Gymnastics/Movement Classes	0.275	0.275	0.05	0.011
Karate/Martial Arts	0.214	0.214	0.093	0.064
Children's Clubs (4H, Scouts)	0.205	0.201	0.323	0.299
Music Activities	0.263	0.259	0.268	0.235
Library/Book Mobiles	0.275	0.272	0.226	0.19
Pet Stores/Animal Shelters	0.284	0.284	0.038	-0.002
Horseback Riding	0.179	0.18	-0.014	-0.04
Rafting/Tubing	0.285	0.285	0.007	-0.034
Car Rides/Bus Rides	0.211	0.211	0.082	0.053
After School Care	0.125	0.124	0.041	0.024
Daycare/Preschool	0.221	0.221	0.003	-0.028
School	0.017	0.015	0.155	0.155
Playing Alone	0.086	0.086	0.009	-0.003
Watching TV/Videos/DVDs	0.08	0.079	0.048	0.038
Listening to Music	0.284	0.284	0.086	0.047
Dancing/Singing	0.268	0.267	0.106	0.069
Playing Video Games	0.116	0.114	0.129	0.114
Art Activities/Drawing	0.212	0.209	0.213	0.186
Rough Housing	0.221	0.221	0.011	-0.02
Cuddling with Child	0.308	0.309	0.043	0
Basketball	0.289	0.286	0.241	0.203
Cooking/Preparing Meals	0.302	0.3	0.187	0.147

Appendix E. Six Factor Oblimin Rotation Solution Item Loadings

HCAS ITEM	F1	F2	F3	F4	F5	F6
Picking up Toys	**0.745**	0.168	-0.094	0.036	0.124	0.245
Cleaning up Room	**0.627**	0.133	-0.071	-0.014	0.219	0.313
Reading/Looking at Books	**0.611**	0.162	0.132	-0.048	0.159	0.107
Adult/Child Play Times	**0.563**	0.198	0.205	0.11	0.018	-0.09
Telling Child Stories	**0.466**	0.138	0.194	0.092	0.213	0.108
Bedtime Stories	**0.464**	0.108	0.316	0.059	0.134	0.006
Dancing/Singing	**0.458**	0.19	0.24	0.134	-0.14	-0.046
Playing Ball Games	**0.441**	-0.001	0.245	0.284	0.071	0.044
Listening to Music	**0.407**	0.22	0.244	0.15	-0.094	-0.037
Family Talks	**0.398**	0.139	0.157	0.144	0.304	0.361
Household Chores	**0.397**	0.228	-0.123	0.077	0.315	0.345
Art Activities/Drawing	**0.385**	0.012	0.164	-0.007	0.072	0.062
Cuddling with Child	**0.365**	0.101	0.243	0.185	0.057	-0.099
Doing Errands	0.23	**0.788**	0.117	0.233	0.256	0.079
Food Shopping	0.211	**0.689**	0.164	0.158	0.153	0.031
Going Shopping	0.188	**0.652**	0.294	0.237	0.04	0.058
Eating Out	0.075	**0.425**	0.268	0.227	0.07	0.161
Children's Festivals	0.199	0.114	**0.819**	0.189	0.317	0.269
Community Celebrations	0.059	0.119	**0.676**	0.278	0.326	0.254
County/Community Fairs	0.073	0.067	**0.639**	0.185	0.327	0.19
Hay Rides	0.212	-0.007	**0.634**	-0.013	0.364	0.192
Music Concerts/Children's Theater	0.186	0.168	**0.602**	0.224	0.261	0.179
Parades	0.126	-0.05	**0.6**	0.263	0.29	0.172
Community Gardens	0.222	0.081	**0.572**	0.12	0.398	-0.06
Zoo/Animal Reserves	0.07	0.172	**0.563**	0.116	0.32	-0.053
Indoor Playgrounds	0.272	0.121	**0.51**	0.235	0.042	0.104
Animal Farms/Petting Zoos	0.086	0.11	**0.501**	0.04	0.386	0.033
Storytellers	0.178	-0.084	**0.501**	0.094	0.157	0.194
Child Play Groups	0.231	0.1	**0.488**	0.187	0.2	0.233
Children's Museums/Science Centers	0.105	0.147	**0.479**	0.186	0.293	0.06
Daycare/Preschool	-0.003	0.108	**0.434**	0.024	-0.051	0.005
Recreation/Community Centers	0.104	0.211	**0.427**	0.294	0.268	0.108
Parks/Nature Reserves	0.149	0.227	**0.42**	0.174	0.519	-0.058
Car Rides/Bus Rides	0.15	0.021	**0.394**	0.008	-0.062	0.01

Nature Trail Walks	0.132	0.134	**0.39**	0.183	0.785	-0.15
After School Care	-0.065	0.052	**0.387**	-0.105	-0.076	0.043
Music Activities	0.282	0.013	**0.373**	-0.031	0.018	0.192
Swimming	0.002	0.208	0.118	**0.881**	0.124	-0.173
Water Play/Swimming	0.012	0.188	0.121	**0.854**	0.065	-0.198
Visiting Friends	0.296	0.121	0.237	**0.569**	0.212	0.407
Having Friends Over to Play	0.248	0.043	0.114	**0.55**	0.221	0.403
Visiting Neighbors	0.219	0.097	0.17	**0.445**	0.247	0.373
Sleepovers	0.139	0.047	0.13	**0.368**	0.192	0.309
Hiking	0.088	0.111	0.344	0.229	**0.795**	-0.111
Nature Trail Walks	0.132	0.134	0.39	0.183	**0.785**	-0.15
Planting Trees/Flowers	0.429	0.062	0.282	0.065	**0.655**	0.177
Doing Yard Work	0.297	0.114	0.022	0.071	**0.557**	0.166
Growing Vegetable Garden	0.282	0.034	0.153	0.078	**0.538**	0.091
Camping	-0.01	0.045	0.176	0.229	**0.48**	0.108
Boating/Canoeing	0.003	0.03	0.17	0.349	**0.472**	0.131
Caring for Pets/Animals	0.077	0.177	-0.071	0.065	**0.324**	0.295
Going to Church	0.111	0.018	0.099	-0.061	-0.026	**0.901**
Religious Activities	0.135	0.037	0.203	-0.072	0	**0.89**
Praying	0.243	-0.021	0.094	-0.079	0.024	**0.788**
Children's Clubs (4H, Scouts)	0.035	0.054	0.103	0.025	0.267	**0.429**
Cross Load within 0.10						
Nature Centers	0.114	0.148	**0.494**	0.137	**0.588**	-0.068
Decorating Home (Holidays)	**0.424**	-0.281	**0.472**	0.172	**0.484**	0.166
Picnics	0.189	0.13	**0.478**	0.327	**0.464**	0.117
Holiday Dinners	**0.389**	**-0.327**	**0.505**	0.251	**0.435**	0.077
Fishing	0.017	0.054	0.097	**0.368**	**0.405**	0.129
Rafting/Tubing	-0.035	-0.007	0.046	**0.364**	**0.376**	0.113
Family Member's Birthdays	**0.342**	**-0.343**	**0.456**	0.211	**0.375**	0.093
Family Meetings	**0.353**	0.011	0.181	0.097	**0.361**	0.434
Taking Walks/Strolls	**0.38**	0.121	**0.328**	0.14	0.256	-0.02
Outdoor Playgrounds	**0.322**	0.013	**0.365**	0.198	0.08	0.053
Did not load above 0.32						
Pet Stores/Animal Shelters	0.007	0.19	0.244	0.067	0.274	0.083
Cooking/Preparing Meals	0.3	0.242	0.043	0.111	0.271	0.17
Family Gatherings	0.208	0.005	0.309	0.266	0.26	0.106
Playing Arcade Games	-0.004	0.02	0.306	0.277	0.235	0.243
Riding Bike/Wagon	0.288	0.081	0.201	0.28	0.229	0.125

Library/Book Mobiles	0.189	0.029	0.257	0.011	0.228	0.195
Playing Board Games	0.309	0.111	0.173	0.175	0.198	0.169
Karate/Martial Arts	0.006	0.133	0.096	0.189	0.184	0.205
Playing Video Games	0.006	0.078	-0.031	0.141	0.137	0.253
Horseback Riding	-0.013	0.024	0.245	0.032	0.132	-0.013
Soccer	0.275	-0.116	0.159	0.192	0.109	0.168
Basketball	0.316	-0.118	0.16	0.29	0.099	0.231
Baseball	0.188	-0.113	0.176	0.295	0.033	0.095
Gymnastics/Movement Classes	0.114	0.094	0.312	0.22	0.01	0.082
Rough Housing	0.287	0.033	0.197	0.179	-0.016	-0.106
Watching TV/Videos/DVDs	0.125	0.027	0.031	0.134	-0.055	0.05
Playing Alone	0.171	0.253	0.046	0.003	-0.086	-0.017
School	0.11	-0.185	0.256	-0.192	-0.111	0.051
Duplicate Item						
Doing Errands	0.281	0.739	0.191	0.27	0.24	0.085

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