Behavioral and Physiological Factors Associated With Selective Eating in Children With Autism Spectrum Disorder

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MeSH TERMS

- child behavior
- child development disorders, pervasive
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- feeding behavior
- food habits
- sensation

Selective eating is common in children with autism spectrum disorder (ASD), but it is not yet well understood. The objectives of this study were to examine a new definition of selective eating, compare behavioral measures between children with ASD and selective eating and those without selective eating, and determine relationships among behavioral measures and measures of selective eating. Participants were assigned to groups on the basis of number of foods eaten compared with a population-based sample. Results of one-way multivariate analysis of variance indicated no overall effect of group for challenging behaviors, sensory reactivity, or repetitive behaviors. Between-participant tests indicated that scores for compulsive behaviors were significantly lower ($p = .036$) for the selective eating group. Correlations were moderately strong among variables relating to food intake and behavioral variables, but were not significant between selective eating and behavioral variables. Further research is needed to validate the definition of selective eating and to identify targets for intervention.

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Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by impairments in social communication and the presence of restricted and repetitive patterns of behavior and interests (American Psychiatric Association, 2013). Current estimates indicate that 1 in 68 U.S. children have ASD (Wingate et al., 2014). *Selective eating,* defined as accepting only a limited variety of foods and refusing many foods, is a common problem for children with ASD (Bandini et al., 2010; Ledford & Gast, 2006; Schreck, Williams, & Smith, 2004). Compared with other populations, children with ASD have a fivefold increase in selective eating (Sharp et al., 2013).

Selective eating can have a negative impact on both the child with ASD and his or her family. Parents of children with ASD consistently report concern about their child's eating habits (Bicer & Alsaffar, 2013; Williams, Dalrymple, & Neal, 2000), which may be accompanied by stress (Anderson, Must, Curtin, & Bandini, 2012; Rogers, Magill-Evans, & Rempel, 2012). Although the research is not conclusive, several studies have found that children with ASD may be at risk for nutritional deficits resulting from limited dietary variety (Emond, Emmett, Steer, & Golding, 2010; Hyman et al., 2012; Zimmer et al., 2012). Despite these potential negative consequences, long-term effects of selective eating have not yet been explored in the literature.

One reason for the paucity of studies on the effects of selective eating is the lack of an objectively measured definition that is consistently applied. Several studies have compared the dietary variety of children with ASD to that of children with typical development and with developmental disability and concluded that those with ASD have less dietary variety and more food refusal (Bandini et al., 2010; Marshall, Hill, Ziviani, & Dodrill, 2013; Williams, Hendy, & Knecht, 2008; Zimmer et al., 2012). Other studies, in the United States and other countries, have found that children with ASD do not meet standard recommendations for nutrient intake and dietary variety (Bicer & Alsaffar, 2013; Hyman et al., 2012; Xia, Zhou, Sun, Wang, & Wu, 2010). However, these studies have failed to separate children with ASD into those with selective eating and those without. An estimated 58%–67% of parents of children with ASD report selective or picky eating in their child (Bicer & Alsaffar, 2013; Kerwin, Eicher, & Gelsinger, 2005; Williams et al., 2000). A standard definition of selective eating would strengthen further study of the phenomenon.

The clinical presentation of children with ASD and selective eating is complex. In the literature, feeding problems have been associated with aggression, internalizing behaviors, externalizing behaviors, repetitive behaviors, anxiety, and sensory reactivity (Johnson et al., 2014; Matson, Fodstad, & Dempsey, 2009; Nadon, Feldman, Dunn, & Gisel, 2011; Paterson & Peck, 2011). This complicated presentation can lead to difficulty determining which interventions would be most effective for selective eating. Recognizing this problem, researchers have recommended the need for multidisciplinary assessments and treatments (Johnson et al., 2014; Kral, Eriksen, Souders, & Pinto-Martin, 2013; Sharp et al., 2013). However, most interventions reported in the literature are behavioral in nature and may not take into account potential underlying causes (Kodak & Piazza, 2008; Sharp, Jaquess, Morton, & Herzinger, 2010). A deeper understanding of the factors associated with selective eating is needed to develop and test holistic interventions for this problem in children with ASD.

The objectives of this study were to examine a new definition of selective eating, compare behavioral measures between children with ASD with and without selective eating, and determine associations between behavioral measures and measures of selective eating. We hypothesized that grouping participants using a standard definition of selective eating would result in significant differences between groups in measures of food acceptance and refusal and of challenging behaviors, anxiety, repetitive behaviors, and sensory reactivity. Additionally, we hypothesized that behavioral variables would be highly correlated with measures of food variety and refusal.

Method

Participants

Study flyers were distributed to outpatient clinics and schools for children with ASD. Included children were between ages 4 and 10 yr with English-speaking parents. Children who were currently in a nonoral feeding phase (e.g., using a gastrostomy tube) were excluded from the study. All participants were also screened for inclusion using the Social Communication Questionnaire (SCQ; Rutter, Bailey, & Lord, 2003), using cutoff scores suggested for maximum sensitivity in younger age groups (Corsello et al., 2007). Participants were offered a $20 gift card for participation in the study. Institutional review board approval was obtained for this study before initiation of recruitment and data collection. Informed consent was obtained for all study participants.

Parents of 45 children responded to the flyer and were screened for inclusion. Of those who were screened, 39 qualified for the study. Thirty-five participants completed all data collection; 4 were not able to complete it because of scheduling difficulties. Table 1 presents child and informant characteristics.

Instruments

Demographic Information. A demographic questionnaire captured general participant information, including race and ethnicity, health history, and dietary restrictions. Food insecurity was identified using a validated screening tool (Hager et al., 2010).

Body Mass Index Percentile. A portable stadiometer and electronic scale were used to measure each child's height and weight. Children were weighed and measured 3 times each in light clothing (except for 1 child who was able to be weighed only twice), and the average of each measurement was used to calculate the z score for body mass

Table 1. Characteristics of Participants by Group

	M (*SD*) or *n* (%)	
Characteristic	Selective ($n = 17$)	Nonselective ($n = 18$)
SCQ score	19.8 (5.1)	20.1 (5.0)
Age, mo	79 (22.5)	83.6 (23.4)
zBMI	59.8 (32.6)	72.2 (28.8)
Gender		
Male	15 (88.2)	17 (94.4)
Female	2 (11.8)	1 (5.6)
Race/ethnicity		
White	13 (76.5)	9 (50.0)
Non-White	4 (23.5)	9 (50.0)
Respondent		
Mother	15 (88.2)	13 (72.2)
Father	2 (11.8)	5 (27.8)
Food security status		
Secure	13 (76.5)	12 (66.7)
Insecure	4 (23.5)	6 (33.3)

Note. M = mean; SCQ = Social Communication Questionnaire; *SD* = standard deviation; zBMI = z score for body mass index. No statistically significant differences were found between groups.

index (zBMI) with the Centers for Disease Control and Prevention BMI percentile calculator for children and teens (http://nccd.cdc.gov/dnpabmi/Calculator.aspx).

Food Intake. Food intake was measured using a food frequency questionnaire (FFQ; Bandini et al., 2010; Rockett, Wolf, & Colditz, 1995; Willett, 1998) that contained 126 food items with space for additional items. Total food intake was calculated by using parent report of the total number of foods that the child had eaten over the past year on the FFQ. Beverages were not taken into consideration for total food intake. Refusal rate was calculated by dividing the total number of foods eaten by the number of foods offered to the child (total number of foods on the FFQ minus number of foods not offered).

Sensory Reactivity. Sensory reactivity was measured using the Short Sensory Profile (SSP; Dunn, 1999), which is derived from the Sensory Profile (Dunn, 1999). The SSP is a 38-item parent questionnaire designed to measure behaviors associated with abnormal sensory processing in children ages 3–10 yr (McIntosh, Miller, Shyu, & Dunn, 1999). A total score is given for overall sensory processing ability, and separate scores are given for each of seven domains. Raw total score and Taste/Smell Sensitivity score were included in this study.

Challenging Behaviors. Anxiety and challenging behaviors were measured using the Child Behavior Checklist (CBCL) for ages 1.5–5 yr or 6–18 yr (Achenbach & Rescorla, 2001). The CBCL is a 118-item caregiver report measure that evaluates the frequency of occurrence of a variety of behaviors. This study included T scores for the syndrome scales of Anxiety/Depression and Somatic Complaints and the broad behavior scales of Internalizing Behaviors and Externalizing Behaviors.

Mealtime Behaviors. Mealtime behaviors were measured using the Brief Assessment of Mealtime Behavior in Children (BAMBIC; Hendy, Seiverling, Lukens, & Williams, 2013), a 10-item parent report questionnaire on mealtime behavior derived from the 18-item Brief Autism Mealtime Behavior Inventory (BAMBI; Lukens & Linscheid, 2008). Raw subscale scores for Limited Variety, Food Refusal, and Disruptive Behavior were included as variables in this study.

Restricted and Repetitive Behaviors. Restricted and repetitive behaviors were measured using the Repetitive Behavior Scale–Revised (RBS–R; Bodfish, Symons, & Lewis, 1999; Bodfish, Symons, Parker, & Lewis, 2000), a 43-item caregiver report measure. Scoring for the RBS–R was performed using the algorithm developed by Lam and Aman (2007). Raw total scores were included in this study for the Compulsive Behavior and Ritualistic/Sameness Behavior subscales and the total score.

Procedures

Participants were screened for inclusion on the phone or in person using the SCQ. Data collection took place over one or two sessions, either in the family's home or during an outpatient visit, depending on parent preference and availability. All measures were administered using standard instructions in a setting with as little distraction as possible.

Analysis

Data were analyzed using IBM SPSS Statistics (Version 21; IBM Corp., Armonk, NY). Demographic characteristics were compared between groups using paired t tests for continuous variables and χ^2 for dichotomous variables. Differences between groups were analyzed using one-way multivariate analysis of variance (MANOVA). Correlations between variables were analyzed using the Pearson correlation coefficient. Statistical significance was assessed at a p of .05.

Results

Assignment to Groups

Participants were assigned to either the selective or the nonselective group according to the number of foods eaten yearly compared with a population-based sample of 872 children ages 4–11 yr included as part of the National Health and Nutrition Examination Survey (NHANES) 2005–2006 (Watowicz & Tanner, 2014). Items included on the study FFQ (Bandini et al., 2010) were matched to the items included on the NHANES FFQ (National Cancer Institute's Diet History Questionnaire; Subar et al., 2001). Participants in the selective group consumed 50 or fewer total foods in the past year (5th percentile of foods eaten in the NHANES).

Differences in Food Intake Between Groups

No statistically significant differences were found between the selective and nonselective eaters for SCQ scores, age, zBMI scores, gender, mother or father as respondent, race or ethnicity, or food security status (see Table 1). Results of the MANOVA indicated a main effect of group, $F(1, 34) = 14.31$, $p < .001$, observed power = 1.00. Between-subjects analyses revealed that the selective eating group ate fewer total foods ($p < .001$) and had a higher rate of food refusal ($p < .001$) on average than the nonselective group (Table 2). The selective eating group also had significantly higher scores on the Limited Variety subscale of the BAMBIC ($p < .001$); the difference in scores on the Food Refusal domain of the BAMBIC approached significance ($p = .082$).

Table 2. Comparison of Eating Parameters and Behavioral Variables Between Groups

Variable	Selective (n = 17) M (SD)	Nonselective (n = 18) M (SD)	F (p)
Total foods	36.75 (9.56)	73.06 (14.50)	75.303 (<.001)**
Refusal rate	0.59 (0.17)	0.24 (0.18)	35.471 (<.001)**
BAMBIC			
Limited Variety	18.41 (1.77)	13.56 (3.58)	25.335 (<.001)**
Food Refusal	7.82 (3.81)	5.89 (2.47)	3.211 (.082)
Disruptive Behavior	4.65 (2.32)	3.72 (1.13)	2.296 (.139)
SSP			
Total score	9.17 (4.60)	12.28 (4.38)	0.005 (.946)
Taste/Smell Sensitivity	120.12 (17.80)	120.50 (15.40)	4.092 (.051)
RBS–R			
Compulsive Behavior	2.52 (1.84)	4.50 (3.20)	4.773 (.036)*
Ritualistic/Sameness Behavior	8.47 (6.44)	10.67 (8.22)	0.768 (.387)
Total score	27.12 (14.35)	32.44 (19.75)	0.825 (.370)
CBCL			
Anxiety/Depression	56.65 (6.16)	57.80 (6.73)	0.267 (.608)
Somatic Complaints	58.59 (8.64)	59.11 (8.91)	0.031 (.861)
Internalizing Behaviors	61.35 (9.87)	62.72 (9.81)	0.169 (.684)
Externalizing Behaviors	59.71 (7.83)	63.06 (9.76)	1.244 (.273)

Note. BAMBIC = Brief Assessment of Mealtime Behavior in Children; CBCL = Child Behavior Checklist; M = mean; RBS–R = Repetitive Behavior Scale–Revised; SD = standard deviation; SSP = Short Sensory Profile.
*p < .05. **p < .01.

Behavioral Differences Between Groups

No significant main effect of group was found for behavioral variables, $F(1, 34) = 1.348$, $p = .263$, observed power = .445. The selective eating group had marginally higher scores on the SSP Taste/Smell Sensitivity domain ($p = .051$), but not on total score ($p = .946$). The nonselective group had significantly higher scores on the Compulsive Behavior subscale of the RBS–R ($p = .036$), but there were no differences for other variables. One item on the RBS–R addresses repetitive behaviors during mealtime, and a significant difference was found between groups for this item, $t(33) = 7.046$, $p = .012$. The mean score for participants in the selective group on this item was 2.235 (standard deviation [SD] = 0.2191), whereas the mean score for participants in the nonselective group was 1.389 (SD = 0.2306). There were no significant differences for CBCL variables included in the analysis.

Correlations Among Food-Related and Behavioral Variables

Correlations among variables measuring aspects of food intake were moderate to strong. Statistically significant strong relationships were found among measures of total foods, refusal rate, and the Limited Variety subscale of the BAMBIC, $r = \pm.642–.790$, $p < .01$ (Table 3). Statistically significant moderate positive relationships were found between the Food Refusal subscale and the Limited Variety, $r = .486$, $p < .01$, and Disruptive Behavior, $r = .588$, $p < .01$, subscales of the BAMBIC. A statistically significant moderate positive relationship was found between SSP Taste/Smell Sensitivity scores and total foods eaten, $r = .363$, $p < .05$. In addition, statistically significant strong negative relationships were found between SSP Taste/Smell Sensitivity scores and Limited Variety, $r = –.528$, $p < .01$, and Food Refusal, $r = –.419$, $p < .01$, scores on the BAMBIC.

Correlations among behavioral variables were also moderate to strong. Statistically significant moderate to strong positive relationships were found between RBS–R total score and CBCL subscale scores, $r = .343–.566$, $p < .05$ (Table 4). CBCL subscales were strongly positively correlated with each other, $r = .475–.744$, $p < .01$. No

Table 3. Relationships Among Food-Related Variables

Variable	1	2	3	4	5	6
FFQ						
1. Total foods	—	–.790**	–.733**	–.284	–.224	.363*
2. Refusal rate	–.790**	—	.642**	.324	.201	–.199
BAMBIC						
3. Limited Variety	.733**	.642**	—	.486**	.298	–.528**
4. Food Refusal	–.284	.324	.486**	—	.588**	–.419*
5. Disruptive Behavior	–.224	.201	.298	.588**	—	–.262
SSP						
6. Taste/Smell Sensitivity	.363*	–.199	–.528**	–.419*	–.262	—

Note. BAMBIC = Brief Assessment of Mealtime Behavior in Children; FFQ = food frequency questionnaire; SSP = Short Sensory Profile.
*p < .05. **p < .01.

statistically significant relationships were found between scores on the RBS–R or the CBCL and the number of total foods eaten or refusal rate.

Discussion

The purpose of this descriptive study was to explore the relationships between behavioral challenges and selective eating in children with ASD. Specifically, we sought to examine a new definition of selective eating, compare behavioral measures between children with ASD with and without selective eating, and determine associations between behavioral measures and measures of selective eating. To meet these objectives, we analyzed scores on a variety of measures using comparative and associational statistical tests.

We hypothesized that significant differences would exist between groups in measures of food refusal and acceptance and in challenging behaviors, anxiety, repetitive behaviors, and sensory reactivity. In addition, we hypothesized that behavioral variables would be highly correlated with food-related variables. We found evidence to support our hypothesis that a significant difference exists between groups for variables related to food intake, but we did not find evidence to support our other hypotheses.

The differences observed between the selective and nonselective groups provide additional support for the definition of selective eating used in the study. The selective eating group had significantly lower intake of foods, higher food refusal rates, and higher Limited Variety scores on the BAMBIC. They did not have increased scores on the remaining sections of the BAMBIC, which may be because the BAMBIC describes specific actions (e.g., refusing to open one's mouth) rather than verbal refusal. Although refusal rates were significantly different between groups, we did not include refusal in our definition of selective eating because of the contextual influence that repeated refusal may have over time. Parents of typically developing infants and toddlers offer a food only 3–5 times before concluding that the child does not like it (Carruth, Ziegler, Gordon, & Barr, 2004). Thus, although food refusal may be a feature of selective eating, it may represent parent persistence in continuing to offer new foods more than the child's preferences.

Our findings regarding repetitive behaviors, sensory reactivity, and challenging behaviors were inconsistent with those of Johnson et al. (2014). Note that scores were significantly different between groups on the one item of the RBS–R that addresses repetitive behaviors during mealtime, suggesting that the repetitive behaviors of children with selective eating may not be fully captured by the RBS–R. Participants in the selective eating group had marginally lower scores in the SSP Taste/Smell Sensitivity domain and no difference in SSP total score. This finding suggests that sensory reactivity for selective eaters may be limited to the gustatory and olfactory systems. No significant differences were observed between groups for Anxiety/Depression or Somatic Complaints as measured by the CBCL, suggesting that selective eating is not associated with social–emotional problems as hypothesized. However, Johnson et al. (2014) found significant correlations between each of these measures and scores on the BAMBI. Parent-report measures that ask about child behavior may be more likely to result in the false identification of eating problems in a child than measures derived from FFQ data. In addition, the BAMBI includes a wide variety of feeding problems; therefore, total score may not be representative of selective eating status.

Consistent with previous research, variables that measured food intake were highly correlated with each other, as were those that measured sensory reactivity, repetitive behaviors, and challenging behaviors (Bandini et al., 2010; Johnson et al., 2014). These results are consistent with the suggestion that sensory hyperreactivity, repetitive behaviors,

Table 4. Relationships Among Food-Related and Behavioral Variables

Variable	1	2	3	4	5	6	7
FFQ							
1. Total foods	—	−.790**	.145	.236	.010	.185	.202
2. Refusal rate	−.790**	—	−.039	.012	−.111	−.090	−.113
RBS–R							
3. Total score	.145	−.039	—	.343*	.471**	.566**	.460**
CBCL							
4. Anxiety/Depression	.236	.012	.343*	—	.255	.676**	.475**
5. Somatic Complaints	.010	−.111	.471**	.255	—	.744**	.564**
6. Internalizing Behaviors	.185	−.090	.566**	.676**	.744**	—	.642**
7. Externalizing Behaviors	.202	−.113	.460**	.475**	.564**	.642**	—

Note. CBCL = Child Behavior Checklist; FFQ = food frequency questionnaire; RBS–R = Repetitive Behavior Scale–Revised.
*$p < .05$. **$p < .01$.

and challenging behaviors make up a cluster of symptoms that are often seen together, regardless of selective eating status (Gabriels et al., 2008).

This study has several limitations. Diagnosis of ASD was based on parent report and SCQ scores rather than being independently validated through administration of the Autism Diagnostic Observation Schedule (Lord, Rutter, Dilavore, & Risi, 1999). The small sample size resulted in decreased power for analyzing differences between groups on behavioral variables. It may also limit our ability to generalize results, along with the fact that participants were mainly White. In addition, we used parent-report tools for all measurements.

Future work should validate the definition of selective eating used in this study in a larger sample of children with ASD and in other populations. Models for assessment and intervention that take into account sensory reactivity and psychosocial problems in addition to patterns of behavior should be developed and tested. The role of oral–motor skills in selective eating should also be explored. Although little research has been done on the oral–motor skills of children with ASD, children with ASD have motor coordination deficits that may be apparent even from an early age (Dziuk et al., 2007; Fournier, Hass, Naik, Lodha, & Cauraugh, 2010; Lane, Harpster, & Heathcock, 2012). In addition, difficulty with oral–motor skills has been associated with feeding problems in children with anatomical and neurological anomalies (Field, Garland, & Williams, 2003).

Implications for Occupational Therapy Practice

The results of this study have the following implications for occupational therapy practice:

- It may not be possible to identify a "typical" behavioral profile of children with ASD and selective eating.
- Clinicians must conduct a thorough interdisciplinary evaluation of each child to assess anxiety, sensory reactivity, other potential physiological causes, and non-food-related challenging and repetitive behaviors. ▲

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