



April 2016

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### Recommended Citation

Smith, J. A. (2016). Sensory Processing as a Predictor of Feeding/Eating Behaviors in Children with Autism Spectrum Disorder. *The Open Journal of Occupational Therapy*, 4(2). <https://doi.org/10.15453/2168-6408.1197>

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# Sensory Processing as a Predictor of Feeding/Eating Behaviors in Children with Autism Spectrum Disorder

## Abstract

*Background:* Children with Autism Spectrum Disorder (ASD) frequently have feeding and eating difficulties as well as unusual responses to sensory stimuli. This can lead to significantly compromised occupational performance.

*Method:* A secondary data analysis study design was used to investigate sensory processing characteristics as predictors of feeding and eating disturbances. Study subjects were children aged 2 to 14 years (N = 171) with ASD. The Short Sensory Profile (SSP) was used to determine the child's sensory processing abilities. Correlational and multiple regression methods were employed to analyze the relationship between sensory processing and feeding and eating behaviors.

*Results:* Results suggest that six out of eight of the sensory domains from the SSP were predictive of eating behaviors.

*Discussion:* This study provides evidence to inform practice regarding the association of sensory processing and eating behaviors and supports the need for assessing sensory processing in children with ASD.

## Keywords

ASD, Feeding and Eating, Short Sensory Profile, Sensory Domains, Occupational Performance

## Cover Page Footnote

I am very grateful to Dr. Winifred Schultz-Krohn for her ongoing support, expertise, and assistance in reviewing this article, and to my dissertation chair, Dr. Angela Hegamin, for her invaluable guidance throughout the research process. I would also like to acknowledge Dr. Rebecca Landa, Director of the Center for Autism and Related Disorders, who allowed me to collect data at the Kennedy Krieger Institute, and Dr. Deepa Menon, Assistant Medical Director of CARD, who was directly involved with the study as a member of the medical staff at the Kennedy Krieger Institute.

## Credentials Display

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DOI: 10.15453/2168-6408.1197

## **Background and Literature Review**

Autism Spectrum Disorder (ASD) is a complex disorder with different levels of severity of symptoms. ASD is characterized by impairments in social interaction and communication, as well as by restricted, repetitive, and stereotyped patterns of behavior, interests, and activities (American Psychiatric Association [APA], 2013). On average, children identified with ASD are not diagnosed until after the age of 4, although some children are diagnosed as early as the age of 2 (Centers for Disease Control and Prevention [CDC], 2014). Recent research, however, suggests that many children with ASD can be identified much earlier than this (Cangialose & Allen, 2014; Jeans, Santos, Laxman, McBride, & Dyer, 2013; Soares & Patel, 2012). Early detection makes it possible for children with ASD to begin intervention programs as soon as possible, which may result in better outcomes. The CDC (2014) estimates that one in every 68 children has been identified with ASD.

In addition to the impairments described above, children with ASD have impaired occupational performance in several areas, including activities of daily living skills and instrumental activities of daily living (Kao, Kramer, Liljenquist, Tian, & Coster, 2012; Koenig & Rudney, 2010). These children also frequently exhibit behaviors associated with sensory processing difficulties, which can manifest themselves in a variety of ways. Sensory processing refers to the way that sensory information (auditory, visual, vestibular, or proprioceptive stimuli) is received and interpreted in the cerebral cortex and brainstem for the purpose

of enabling adaptive responses to the environment and allowing for engagement in meaningful activities and occupations (Johnson-Ecker & Parham, 2000). Sensory processing disorders can have a profoundly negative impact on the child's ability to engage fully in all aspects of daily living, including the occupation of feeding and eating. To provide the most effective interventions for children with feeding and eating difficulties, researchers need more information about the association between sensory processing and occupational performance.

## **Feeding Problems in Children with Autism Spectrum Disorder**

Feeding problems are more prevalent in children with developmental disabilities than in neurotypical children (Provost, Crowe, Osbourn, McClain, & Skipper, 2010; Sharp et al., 2013). Children with ASD often display atypical and problematic behaviors around the activity of feeding and eating. Many of these children have idiosyncratic food preferences, restricted diets limited in variety, aversion to certain textures, and excessive mouthing of unusual or inedible objects (Hendy, Seiverling, Lukens, & Williams, 2013; Seiverling, Williams, & Sturmey, 2010). Additionally, children with ASD exhibit at least two of the following behaviors that can significantly interfere with mealtime eating behaviors: extreme attachment to routines and patterns and resistance to changes in routines, repetitive speech or movements, intense and restrictive interests and difficulty integrating sensory information, or strong seeking or avoiding behavior of sensory stimuli (APA, 2013).

Parents, clinicians, and caregivers of children with ASD frequently report feeding difficulties and unusual eating patterns, the majority of which are anecdotal accounts.

Children with ASD are almost twice as likely to experience feeding and eating difficulties (compared to neurotypical children), and children with ASD who exhibit these problems experience an average of three times as many problems simultaneously (Martins, Young, & Robson, 2008). Children with ASD exhibit more general eating problems than children without ASD, including refusing foods, the need for specific presentations of foods, specific utensils, limited textures, and eating a narrow variety of foods (Cermak, Curtin, & Bandini, 2010; Kuschner, Bennetto, & Silverman, 2005; Schreck & Williams, 2006).

### **Sensory Processing and Eating Behaviors in Children with ASD**

Sensory processing difficulties and unusual responses to sensory stimuli may affect auditory, visual, tactile, movement, and oral sensory processing in children with ASD (O'Donnell, Deitz, Kartin, Nalty, & Dawson, 2012; van der Linde, Franzsen, Barnard-Ashton, 2013). Difficulties processing and responding to sensory stimuli constantly challenges a child with sensory processing deficits and leads to impairments with monitoring and regulating the degree, intensity, and nature of sensory input in order to generate an appropriate response to incoming sensory information (Dunn, 1999).

Despite widespread agreement in the literature that children with ASD have sensory

processing disorders of some kind, and that unusual and maladaptive eating habits are common in this population, there is limited evidence regarding the specific association between sensory processing disturbances and maladaptive feeding and eating behaviors. A pilot study by Paterson and Peck (2011) provides preliminary data linking sensory processing difficulties and eating behaviors. Nadon, Ehrmann Feldman, Dunn, and Gisel (2011) found that children with tactile sensitivities and visual or auditory sensitivities presented with increased eating problems compared to children with typical sensory processing performance. Suarez, Nelson, and Curtis (2012) found that children who were more selective in the number of foods that they would eat had higher sensory over-responsivity, especially in the area of tactile sensitivity.

Although there is much information in the literature regarding the prevalence of sensory processing difficulties in children with ASD, more studies linking sensory processing to participation in meaningful occupations are needed. The nature of sensory processing difficulties in autism and the relationship to functional behavior and specific occupational performance tasks are poorly understood. While some support for the link between sensory processing and eating behaviors can be found in the current literature, gaps in the existing evidence make it difficult to know whether specific patterns of sensory processing difficulties exert an influence on feeding and eating for children with ASD. Understanding the association between distinct sensory subtypes and atypical or maladaptive mealtime behaviors of children with

ASD provides clinicians with guidelines for the early identification of those children who may benefit from early sensory-based intervention.

The current study investigated sensory processing domains as predictors of feeding and eating behaviors in children with ASD. It sought to discover if there are specific areas (domains) of sensory processing that are more predictive of feeding and eating behaviors. Results provide evidence to inform practice regarding the association between sensory processing and eating behaviors in children with ASD. The findings also supply evidence-based data regarding potential target areas of intervention related to the sensory processing differences in children with ASD who have feeding challenges. Research questions included:

- Can sensory processing domains from the Short Sensory Profile (SSP) predict feeding and eating behaviors in children with ASD?
- What child characteristics are associated with feeding and eating behaviors?

### **Method**

A cross-sectional secondary data analysis study design was used to quantitatively examine variables associated with the sensory processing of children with ASD and feeding and eating behaviors. The researcher obtained Institutional Review Board approval and no researcher-participant interaction occurred. The researcher extracted data directly from forms in the participants files at the Kennedy Krieger Institute in Baltimore, MD.

### **Participants**

The sample consisted of 171 children between the ages of 2 and 15 years ( $M = 5.58$ ,  $SD = 2.85$ ) who were clients at the Kennedy Krieger Institute and who were enrolled in the Autism Treatment Network (ATN) Registry (Autism Speaks, nd) between 2008 and 2010. Inclusion criteria included a current diagnosis of autism, Asperger's Syndrome, or pervasive developmental disorder/not otherwise specified (PDD/NOS). A physician at the Kennedy Krieger Institute confirmed the diagnosis using criteria from the DSM-IV-TR. Exclusion criteria included children who were blind or deaf and children who were involved in another research protocol. The ATN is a national network of hospitals and physicians dedicated to furthering the understanding of autism and improving treatments for children and adolescents with autism (Autism Speaks, nd). The ATN developed and implemented a standardized protocol for a multidisciplinary and comprehensive evaluation of children with ASD and maintains a database (Registry) that contains anonymous clinical data about participating children. The study sample represents a sub-sample of the total registry database.

The study included a total of 171 children. A convenience sampling method was used to obtain study subjects (participants were randomly selected if they met the inclusion criteria until the required number as indicated in the a-priori sample size calculation was reached). The majority of the participants were male (80.7%), 73.1% were identified as Caucasian/White, 20.5% as Black or African American, and 4.1% as Asian. Ages ranged

from 2 to 14 years ( $M = 5.58$ ,  $SD = 2.85$ ). The most prevalent diagnoses (using the DSM-IV-TR) were pervasive developmental disorder/not otherwise specified (PDD-NOS) (48.5%) and autism-current/active state (45.6%). Other diagnoses included Asperger's Disorder (3.5%) and autism-residual (1.8%).

### **Instrumentation**

The variables in this study were measured by selected items taken from the ATN forms and from the SSP (Dunn, 1999). The ATN instruments were designed to collect quantitative data from both caregivers and physicians. Selected information from forms completed by the caregivers and by the physician was used in this study. The Diagnosis and Treatment Form-Parent Report (a Likert scale questionnaire) was used to obtain information about eating habits, sensory and behavioral issues, hitting, repetitive behaviors, sensory problems, and compulsive behaviors. Items from the Developmental and Medical History/Health Condition Form (completed by the caregiver) were used to measure newborn feeding status and history of gastro-intestinal problems. Items from the Diagnosis and Treatment Form-Clinician Report (completed by the physician) were used to measure nutritional status and feeding difficulties. Data collection forms used by the ATN provided demographic information (age, gender, and ethnicity) and child diagnosis.

The SSP (Dunn, 1999) is an abbreviated version of the Sensory Profile that consists of the items that demonstrate the highest discriminative power of atypical sensory processing. It is a 38-

item questionnaire that uses a 5-point Likert scale and is completed by the child's caregiver. Seven domains (tactile sensitivity, taste/smell sensitivity, movement sensitivity, under-responsive/seeking sensation, auditory filtering, low energy/weak, and visual/auditory sensitivity) reflect how the child's nervous system responds to incoming sensory information. In addition, the Total Score (sum of the section scores) reflected the child's overall sensory processing ability. The SSP has been shown to be a valid tool for identifying sensory processing disorders in children with ASD (Dunn, 1999). Internal consistency of the sections in the scale range from .70 to .90. Internal validity correlations for the sections range from .25 to .76 and were all significant at  $p < .01$ . Many studies have used the SSP to examine the relationship between sensory processing disorders and behaviors of children with ASD (Baker, Lane, Angley, & Young, 2008; Gal, Dyck, & Passmore, 2010; Lane, Dennis, & Geraghty, 2010).

### **Data Analysis**

The data were analyzed using SPSS PASW Statistics 18 (IBM Corp). An alpha level of 0.05 was used for all statistical tests. Pearson's correlation coefficients were calculated for continuous variables. Ordinal dependent variables were treated as continuous variables. Simultaneous multiple linear regression was used to model the relationship between multiple independent predictor variables and the dependent outcome variable.

## Results

### Descriptive Analysis

**Child characteristics.** Several child characteristics of interest were present in the study sample. These included feeding difficulties in the first month of life; the presence of behavioral issues, such as hitting, repetitive behaviors, or sensory problems; compulsive behaviors, such as completing routines in the same manner; and sensory issues, such as reacting to lights, sounds, or textures, in the month prior to the completion of the parent questionnaire (see Table 1).

**Table 1**  
*Child Characteristics of Study Sample*

Characteristic	Percentage	<i>n</i>
Feeding difficulty in the first month of life	31.6%	54
Behavioral Issues	30%	52
Compulsive Behaviors		
Mild problem	36.8%	52
Moderate problem	19.3%	33
Severe problem	36.8%	11
Sensory Issues		
Mild problem	38%	65
Moderate problem	29.2%	50
Severe problem	11.7%	20

**Feeding and eating behaviors.** The sample population in this study had problematic feeding and eating behaviors in all areas except for Pica. Moderate to severe problems with eating habits (eating few foods or certain types of foods) were present in 41.5% of the sample; 38.6% always or frequently (100% -75% of the time) avoided certain tastes or food smells that are typically a part of a child's diet; 39.2% always or frequently limited themselves to a particular food texture or temperature; 47.3% always or frequently were

picky eaters; and, 33.9% would only eat certain tastes.

**Sensory processing performance.** The majority (76%) of the subjects presented with sensory processing dysfunction when compared to the normative data provided for the SSP. Notably, probable or definite differences in sensory processing appeared in 66% of the subjects in the domain of tactile sensitivity, 73% in the domain of under-responsive/seeking sensation, and 74% in the domain of auditory filtering. Additionally, 81% of the study subjects scored in the probable or definite difference range for the total sensory processing score. Table 2 shows the number of study participants with typical, probable, and definite differences on the SSP.

**Table 2**  
*Number of Study Participants with Typical, Probable and Definite Difference on the SSP*

SSP Section	Typical Performance ( <i>n</i> =)	Probable Difference ( <i>n</i> =)	Definite Difference ( <i>n</i> =)	TOTAL ( <i>N</i> =)
SSPMvmt	125	13	29	167
SSPTaste/ Smell	79	23	67	169
SSPTactile	58	41	70	169
SSPUnder	47	25	99	171
SSPAudFil	42	32	95	169
SSPLowEner	89	18	64	171
SSPVisAud	89	32	47	168
SSPTotal	30	30	111	171

### Bivariate Analysis

Pearson product-moment correlation coefficients were computed to assess the linear relationship between the variables in this study.

Among the independent variables in the study sample, there were significant, positive correlations between how the child responds to touch sensations (tactile sensitivity) in daily life and all of the other independent variables (IVs) involving sensory processing (taste/smell sensitivity, movement sensitivity, under-responsive/seeking sensation, auditory filtering, and visual/auditory sensitivity). Additionally, the ability to use and screen out sounds in daily life (auditory filtering) had a statistically significant, positive correlation with the

ability to notice sensory events in daily life (under-responsive/seeking sensation),  $r(169) = .582, p < .01$ . There was also a statistically significant positive correlation between the response to sounds and sights in daily life (visual/auditory sensitivity) and auditory filtering,  $r(169) = .362, p < .01$ .

Significant correlations were low or mild (.2-.3), suggesting weak but positive relationships between difficulties in sensory processing in several areas and feeding behaviors (see Table 3).

**Table 3**

*Pearson Product-Moment Correlations between Sensory Domains and Feeding and Eating Behaviors. Bivariate Correlation Coefficient is Depicted for Each Pair of Variables. Degrees of Freedom are 168 or 169 for all Analyses.*

	Eating Habits	Avoids certain tastes or food smells	Will only eat certain tastes	Limits self to particular food textures/temperatures	Picky eater
Tactile Sensitivity	-0.097	0.275***	0.152*	0.237**	0.236**
Taste/Smell Sensitivity	-0.490***	0.772***	0.798***	0.868***	0.822***
Movement Sensitivity	-0.137	0.029	0.052	0.080	0.072
Under-responsive/Seeks Sensation	-0.065	0.281***	0.231**	0.222**	0.175*
Auditory Filtering	-0.101	0.198**	0.250**	0.184*	0.150*
Low Energy/Weak	-0.049	0.078	0.028	-0.040	-0.176*
Visual/Auditory Sensitivity	-0.101	0.223**	0.168*	0.157*	0.084
SSP Total	-0.290***	0.515***	0.449***	0.457***	0.387***

\* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ .

**Multivariate Analysis**

Multiple regression analysis was used to answer the following research question: Can sensory processing domains from the SSP predict feeding and eating behaviors in children with ASD? The dependent variable—feeding and eating behaviors—consisted of several selected behaviors identified by the child’s caregiver on the SSP and

eating habits, avoids certain tastes or smells, only eats certain foods, limits self to particular food textures or temperatures, and picky eater. The independent variables consisted of the sensory domains from the SSP (tactile sensitivity, taste/smell sensitivity, movement sensitivity, under-responsive/seeking sensation, auditory filtering, low energy/weak, visual/auditory sensitivity) and the total score (total of all domain section scores).



Taste/smell sensitivity ( $B = -.082, p < .001$ ) was predictive of eating habits, accounting for 27.2% of the variance in the model. The following independent variables had significant predictive value for avoids certain tastes or food smells: taste/smell sensitivity ( $B = 0.176, p < .001$ ), auditory filtering ( $B = -0.041, p = .033$ ), and the total score ( $B = 0.026, p = .003$ ). The results of the regression indicate that these three predictors explained 63.2% of the variance in the model. Taste/smell sensitivity ( $B = .216, p < .001$ ) and tactile sensitivity ( $B = -0.044, p = .013$ ) were significantly associated with only eats certain foods. These two predictors explained 65.9% of the variance in the model. Taste/smell sensitivity ( $B = 0.244, p < .001$ ) and visual/auditory sensitivity ( $B = -0.034, p = .032$ ) were significantly associated with

limits self to particular food textures or temperatures, accounting for 76.2% of the variance ( $R^2 = .762, F(7,163) = 74.636, p < .001$ ). Taste/smell sensitivity ( $B = 0.217, p < 0.001$ ), low energy/weak ( $B = -0.058, p < .001$ ), visual/auditory sensitivity ( $B = -0.061, p < .001$ ), and the total score ( $B = 0.018, p = .024$ ) were significantly associated with picky eater. These four variables account for 72.5% of the variance in the model. See Table 4 for the multivariate models predicting feeding and eating behaviors from the sensory domains.

Atypical sensory responses to taste and smell, visual and auditory stimuli, tactile sensitivities, low energy or weakness, and a higher combined Total Score of all sensory domains were predictive of feeding and eating behaviors as identified in this study.

**Table 4**

*Multivariate Models for the Prediction of Feeding and Eating Behaviors from the SSP (N = 171)*

RQ1 Models	Unstandardized Coefficients		Standardized Coefficients	Sig
	B	Std. Error	Beta	
<b>DV: Eating Habits</b>				
Tactile Sensitivity	.029	.017	.177	.082
Taste/Smell Sensitivity	-.082	.017	-.444	.000*
Movement Sensitivity	-.036	.023	-.117	.112
Auditory Filtering	.017	.018	.092	.354
Low Energy/Weak	-.005	.014	-.028	.739
Visual/Auditory Sensitivity	.015	.017	.077	.387
Total-SSP	-.011	.008	-.244	.188
<b>DV: Avoids Tastes/Food Smells</b>				
Tactile Sensitivity	-.015	.018	-.061	.393
Taste/Smell Sensitivity	.176	.018	.641	.000*
Movement Sensitivity	-.040	.024	-.087	.096
Auditory Filtering	-.041	.019	-.150	.033*
Low Energy/Weak	-.004	.015	-.017	.776
Visual/Auditory Sensitivity	-.021	.018	-.073	.248
Total-SSP	.026	.009	.396	.003*
<b>DV: Will Only Eat Certain Tastes</b>				
Tactile Sensitivity	-.044	.018	-.173	.013*
Taste/Smell Sensitivity	.216	.018	.759	.000*
Movement Sensitivity	-.003	.024	-.007	.893
Auditory Filtering	.013	.019	.046	.490
Low Energy/Weak	.002	.015	.007	.902
Visual/Auditory Sensitivity	-.020	.018	-.066	.278

Total-SSP	.012	.009	.179	.156
<b>DV: Limits Self to Texture/Temp</b>				
Tactile Sensitivity	-.010	.015	-.039	.502
Taste/Smell Sensitivity	.244	.015	.824	.000*
Movement Sensitivity	-.004	.021	-.008	.850
Auditory Filtering	-.019	.017	-.064	.255
Low Energy/Weak	-.015	.013	-.055	.253
Visual/Auditory Sensitivity	-.034	.016	-.109	.032*
Total-SSP	.013	.008	.182	.085
<b>DV: Picky Eater</b>				
Tactile Sensitivity	.002	.016	.008	.894
Taste/Smell Sensitivity	.217	.016	.751	.000*
Movement Sensitivity	-.017	.022	-.035	.437
Auditory Filtering	-.026	.017	-.089	.140
Low Energy/Weak	-.058	.014	-.218	.000*
Visual/Auditory Sensitivity	-.061	.017	-.199	.000*
Total-SSP	.018	.008	.257	.024*

\* Significant at the  $p = .05$  level

## Discussion

The purpose of this study was to examine the relationship between sensory processing and feeding and eating behaviors in children with ASD. Six out of eight of the sensory processing domain sections of the SSP were found to be significant predictors of feeding and eating behaviors in children with ASD. Only taste/smell sensitivity and the total score were predictors of problematic feeding and eating behaviors. Several sensory processing domains had an inversely proportional relationship with feeding and eating behaviors in the study sample; atypical performance in the areas of tactile sensitivity, visual/auditory sensitivity, and low/weak energy were predictors of more typical feeding and eating behaviors. This was a surprising finding, and it is in contrast to other studies that have linked sensory difficulties in multiple sensory domains with eating problems (Nadon et al., 2011; Suarez et al., 2012). This may be due in part to the differences in the measures used to identify eating behaviors. Dunn (1999) asserts that the most important score on the SSP is the total score, as it provides the best indication of the child's overall

sensory processing ability. This study supports Dunn's findings regarding the association between the total score and maladaptive feeding behaviors. The association of sensory processing abilities and feeding and eating behaviors provides much needed evidence for therapists working with children with ASD who have sensory processing challenges and feeding problems. Understanding the relationship between the child's total sensory processing abilities (vs. specific areas of sensory processing) and feeding and eating behaviors has implications for targeted intervention planning. In addition, the results support previous research findings that children with ASD process sensory information differently from their neurotypical peers (Lane et al., 2010; Liu, 2013; O'Donnell et al., 2012; van der Linde et al., 2013).

## Limitations

Several limitations in this study must be noted. The study employed secondary data analysis and relied on information that was available to the researcher for the constructs of interest. A caregiver report tool was used to obtain information about the study subjects. It is unknown if the

caregiver fully understood the questions or the terminology used in the questionnaires. Further, the small number of items on the SSP does not allow for detailed analysis of sensory threshold data (Lane et al., 2010). A more extensive sensory processing assessment tool may have yielded more sensitive findings.

Another important limitation was the lack of a comprehensive, psychometrically sound tool to assess mealtime behaviors. Although feeding and eating problems are pervasive in children with ASD and the incidence is widely documented in the literature, a specific parent questionnaire addressing this area was not included in the ATN protocol for the subjects in the study sample. The researcher developed the measure used for Eating/Feeding Behaviors based on information available in the existing ATN protocol. Although the researcher conducted a multiple source review and received input from an expert panel, the measure was not formally tested for validity and reliability.

Therefore, data used in the current study may not have been sensitive enough to capture the full scope of mealtime behaviors.

### **Implications for Clinical Practice**

The results of this study confirm that abnormal sensory processing is a pronounced problem in children with ASD. Difficulty with processing sensory information was both associated with and predictive of abnormal feeding and eating problems. Given the high prevalence of children with ASD who have significant occupational performance deficits associated with mealtime routines (Gale, Eikeseth, & Rudrud, 2011; Hendy et

al., 2013; Suarez, Atchison, & Lagerwey, 2013), the findings from this study support the need for early identification of and intervention for sensory processing problems with this population. A description of the distinct sensory processing patterns of the child with maladaptive feeding and eating behaviors provides clinicians with evidence-based guidelines to use in preclinical evaluation of feeding and eating concerns.

### **Implications for Research**

Further research is needed to define more clearly the patterns of sensory processing in children with ASD as they relate to occupational performance, such as feeding and eating. Studies with large samples that yield statistical power, using the SSP as an initial screening tool, followed by an in-depth sensory processing assessment, may yield more precise information regarding the distinctive sensory processing patterns of children who present with mealtime problems. Using more detailed measures of feeding and eating behaviors that have been found to be prevalent among children with ASD may yield more specific associations between the individual sensory domains and specific mealtime behaviors. Further testing of the hypotheses will assist in more precise identification of sensory processing typologies and key child characteristics. The findings that result from future studies replicating this research with more precise measurement tools may differentiate peculiar mechanisms of sensory processing, providing much needed evidence for the development of interventions targeted to specific problem areas.

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