

University of Galway Research Repository

Feeding problems, gastrointestinal symptoms, challenging behavior and sensory Issues in children and adolescents with Autism Spectrum Disorder

Title	Feeding problems, gastrointestinal symptoms, challenging behavior and sensory Issues in children and adolescents with Autism Spectrum Disorder
Author(s)	Leader, Geraldine;Tuohy, Elaine;Chen, June L.;Mannion, Arlene;Gilroy, Shawn P.
Publication Date	2020-01-18
Publication information	Leader, Geraldine, Tuohy, Elaine, Chen, June L., Mannion, Arlene, & Gilroy, Shawn P. (2020). Feeding Problems, Gastrointestinal Symptoms, Challenging Behavior and Sensory Issues in Children and Adolescents with Autism Spectrum Disorder. Journal of Autism and Developmental Disorders, 50(4), 1401-1410. doi:10.1007/s10803-019-04357-7
Publisher	Springer
Link to publisher's version	https://doi.org/10.1007/s10803-019-04357-7
Item record	http://hdl.handle.net/10379/16259

This is a post-print of an article published in *Journal of Autism and Developmental Disorders*. The final version is available online at:

<https://doi.org/10.1007/s10803-019-04357-7>

Feeding problems, gastrointestinal symptoms, challenging behavior and sensory issues in children and adolescents with autism spectrum disorder.

Geraldine Leader¹

Elaine Tuohy¹

June L. Chen²

Arlene Mannion¹

Shawn P. Gilroy³

1. Irish Centre for Autism and Neurodevelopmental Research (ICAN), School of Psychology, National University of Ireland, Galway.

2. Department of Special Education, Faculty of Education, East China Normal University, Shanghai, China.

3. Louisiana State University, Baton Rouge, LA 70803

Corresponding author: Geraldine Leader, Ph.D., Irish Centre for Autism and Neurodevelopmental Research, School of Psychology, National University of Ireland, Galway, Ireland. Tel: 0035391 493434, Fax: 00353 91 521355.

Corresponding Author Email Address: geraldine.leader@nuigalway.ie

Abstract

Frequency of feeding problems, gastrointestinal (GI) symptoms, challenging behavior, sensory problems and comorbid psychopathology were assessed using the following questionnaires: Screening Tool for Feeding Problems for Children, GI Symptoms Inventory, Behavior Problems Inventory Short Sensory Profile, and Autism Spectrum Disorder-Comorbidity Child (ASD-CC) in 136 children and adolescents with ASD. Eighty-four percent had food selectivity, followed by food refusal (78.7%), rapid eating (76.5%), chewing problems (60.3%), food stealing (49.3%) and vomiting (19.1%). Higher rates of GI symptoms, challenging behavior, and sensory issues were found in those who presented with rapid eating, food refusal and food stealing than those without these problems. Comorbid psychopathology predicted rapid eating, food selectivity and food refusal.

Keywords: Autism spectrum disorder, Feeding Problems, Gastrointestinal Symptoms, Comorbidity, Sensory Issues, Challenging Behavior, Comorbid Psychopathology.

Feeding problems, gastrointestinal symptoms, challenging behavior and sensory issues in children and adolescents with autism spectrum disorder.

1. Introduction

1.1 Feeding Problems

Feeding problems are defined as a disorder in which the inability or refusal to orally consume adequate nutritional, hydration or caloric intake in the amounts required to thrive, results in negative nutritional, developmental, social and psychological consequences (Babbitt et al., 1994). The DSM-5 (American Psychiatric Association, 2013) identifies numerous feeding disorders, with Pica/Rumination Disorder (Råstam, 2008) and Avoidant/Restrictive Food Intake Disorder (Kenney & Walsh, 2013) being the most documented in individuals with autism spectrum disorders (ASD). These feeding disorders encompass a number of issues including food selectivity, disruptive mealtime behaviors (Sharp et al., 2013), food refusal, limited food repertoire, and restricted intake (Bandini et al., 2010).

Comorbid conditions that co-occur with autism spectrum disorder (ASD) include gastrointestinal symptoms, sleep problems, epilepsy, behavior problems, attention-deficit/hyperactivity disorder, anxiety, and toileting problems (Devlin et al. 2008; Francis et al. 2017; Leader & Mannion, 2016; Mannion & Leader, 2014a; b; c; d; Williams et al. 2015). Feeding problems are also a comorbidity in ASD (Mannion & Leader, 2013b). Prevalence rates of feeding problems in children and adolescents with ASD have varied significantly between studies. Earlier studies demonstrated a prevalence ranging from 6% to 33% (Coffey & Crawford, 1971). More recently, Schreck et al. (2004) reported that prevalence rates of feeding problems range from 13% to 80%. This was supported by Nadon et al. (2011) who documented that 80% of children with ASD experience feeding problems. Children with

ASD have significantly more feeding problems and eat a narrower range of foods than children without ASD (Seiverling et al. 2018). Given the elevated prevalence of feeding problems in recent years, it is credible that feeding problems affect a substantial proportion of individuals with ASD.

Evidence suggests that comorbid feeding problems may place an individual with ASD at risk from medical complications. The incidence of chronic feeding problems can result in multiple medical and developmental implications such as malnutrition, growth retardation, social deficits and poor academic achievement (Sharp et al. 2013). Skill deficits, such as oral-motor delays which affect the child's ability to swallow, chew and suck, have also been reported as significant issues in feeding (Ahearn, 2001). Schreck et al. (2004) commented that children with a co-occurring feeding problem and ASD display higher risks of nutritionally related medical problems; for example, rickets (Clark et al. 1993) or poor bone health (Hediger et al., 2007). Sharp et al. (2013) reported that feeding problems in children with ASD can result in malnutrition and invasive medical procedures, such as the insertion of feeding tubes (Kerwin, 1999). Children with ASD who present with feeding problems have greater vitamin and mineral deficiencies (Bandini et al., 2010), such as lower intakes of calcium (Sharp et al., 2013), iron deficiencies (Latif et al. 2002), and less consumption of vitamin C (Emond et al. 2010). Cornish (1998) noted that children with ASD exhibited a preference for foods composed of sugars or fats, which supports the emerging evidence for greater risks of obesity in this population (Egan et al. 2013).

1.2 Feeding Problems and Gastrointestinal Symptoms

Research regarding the relationship between feeding problems and gastrointestinal (GI) symptoms is limited (Mannion & Leader, 2013b; Matson & Fodstad, 2009). Mannion et al. (2013) found that 79.3% of a sample with ASD presented with at least one gastrointestinal

symptom. Mannion et al. (2013) reported that the most common GI symptoms were abdominal pain and constipation, affecting 51.7% and 49.4% of participants with ASD respectively. Wang et al. (2011) reported that children with ASD experienced considerably more GI issues in comparison to typically developing children. Field et al. (2003) found that the majority of their participants had medical issues underlying the individual's feeding problems.

Kerwin, et al. (2005) conducted a study regarding GI symptoms and eating behavior in a sample of children with ASD with over 60% of children reporting strong food preferences. It was reported that some children experienced at least one GI symptom weekly, with bowel issues appearing to be connected to feeding (Kerwin et al., 2005). Field et al. (2003) investigated childhood feeding problems in order to further examine potential predisposing factors for feeding problems in children with developmental delay. They concluded that gastroesophageal reflux was the most prevalent condition found in the sample and was the factor most associated with food refusal. Food refusal was demonstrated as being a complex feeding issue most commonly present in individuals with ASD. It was reported that 14 out of 20 children with ASD who demonstrated food selectivity, experienced constipation or diarrhea (Field et al. 2003).

1.3 Feeding Problems and Challenging Behavior

Matson and Fodstad (2009) identified repetitive and restrictive behaviors as trademark characteristics of ASD that can manifest as ritualised eating behaviors and feeding inflexibility. They stated that an overlap between challenging mealtime behaviors and feeding problems may exist due to cognitive obsessions and behavioral rituals. Sharp et al. (2013) stated that challenging mealtime behavior can affect social skills and interactions due to the social demands of feeding situations. Difficulties with socialisation may impact on the

pleasure of eating in the company of other individuals (Nadon et al. 2011), resulting in challenging behaviors. Despite the acknowledgement of the comorbidity of challenging behavior and feeding problems, the literature demonstrates little understanding regarding the rationales behind these behaviors (Nadon et al. 2013).

1.4 Feeding Problems and Sensory Issues

Emond et al. (2010) commented that effective behavioral strategies need to address sensory sensitivities, for example colour, taste, and texture, in children with ASD.

Twachtman-Reilly et al. (2008) describe sensory modulation as being the mechanism that permits an individual to filter the mass of sensory information that continually floods the nervous system in an appropriate manner. Leekam et al. (2007) reported that 78 to 90% of children with ASD experience sensory processing issues. Laud et al. (2009) remarked that sensory impairment/defensiveness is frequently noted in the literature as a reason for high prevalence rates of feeding problems in ASD.

Cermack et al (2010) observed an association between feedings issues and sensory defensiveness; and determined that sensory sensitivity can be regarded as a mechanism to explain food selectivity. Nadon et al. (2011) examined the relationship between sensory processing problems and the number of eating problems in children with ASD, and found an association between both. A significant association was found between visual and auditory sensitivity and the number of eating problems in children with ASD.

1.6 Eating Phenotype

Given the associations between feeding problems and other co-occurring conditions, it is possible that an eating phenotype exists in children with ASD. A subgroup of children with ASD and feeding problems may be more likely to display challenging behavior, gastrointestinal symptoms, comorbid psychopathology, and sensory issues. It is known that

ASD is a heterogeneous condition (Masie et al. 2017). Phenotypes have been identified for other co-occurring conditions, such as sleep problems. One example is Goldman et al. (2009), who defined the sleep phenotype in ASD. Yet, little is known about the eating phenotype. The current study aims to better understand how feeding problems such as rapid eating, food refusal, food selectivity, and food stealing are related to other co-occurring conditions, such as challenging behavior, gastrointestinal symptoms, and sensory issues. By doing so, we can better understand the eating phenotype in children with ASD.

1.7 Current Study

The current study will investigate feeding problems in relation to gastrointestinal symptoms, challenging behavior, sensory issues, and comorbid psychopathology in a sample of children and adolescents with ASD. The differences between those who display feeding problems and those who do not will be analysed in terms of GI symptoms, challenging behavior, sensory issues, and comorbid psychopathology. The predictors of the various feeding problems will be analysed.

2. Method

2.1 Participants

The study sample comprised 136 children and adolescents with a diagnosis of autism spectrum disorders in accordance with DSM-IV-TR criteria (American Psychiatric Association, 2000). ASD diagnosis was reported by parental report. Participants received their diagnosis from a multidisciplinary team, including a psychologist, speech and language therapist, and occupational therapist. The mean age of the sample was 8.36 years (*S.D.* = 4.13). Seventy two per cent ($n=98$) of the participants were males, and twenty eight per cent were female ($n=38$).

2.2 Measures

2.2.1 Demographic information. A self-constructed questionnaire provided information on the participant's gender and age.

2.2.2 Screening Tool of Feeding Problems for Children (STEP-CHILD). The Screening Tool of Feeding Problems for Children (STEP-CHILD; Seiverling et al., 2011) is an informant-based questionnaire which measures feeding problems in children. The STEP-CHILD contains 15-items. Factor analysis yielded six subscales; (1) Chewing Problems, (2) Rapid Eating, (3) Food Refusal, (4) Food Selectivity, (5) Vomiting, and (6) Stealing Food. Caregivers report the number of times their child has exhibited each feeding problem using a three-point rating scale. The subscales demonstrated a mean internal validity of 0.62. Convergent validity was confirmed by expected associations with another psychometrically tested measure of feeding problems, the Children's Eating Behavior Questionnaire (CEBQ; Wardle et al. 2001). To determine who presented with a feeding problem, the true severity score was observed. If the score was zero, it was determined that there was no feeding problem or harm caused to the child. If the score was one or more, this indicated the presence of a feeding problem that caused harm to the child.

2.2.3 Gastrointestinal Symptom Inventory. The Gastrointestinal (GI) Symptom Inventory (Autism Treatment Network, 2005) is a 35-item questionnaire that was developed by the Autism Treatment Network (ATN). It was constructed on previous questionnaires and on clinical symptom assessment for children with Autism Spectrum Disorders and identified GI disorders. The inventory is scored dichotomously; specifically whether or not the child possesses any gastrointestinal symptoms. The GI symptoms measured on the inventory include abdominal pain, nausea, bloating, constipation, and diarrhea. The GI Inventory has been employed in published research (Leader et al. 2018; Mannion & Leader 2013a; 2016; Mazefsky et al. 2014; Mazurek et al., 2013; Williams et al., 2010; Williams, Christofi, Clemmons, Rosenberg, & Fuchs, 2012a; Williams et al. 2010, 2012a, b).

2.2.4 Behavior Problems Inventory - Short Form (BPI-S). The Behavior Problems Inventory - Short Form (BPI-S; Rojahn et al., 2012a) is an informant-based behavior rating tool designed to evaluate maladaptive behaviors. The BPI-S possesses three subscales; (1) Self-Injurious Behavior (8 items), Stereotyped Behavior (12 items), and Aggressive/Destructive Behavior (10 items). Each item is in the Self-Injurious Behavior and Aggressive/Destructive Behavior subscales are rated on a frequency scale, and a severity scale, while the Stereotyped Behavior subscale is rated on a frequency scale only. Rojahn et al. (2012b) investigated the reliability and validity of the BPI-S. BPI-S is considered psychometrically sound. The sensitivity of the Self-Injurious Behavior subscale was 0.94, the sensitivity of the Stereotyped Behavior subscale and Aggressive/Destructive subscale were 0.92 and 0.99 respectively. The structure validity of the BPI-S demonstrates R^2 values of 0.57 for the Self-Injurious Behavior subscale, 0.70 for the Aggressive/Destructive Behavior subscale and 0.67 for the Stereotyped Behavior subscale. The internal consistency values on the BPI-S subscales ranged from fair (0.70; Self-Injurious Behavior) to good (0.80; Aggressive/Destructive Behavior and Stereotyped Behavior).

2.2.5 Short Sensory Profile (SSP). The Short Sensory Profile (SSP; Dunn, 1999) is a 38-item caregiver report measure to assess a child's sensory processing abilities. The scoring system is a Likert scale. Items are scored on a 1-point to 5-point scale. The SSP has seven subscales; (1) Tactile Sensitivity, (2) Taste/Smell Sensitivity, (3) Movement Sensitivity, (4) Underresponsive/Seeks Sensation, (5) Auditory Filtering, (6) Low Energy/Weak, and (7) Visual/Auditory Sensitivity. Subscale scores and a total score are interpreted on the SSP, with the total score being the most sensitive indicator of sensory dysfunction. Dunn (1999) reported that internal consistency of the sections within the scale ranged from .70 to .90, and the internal validity correlations for the sections ranged from .25 to .76 and were all significant at $p < .01$.

2.2.6 Autism Spectrum Disorder – Comorbid for Children (ASD-CC). The ASD-CC (Matson & González, 2007), is a 39-item, informant-based rating scale constructed to evaluate symptoms of psychopathology and emotional difficulties which occur with ASD. Items are included to assess conditions such as depression, Attention Deficit/Hyperactivity Disorder, conduct disorder, eating disorders/difficulties, Obsessive Compulsive Disorder, tic disorders and specific phobias. Caregivers rate each item to the magnitude that it has been a recent problem. Factor analysis generated seven subscales for the ASD-CC; (1) Tantrum Behavior, (2) Repetitive Behavior, (3) Worry/Depressed, (4) Avoidant Behavior, (5) Under-Eating, (6) Conduct and (7) Over Eating. Construct validity was established for Tantrum Behavior, Worry/Depressed, Repetitive Behavior, Conduct, and Over-Eating factors. The ASD-CC possesses satisfactory inter-rater and test-retest reliability ($k = .46$ and $k = .51$, respectively); in addition to internal consistency ($\alpha = .91$) (Matson & Dempsey, 2008).

2.3 Informants

Informants were parents of children and adolescents diagnosed with ASD. Rating scales were completed by parents independently according to the instructions printed on top of the questionnaires.

2.4 Procedure

Parents and guardians were made aware of the study through parent support groups and special schools. If parents wished to participate in the study, they were provided with a participant information sheet and a consent form to complete. Once consent was obtained, the informants were provided with the battery of above questionnaires to complete in their own time.

3. Results

3.1 Analyses

Using the statistical program software, IBM SPSS version 22, a series of *t*-tests were run on the six severity subscales of the STEP-CHILD and the ASD-CC, the GI Inventory, BPI-S, and the SSP. A series of multiple regressions were run to determine the predictors of the specific feeding problems. The results of the *t*-tests indicated which predictor variables to include in the multiple regressions. Consequently, the four predominant feeding problems subscales were reported.

3.2 Rapid Eating

A summary of means and standard deviations of the study measures is given in Table 1. It was found that 76.5% ($n = 104$) of participants presented with rapid eating. A series of independent *t*-tests were performed to compare individuals who exhibited rapid eating and individuals who did not exhibit rapid eating on the ASD-CC, the GI Inventory, and the SSP. Levene's test for equality of variances was not significant, ensuring homogeneity of variance. Results conveyed a significant difference in the ASD-CC total scores ($t_{(134)} = 4.24, p < .01$) between those who exhibited rapid eating and those who did not. A significant difference was noted in the GI Inventory total scores ($t_{(134)} = 4.53, p < .01$) and in SSP total scores ($t_{(134)} = 3.54, p = 0.001$) between those who exhibited rapid eating and those who did not. Those who displayed rapid eating experienced more GI symptoms, sensory issues, and comorbid psychopathology than those who did not display rapid eating.

---Insert Table 1 about here---

In the first stepwise multiple regression, rapid eating was entered as the criterion variable. Age and gender were added to the first block of the predictor variables, while the ASD-CC total score, the GI Symptoms Inventory total score, and the SSP total score were added to the second block. The predictors of GI Symptoms Inventory total score and the ASD-CC total score were significantly related to rapid eating ($F_{(2, 133)} = 13.43, p < .01, R^2 = 0.17, Adj R^2 =$

0.16). GI total scores and ASD-CC accounted for 16% of the variance of rapid eating in this population. A summary of the significant predictors in the stepwise regression analysis for each feeding problem can be observed in Table 2.

---Insert Table 2 about here---

3.3 Food Refusal

It was found that 78.7% ($n = 107$) of participant presented with food refusal. A series of independent t -tests were conducted to compare individuals who demonstrate food refusal and individuals who did not demonstrate food refusal on the ASD-CC, the GI Inventory, the BPI-S Aggressive/Destructive frequency and severity subscales, and the SSP. Levene's test for equality of variances was significant in the ASD-CC ($F = 5.41, p = 0.02$) and the BPI-S Aggressive/Destructive frequency ($F = 10.20, p = 0.002$) and severity ($F = 12.50, p = 0.001$). Results showed a significant difference in the ASD-CC total scores ($t_{(61.63)} = 6.03, p < .01$) between those who displayed food refusal and those who did not. A significant difference was observed in the BPI-S Aggressive/Destructive frequency scores ($t_{(75.6)} = 3.60, p = 0.001$) and in the BPI-S Aggressive/Destructive severity scores ($t_{(87.1)} = 3.64, p < .01$) between those who displayed food refusal and those who did not.

Levene's test for equality of variances was not significant for the GI Inventory scores ($F = 0.09, p = 0.76$) and the SSP scores ($F = 0.05, p = 0.83$), confirming homogeneity of variance. Results conveyed a significant difference in the GI Inventory total scores ($t_{(134)} = 2.50, p = 0.02$) and in the SSP ($t_{(134)} = 4.01, p < .01$) between those who exhibited food refusal and those who did not. Therefore, those who displayed food refusal experienced more GI symptoms, more sensory issues, more frequent and severe aggressive/destructive behavior and higher rates of comorbid psychopathology.

In the second stepwise multiple regression, food refusal was entered as the criterion variable. Age and gender were added to the first block of the predictor variables, while the ASD-CC total score, the GI Symptoms Inventory total score, the BPI-S Aggressive/Destructive frequency and severity subscale scores, and the SSP total score were added to the second block. The predictor variable of ASD-CC was significant for food refusal ($F_{(1, 135)} = 32.20, p < .01, R^2 = 0.19, Adj R^2 = 0.19$). The predictor variable of ASD-CC accounted for 19% of the variance of rapid eating in this population.

3.4 Food Selectivity

It was found that 84.6% ($n = 115$) of the sample presented with food selectivity. Independent t -tests were conducted to compare individuals who exhibited food selectivity and individuals who did not demonstrate food selectivity on the ASD-CC, the GI Inventory, and the SSP. Levene's test for equality of variances was not significant, ensuring homogeneity of variance. There was a significant difference in the ASD-CC ($t_{(134)} = 3.75, p < .01$) between those who displayed food selectivity and those who did not. A significant difference was observed in the total scores for the GI Inventory ($t_{(134)} = 2.68, p = 0.008$) and for the SSP ($t_{(134)} = 4.23, p < .01$) between those who displayed food selectivity and those who did not. Therefore, higher rates of GI symptoms, sensory issues and comorbid psychopathology was reported in individuals who experienced food selectivity than in those who did not.

In the third stepwise multiple regression, food selectivity was entered as the criterion variable. Age and gender were added to the first block of the predictor variables. The ASD-CC total score, the GI Symptoms Inventory total score, and the SSP total score were added to the second block. The predictors of gender and SSP total scores were significantly related to food selectivity ($F_{(2, 133)} = 10.20, p < .01, R^2 = 0.13, Adj R^2 = 0.12$). The predictor variables of

gender and SSP total scores accounted for 12% of the variance of the food selectivity in this population.

3.5 Stealing Food

Stealing food occurred in 49.3% ($n = 67$) of participants. A number of independent t -tests were performed to compare individuals who exhibited stealing food and individuals who did not exhibit stealing food on the ASD-CC, the GI Inventory, the BPI-S Self-Injurious Behavior frequency and severity subscales, the BPI-S Stereotyped Behavior frequency subscale, and the SSP. Levene's test for equality of variances was significant in the SSP ($F = 12.32, p = 0.001$). There was a significant difference in total scores on the SSP ($t_{(115.94)} = 2.14, p = 0.03$) between those who engaged in stealing food and those who did not.

Levene's test for equality of variance was not significant on the BPI-S Self-Injurious Behavior frequency ($F = 1.29, p = 0.26$) and severity ($F = 2.91, p = 0.09$) subscale, and on the BPI-S Stereotyped Behavior frequency subscale ($F = 1.05, p = .031$), ensuring homogeneity of variance. Results showed a significant difference in scores on the BPI-S Self-Injurious Behavior frequency ($t_{(134)} = 2.65, p = 0.01$) and on the BPI-S Self-Injurious Behavior severity subscale ($t_{(134)} = 2.70, p = 0.01$) between individuals who engaged in food stealing and those who did not. Likewise, a significant difference was observed on the BPI-S Stereotyped Behavior frequency subscale ($t_{(134)} = 2.84, p = 0.01$) between those who engaged in food stealing and those who did not. For the GI Inventory, Levene's test for equality of variance was not significant ($F = 0.55, p = 0.46$), confirming homogeneity of variance. There was a significant difference in the total scores of the GI Inventory ($t_{(134)} = 2.83, p = 0.01$) between individuals who engaged in food stealing and those who did not. Therefore, those who displayed food stealing were reported to show more frequent and severe self-injurious behavior, more frequent stereotyped behavior, more GI symptoms and sensory issues than those who did not display food stealing.

In the final stepwise multiple regression, stealing food was entered as the criterion variable. Age and gender were added to the first block of the predictor variables. The ASD-CC total score, the GI Symptoms Inventory total score, BPI-S Self-Injurious Behavior frequency and severity subscale scores, BPI-S Stereotyped Behavior frequency subscale score, and the SSP total score were added to the second block. The predictor of ASD-CC total scores was significantly related to stealing food ($F_{(1,134)} = 15.53, p < .01, R^2 = 0.10, Adj R^2 = 0.09$). The predictor variable of ASD-CC total scores accounted for 9% of the variance of stealing food in this population

3.6 Gastrointestinal Symptoms

It was found that overall 82.4% ($n = 112$) of participants experienced at least one gastrointestinal symptom within the last 3 months. It was found that 22.8% ($n = 31$) presented with one symptom only, and 22.8% ($n = 31$) presented with two symptoms. It was found that 22.1% ($n = 30$) of participants presented with three symptoms, while 12.5% ($n = 17$) and 2.2% ($n = 3$) presented with four and five symptoms respectively.

3.7 Challenging Behavior

The means and standard deviations were determined for behavior problems in each of the subscales in the BPI-S. Despite there being no total score on the BPI-S, the frequency and severity are recorded for two subscales; the Self-Injurious Behavior subscale and the Aggressive/Destructive Behavior subscale. The third subscale, Stereotyped Behavior, records frequency only.

3.8 Sensory Issues

The means and standard deviations were determined for sensory issues in each of the subscales in the SSP. The mean of the total score for the SSP was 114.7 ($SD = 24.6$). The

SSP provides cut-off scores; scoring between 38 and 141 demonstrating a definite difference in sensory ability from typical performers, scoring between 142 and 154 exhibiting a probable difference, while scoring between 155 and 190 is considered typical performance. It was found that 85.3% ($n = 116$) of the sample scored in the definite difference category, 10.3% ($n = 14$) scored in the probable difference category, and 4% ($n = 6$) exhibited typical performance.

3.9 Comorbid Psychopathology

The means and standard deviations were determined for the behaviors associated with psychopathology in the ASD-CC. The mean of total score for the ASD-CC was 30.96 ($SD = 13.14$). Despite there being no cut-off for the total score on the ASD-CC, there are cut-offs for its seven subscales. These cut-offs are divided into no/minimal impairment, moderate impairment, and severe impairment, depending on how far the score falls from the mean. The results of the mean scores for the seven subscales were established to have no or minimal impairment, when means were compared to the determined cut-off points.

4. Discussion

The current study investigated the eating phenotype in children and adolescents with ASD, and has expanded current knowledge about feeding problems. Children and adolescents with feeding problems present with higher rates of GI symptoms, challenging behavior and sensory issues than those without feeding problems. When assessing a child with ASD for feeding problems, other comorbid conditions that form part of the eating phenotype need to be considered such as GI symptoms, challenging behavior, and sensory issues.

The current study explored the relationship between feeding problems and challenging behavior. It was found that a significant difference was observed between children and adolescents with ASD who exhibited food refusal and those who did not exhibit food refusal on the BPI-S Aggressive/Destructive frequency and severity subscales. A significant difference was observed between individuals who exhibited stealing food and individuals who did not exhibit stealing food on the BPI-S Self-Injurious Behavior frequency and severity subscales, and the BPI-S Stereotyped Behavior frequency subscale. More research is needed on the relationship between feeding problems and challenging behavior. Nadon et al. (2013) commented regarding the need for future research in this area.

The relationship between feeding problems and comorbid psychopathology was investigated in the current study. The present study acquired similar results, when compared to recognized means on measures of comorbid psychopathology (Mannion et al., 2013; Thorson & Matson, 2012). It was found that comorbid psychopathology was a predictor of rapid eating, food selectivity and food refusal. This is a novel finding and future research is needed to replicate these findings.

Significant differences in sensory issues were reported between those who displayed rapid eating, food refusal, and food stealing in comparison to those who not display these findings, with sensory problems being higher in those who experienced these feeding problems. This supports the finding of Nadon et al. (2011) who documented the association between sensory processing problems and the number of eating problems in children with ASD. In the current study, sensory issues were found to be a partial predictor of food selectivity. This is supported by Cermack et al. (2010) who determined that sensory sensitivity can be regarded as a mechanism to explain food selectivity.

In the current study, high rates of feeding problems were observed. The most common feeding problem was food selectivity, followed by food refusal and rapid eating. Chewing problems, food stealing and vomiting were the next most common feeding problems. This is comparable to the findings of Nadon et al. (2011), who reported the incidence of feeding problems being as high as 80%. The results of the current study support the findings of Bandini et al. (2010), who documented food selectivity as the most frequently reported feeding problem in an ASD population.

A high frequency of gastrointestinal (GI) symptoms was determined in the current study, with the majority of the sample (82.4%) of the sample experiencing at least one GI symptom within the last 3 months. These results are similar to the findings by Mannion et al. (2013), who reported a high frequency of GI symptoms in children and adolescents with ASD. The current study identified abdominal pain and constipation as the most frequently reported GI symptoms. This supports the findings of Mannion et al. (2013), who documented these aforementioned GI symptoms as the most commonly reported in an ASD population. In the current study, significant differences were found in total GI Inventory scores in the STEP-CHILD subscales of rapid eating, food refusal, food selectivity, vomiting and food stealing with more GI symptoms in children and adolescents with ASD who experienced these feeding problems than those who did not. It was also found that GI symptoms partly predicted rapid eating. This is supported by Kerwin et al. (2005), who noted a relationship between gastrointestinal symptoms and eating behaviors.

Response bias may have been a limitation of the current study. While it was not a requirement of the study for participants to have a feeding problem, and while every effort was made to include participants with and without feeding problems, it is possible that more parents of children with feeding problems participated as parents may have more interest in

research that is a current concern for them and their families. It must also be considered that perhaps parents who took part had children who had different feeding problems than of those who chose not to participate. Analyses focused on the group of children and adolescents with ASD as a whole, instead of conducting between-group analyses. Group comparison was not conducted in the current study on those with and without gastrointestinal symptoms, and how having these symptoms affect an individual's feeding problems. The current study did not include a typically developing control group. It should be documented that the STEP-CHILD, which was employed to assess feeding difficulties in children and adolescents with ASD, contains a limitation. This being that the scoring method allows caregivers to report a frequency score, which records the frequency of the feeding problems, while reporting a low severity score, which records the level of harm caused to the child. It can be proposed that caregivers may be aware that a feeding problem exists; however, they may not be aware of the harm or damage that the feeding problem is causing the child. This may be particularly problematic in non-verbal children.

Future research could include a comparison group to analyse those with feeding problems in comparison to those without feeding problems. With regard to gastrointestinal symptoms, future research is needed in this area. In the current study, GI symptoms were recorded if the participant presented with a symptom within the previous three months. Future research could compare children who present with GI symptoms within one month or more frequently, compared to those who present with these symptoms within the previous three months. Future research could compare feeding problems and gastrointestinal symptoms in children and adolescents with ASD in comparison to those who are typically developing. Severity of ASD symptoms could also be included in future research as a variable, as well as measures of social skills and adaptive behavior. By including these measures, researchers and clinicians would be better able to determine the eating phenotype across the autism spectrum.

In conclusion, this study investigated feeding problems in children and adolescents with ASD. Feeding problems and gastrointestinal symptoms were found to be very common among children and adolescents with ASD, as were sensory issues. Behaviors associated with comorbid psychopathology were found to be similar with that of previous research. Future research could more thoroughly examine the relationships between gastrointestinal symptoms, sensory issues, comorbid psychopathology, and challenging behavior in relation to feeding problems in adults with ASD population.

Author Contributions: GL conceived of the study, participated in its design and coordination and drafted the manuscript. ET participated in the design and coordination of the study, performed the measurement and drafted an initial draft of the manuscript. JLC participated in the design of the study and assisted with the statistical analysis. AM conceived of the study, participated in its design and coordination and assisted in the drafting of the manuscript. SPG assisted in the drafting of the manuscript. All authors read and approved the final manuscript.

References

- Ahearn, W.H. (2001). Why does my son only eat macaroni and cheese? Dealing with feeding problems in children with autism. In C. Maurice, R. Foxx, & G. Green (Eds.), *Making a Difference: Behavioral Intervention for Autism*. Austin, TX: Pro-ed.
- American Psychiatric Association (2000). *Diagnostic and statistical manual of mental disorders* (4th ed.). text revision (DSM-IV-TR). Arlington, VA: American Psychiatric Association.
- American Psychiatric Association. (2013) *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing
- Autism Treatment Network (2005). *GI Symptom Inventory Questionnaire, vers.3.0*. New York, NY: Autism Speaks.
- Autism Treatment Network (2010). *Parent Baseline Assessment*. New York, NY: Autism Speaks.
- Babbitt, R. L., Hoch, T. A., Coe, D. A., Cataldo, M. F., Kelly, K. J., Stackhouse, C., et al. (1994). Behavioral assessment and treatment of pediatric feeding disorders. *Journal of Developmental & Behavioral Pediatrics, 15*(4), 278-291.
- Bandini, L. G., Anderson, S. E., Curtin, C., Cermak, S., Evans, E. W., Scampini, R., ... & Must, A. (2010). Food selectivity in children with autism spectrum disorders and typically developing children. *The Journal of Pediatrics, 157*(2), 259-264.
- Cermak, S.A., Curtin, C., & Bandini, L.G. (2010). Food selectivity and sensory sensitivity in

children with autism spectrum disorders. *Journal of the American Association*, 110, 238-246.

Clark, J.H., Rhoden, D.K., & Turner, D.S. (1993). Symptomatic vitamin A and D deficiencies in an eight year old with autism. *Journal of Parenteral and Enteral Nutrition*, 17(3), 284-286.

Coffey, K., & Crawford, J. (1971). Nutritional problems commonly encountered in the developmentally handicapped. In M.A. Smith (Ed.), *Feeding the handicapped child*. Memphis, TN: University of Tennessee Child Development Centre.

Cornish, E. (1998). A balanced approach towards healthy eating in autism. *Journal of Human Nutrition and Dietetics*, 11, 501-509.

Devlin, S., Healy, O., Leader, G., & Reed, P. (2008). The analysis and treatment of problem behavior evoked by auditory stimulation. *Research in Autism Spectrum Disorders*, 2(4), 671-680.

Dunn, W. (1999). *The Sensory Profile manual*. San Antonio: The Psychological Corporation.

Egan, A.M., Dreyer, M.L., Odar, C.C., Beckwith, M., & Garrison, C.B. (2013). Obesity in young children with autism spectrum disorders: Prevalence and associated factors. *Childhood Obesity*, 9(2), 125-131.

Emond, A., Emmett, P., Steer, C., & Goulding, J. (2010). Feeding symptoms, dietary

patterns, and growth in young children with autism spectrum disorders. *Pediatrics*, *126*, e337-e342.

Field, D., Garland, M., & Williams, K. (2003). Correlates of specific childhood feeding problems. *Journal of Pediatrics and Child Health*, *39*, 299-304.

Francis, K., Mannion, A., & Leader, G. (2017). The assessment and treatment of toileting difficulties in individuals with autism spectrum disorders and other developmental disabilities. *Review Journal of Autism and Developmental Disorders*, *4*, 190-204.

Goldman, S. E., Surdyka, K., Cuevas, R., Adkins, K., Wang, L., & Malow, B. A. (2009). Defining the sleep phenotype in children with autism. *Developmental Neuropsychology*, *34*(5), 560-573.

Hediger, M.L., England, L.J., Molly, C.A., Yu, K.F., Manning-Courtney, P., & Mills, J.L. (2007). Reduced bone cortical thickness in boys with autism or autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *38*(5), 848-856.

Horvath, K., Papadimitriou, J.C., Rabszty, A., Drachenberg, C., & Tyson Tildon, J. (1999). Gastrointestinal abnormalities in children with autistic disorder. *The Journal of Pediatrics*, *135*(5), 559-563.

Keen, D.V. (2008). Childhood autism, feeding problems and failure to thrive in early infancy. *European Child and Adolescent Psychiatry*, *17*, 209-216.

Kenney, L., & Walsh, T. (2013). Avoidant/Restrictive food intake disorder. *Eating Disorder Review*, *24*(3), 1-13.

- Kerwin, M.E. (1999). Empirically supported treatments in pediatric psychology: Severe feeding problems. *Journal of Pediatric Psychology, 24*, 193–214.
- Kerwin, M., Eicher, P., & Gelsinger, J. (2005). Parental report eating problems and gastrointestinal symptoms in children with pervasive developmental disorders. *Children's Health Care, 34*(3), 221-234.
- Latif, A.H., Heinz, P., & Cook, R. (2002). Iron deficiency in autism and Asperger syndrome. *Autism, 6*, 103-114.
- Laud, R.B., Girolami, P.A., Boscoe, J.H., & Gulotta, C.S. (2009). Treatment outcomes for severe feeding problems in children with autism spectrum disorder. *Behavior Modification, 33*(5), 520-536.
- Leader, G., Francis, K., Mannion, A., & Chen, J. (2018). Toileting problems in children and adolescents with parent-reported diagnoses of autism spectrum disorder. *Journal of Developmental and Physical Disabilities, 30*(3), 307-327.
- Leader, G., & Mannion, A. (2016). Challenging behaviors. In J.L. Matson (ed.), *Handbook of assessment and diagnosis of autism spectrum disorder* (pp. 209-232). Springer, Cham.
- Leekam, S.R., Nieto, C., Libby, S.J., Wing, L., & Gould, J. (2007). Describing the sensory abnormalities of children and adults with autism. *Journal of Autism and Developmental Disorders, 37*(5), 894-910.
- Mannion, A., & Leader, G. (2013a). An analysis of the predictors of comorbid

psychopathology, gastrointestinal symptoms and epilepsy in children and adolescents with autism spectrum disorder. *Research in Autism Spectrum Disorders*, 7(12), 1663-1671.

Mannion, A., & Leader, G. (2013b). Comorbidity in autism spectrum disorder: A literature review. *Research in Autism Spectrum Disorders*, 7, 1595-1616.

Mannion, A., & Leader, G. (2014a). Attention-Deficit/Hyperactivity Disorder in Autism Spectrum Disorder. *Research in Autism Spectrum Disorders*, 8(4), 432-439.

Mannion, A., & Leader, G. (2014b). Epilepsy in Autism Spectrum Disorder. *Research in Autism Spectrum Disorders*, 8(4), 354-361.

Mannion, A., & Leader, G. (2014c). Gastrointestinal Symptoms in Autism Spectrum Disorder: A literature review. *Review Journal of Autism and Developmental Disorders*, 1(1), 11-17.

Mannion, A., & Leader, G. (2014d). Sleep problems in autism spectrum disorder: A literature review. *Review Journal of Autism and Developmental Disorders*, 1(2), 101-109.

Mannion, A., & Leader, G. (2016). An investigation of comorbid psychological disorders, sleep problems, gastrointestinal symptoms and epilepsy in children and adolescents with autism spectrum disorder: A two year follow-up. *Research in Autism Spectrum Disorders*, 22, 20-33.

Mannion, A., Leader, G. & Healy, O. (2013). An investigation of comorbid psychological

- disorders, sleep problems, gastrointestinal symptoms and epilepsy in children and adolescents with autism spectrum disorder. *Research in Autism Spectrum Disorders*, 7, 35-42.
- Masi, A., DeMayo, M.M., Glozier, N., & Guastella, A.J. (2017). An overview of autism spectrum disorder, heterogeneity and treatment options. *Neuroscience Bulletin*, 33(2), 183-193.
- Matson, J.L., & Dempsey, T. (2008). Stereotypy in adults with autism spectrum disorders: Relationship and diagnostic fidelity. *Journal of Developmental and Physical Disabilities*, 20, 155–165.
- Matson, J. L., & Fodstad, J.C. (2009) The treatment of food selectivity and other feeding problems in children with autism spectrum disorders. *Research in Autism Spectrum Disorders*, 3, 455-461.
- Matson, J.L., & González, M. L. (2007). *Autism spectrum disorders-comorbidity-child version*. Baton Rouge, LA: Disability Consultants LLC.
- Matson, J. L., & Kozlowski, A. M. (2011). The increasing prevalence of autism spectrum disorders. *Research in Autism Spectrum Disorders*, 5, 418-425.
- Matson, J. L., & Nebel-Schwalm, M. S. (2007) Comorbid psychopathology with autism spectrum disorder in children: An overview. *Research in Developmental Disabilities*, 28(4)
- Mazefsky, C.A., Schreiber, D. R., Olino, T. M., & Minshew, N. J. (2014). The association

between emotional and behavioral problems and gastrointestinal symptoms among children with high functioning autism. *Autism, 18*(5), 493-501.

Mazurek, M. O., Vasa, R. A., Kalb, L. G., Kanne, S. M., Rosenberg, D., Keefer, A., ...&

Lowery, L. A. (2013). Anxiety, sensory over-responsivity, and gastrointestinal problems in children with autism spectrum disorders. *Journal of abnormal child psychology, 41*(1), 165-176.

Nadon, G., Feldman, D.E., Dunn, W., & Gisel, E. (2011). Association of sensory processing

and eating problems in children with autism spectrum disorder. *Autism Research and Treatment, 1*-8.

Nadon, G., Feldman, D. E., & Gisel, E. (2013). Feeding Issues Associated with the Autism

Spectrum Disorders. In M. Fitzgerald (Ed.), *Recent advances in autism spectrum disorders - Volume 1*. Rijeka: In Tech.

Råstam, M. (2008). Eating disturbances in autism spectrum disorders with focus on

adolescent and adult years. *Clinical Neuropsychiatry, 5*(1), 31-42.

Rojahn, J., Rowe, E. W., Sharber, A. C., Hastings, R., Matson, J. L., Didden, R., ... &

Dumont, E. L. M. (2012a). The Behavior Problems Inventory-Short Form for individuals with intellectual disabilities: Part I: development and provisional clinical reference data. *Journal of Intellectual Disability Research, 56*(5), 527-545.

Rojahn, J., Rowe, E. W., Sharber, A. C., Hastings, R., Matson, J. L., Didden, R., ...&

- Dumont, E. L. M. (2012b). The Behavior Problems Inventory-Short Form for individuals with intellectual disabilities: Part II: reliability and validity. *Journal of Intellectual Disability Research, 56*(5), 546-565.
- Schreck, K.A., Williams, K., & Smith, A.F. (2004). A comparison of eating behaviors between children with and without autism. *Journal of Autism and Developmental Disorders, 34*(4), 433-438.
- Seiverling, L., Hendy, H.M., & Williams, K. (2011). The screening tool of feeding problems applied to children (STEP-CHILD): Psychometric characteristics and associations with child and parent variables. *Research in Developmental Disabilities, 32*, 1122-1129.
- Seiverling, L., Towle, P., Hendy, H. M., & Pantelides, J. (2018). Prevalence of feeding problems in young children with and without autism spectrum disorder: A chart review study. *Journal of Early Intervention, 40*(4), 335-346
- Sharp, W. G., Berry, R. C., McCracken, C., Nuhu, N. N., Marvel, E., Saulnier, C. A., ...& Jaquess, D. L. (2013). Feeding problems and nutrient intake in children with autism spectrum disorders: a meta-analysis and comprehensive review of the literature. *Journal of autism and developmental disorders, 43*(9), 2159-2173.
- Thorson, R.T., & Matson, J.L. (2012). Cut-off scores for the Autism Spectrum Disorder-Comorbid for Children (ASD-CC). *Research in Autism Spectrum Disorders, 6*(1), 556-559.
- Twachtman-Reilly, J., Amaral, S.C., & Zebrowski, P.P. (2008). Addressing feeding

disorders in children on the autism spectrum in school-based settings: Physiological and behavioral issues. *American Speech Language Hearing Association*, 39, 261-271.

Wang, L.W., Tancredi, D.J., & Thomas, D.W. (2011). The prevalence of gastrointestinal problems in children across the United States with Autism Spectrum Disorders from families with multiple affected members. *Journal of Developmental Behavioral Pediatrics*, 32, 351-360.

Wardle, J., Guthrie, C.A., Sanderson, S., & Rapoport, L. (2001). Development of Children's Eating Behavior Questionnaire. *Journal of Child Psychology and Psychiatry*, 42(7), 963-970.

Williams, K.C., Christofi, F.L., Clemmons, T., Rosenberg, D. & Fuchs, G.J. (2012a). Association of chronic gastrointestinal symptoms with sleep problems may help identify distinct subgroups of autism spectrum disorders. *Gastroenterology*, 142(5), (Suppl.1), S-714.

Williams, K.C., Christofi, F.L., Clemmons, T., Rosenberg, D. & Fuchs, G.J. (2012b). Chronic GI symptoms in children with autism spectrum disorders are associated with clinical anxiety. *Gastroenterology*, 142(5), (Suppl. 1), S-79-S-80.

Williams, K.C., Fuchs, G.J., Furuta, G.T., Marcon, M.A. & Coury, D.L. (2010). Clinical features associated with GI symptoms in Autism Spectrum Disorders (ASD). *Gastroenterology*, 138(5), (Suppl. 1), S-74.

Williams, S., Leader, G., Mannion, A., & Chen, J. (2015). An investigation of anxiety in children and adolescents with autism spectrum disorder. *Research*

in Autism Spectrum Disorders, 10, 30-40.

Table 1.

Means and Standard Deviations of Study Measures

Scale	<i>M</i>	<i>SD</i>
STEP-CHILD		
Chewing Problem	6.70	8.46
Rapid Eating	6.14	6.68
Food Refusal	7.49	6.76
Food Selectivity	8.86	5.20
Vomiting	2.35	2.67
Stealing Food	4.67	4.61
BPI-S		
SIB Frequency	4.9	4.3
SIB Severity	3.7	3.5
Aggressive/Destructive Behavior Frequency	7.8	7.6
Aggressive/Destructive Behavior Severity	6.6	6.5
Stereotyped Behavior Frequency	17.6	10.3
SSP		
Tactile Sensitivity	23.0	6.0
Taste/Smell	8.4	5.1
Movement Sensitivity	11.8	3.4
Under Responsive/seeking sensation	20.6	6.9
Auditory Filtering	14.9	4.9
Low energy/weak	20.9	7.6
Visual/Auditory sensitivity	15.0	4.9
ASD-CC		
Tantrum Behavior	9.32	4.67
Repetitive Behavior	6.43	3.79
Worry/Depressed	3.35	2.65
Avoidant Behavior	6.68	2.98
Under-Eating	1.60	1.91
Conduct	2.10	2.19
Over-Eating	1.48	1.70
GSI		
	Frequency	Percentage
Abdominal Pain	73	53.7%
Constipation	64	47.1%

Feeding problems in autism spectrum disorder

Diarrhea	55	40.4%
Nausea	38	27.9%
Bloating	33	24.3%

Table 2.

Summary of Stepwise Regression Analysis for Significant Predictors of Feeding Problems.

Variable	<i>B</i>	<i>SE</i>	β
Rapid Eating			
Gastrointestinal Symptoms Total Score	1.18	0.40	0.25**
ASD-CC Total Score	0.12	0.04	0.24**
Food Refusal			
ASD-CC Total Score	0.27	0.40	0.44***
Food Selectivity			
Gender	-2.60	1.03	-0.20*
SSP Total Score	-0.07	0.02	-0.31***
Stealing Food			
ASD-CC Total Scores	.010	0.03	0.32***

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