Research report

Clinical differences in children with autism spectrum disorder with and without food selectivity ☆

Valentina Postorino [a,*], Veronica Sanges [a], Giulia Giovagnoli [a,b], Laura Maria Fatta [a], Lavinia De Peppo [a,b], Marco Armando [a], Stefano Vicari [a], Luigi Mazzone [a]

[a] Department of Neuroscience, Child Neuropsychiatry Unit, I.R.C.C.S. Children's Hospital Bambino Gesù, Piazza S. Onofrio 4, 00165, Rome, Italy
[b] L.U.M.S.A., Libera Università Maria SS. Assunta, Dipartimento di Scienze Umane, Piazza delle Vaschette 101, 00193, Rome, Italy

ARTICLE INFO

ABSTRACT

Several studies have described the atypical eating behaviors frequently occurring in children with autism spectrum disorder (ASD), and food selectivity is the most frequent of these problems. The everyday management of mealtime behaviors among children with ASD can have a negative impact on family routines and become a significant stressor for families. However, much remains unknown about why food selectivity is so prevalent among individuals with ASD. The objective of this study was to investigate clinical and behavioral features in individuals with ASD with the aim of identifying distinctive clinical profiles in children with and without food selectivity. A total of 158 children with ASD were enrolled in this study: 79 participants with food selectivity (FS) were age and sex matched with 79 participants without food selectivity (No FS). All participants and their parents completed a battery of psychological tests for a comprehensive evaluation of ASD symptoms, cognitive abilities, adaptive skills, behavioral problems and parental stress level. No statistically significant difference on gastrointestinal symptoms and growth adequacy was found between the FS group and the No FS group. Overall, the FS group showed significantly higher rates of ASD symptoms as compared to the No FS group in the questionnaires completed by parents. Furthermore, parents of the FS group reported significantly higher levels of parental stress and a larger degree of their children's behavioral problems as compared to the No FS group. Finally, there were no differences between the FS and the No FS group on any adaptive skill domain. Our findings suggest that the identification of distinctive clinical and behavioral patterns in children with ASD and food selectivity is a crucial issue for parents and therapists in the daily management.

© 2015 Published by Elsevier Ltd.

Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by impairments in two core domains: social communication and restricted and repetitive patterns of behavior, interests, or activities (American Psychiatric Association, 2013). According to the *Diagnostic and Statistical Manual of mental disorders-5th edition* (DSM-5) criteria, people with ASD fall on a continuum with individuals characterized by the severity of their symptoms in the two core domains. Furthermore, intellectual disability and/or language impairment contribute to the heterogeneous presentation of ASD.

Behavioral problems, such as tantrums, comorbidity with other psychiatric disorders, abnormal sleep patterns and unusual feeding behaviors, are often present in children with ASD and the everyday management of these problems is a challenge for clinicians and families (Dominick, Davis, Lainhart, Tager-Flusberg, & Folstein, 2007). Although not a diagnostic feature of ASD, feeding problems are common in this clinical population, and food selectivity is the most frequent one (Ahearn, Castine, Nault, & Green, 2001; Cornish, 1998; Dominick et al., 2007; Heiss, Moody, Crosley, & Campbell, 2005; Kerwin, Eicher, & Gelsinger, 2005; Nadon, Feldman, Dunn, & Gisel, 2011; Schmitt, Heiss, & Campbell, 2008; Schreck, Williams, & Smith, 2004; Williams, Gibbons, & Schreck, 2005; Williams, Dalrymple, & Neal, 2000).

Literature studies have shown that this atypical eating behavior is more prevalent in children with ASD than in typically developing children. Furthermore, food selectivity is often associated with inadequate nutrient intake (i.e., estimated average requirement [EAR], and adequate intake [AI]) suggesting that a limited diet may put any child at risk for nutritional deficiency (Bandini et al., 2010; Bicer & Alsaffar, 2013; Schmitt et al., 2008).

However, studies examining the prevalence of food selectivity in children with ASD have reported highly variable rates, ranging from 13% to 87% (Ahearn et al., 2001; Bandini et al., 2010; Collins et al., 2003; Cornish, 1998; Dominick et al., 2007; Field, Garland, & Williams, 2003; Kalyva, 2009; Klein & Nowak, 1999; Nadon et al., 2011; Schmitt et al., 2008; Schreck & Williams, 2006; Schreck et al., 2004; Suarez, Nelson, & Curtis, 2013; Whiteley, Rodgers, & Shattock, 2000; Williams et al., 2000, 2005). For instance, Whiteley et al. (2000) reported that 83% of parents indicated that their children ate a restrictive repertoire of foods. Similarly, Schreck and Williams (2006) found that 72% of parents reported their children having a limited food repertoire. On the other hand, Klein and Nowak (1999) found that only 53% of their children with ASD were reluctant to try new foods, and Bandini et al. (2010), comparing food selectivity between children with ASD and typically developing children, indicated an even lower rate (41.7%) of this atypical eating behavior in their sample of children with ASD. It is worth noting that these studies included different definitions of food selectivity, distinct methodologies, including rating scales, checklists and interviews, as well as daily food record diaries, and this issue may represent a possible explanation for these discrepancies. Therefore, a degree of variability may disappear if similar assessment criteria and definitions of food selectivity were used. Such a definition was provided by Bandini et al. (2010) to comprise three separate domains: food refusal, limited food repertoire and high-frequency single food intake (Bandini et al., 2010). In more detail, these authors defined food refusal based on the absolute number of foods the parent indicated that the child would not eat, as well as the percentage of foods the child would not eat relative to the number of foods offered. Limited food repertoire was described as the number of unique foods (including beverages) each child consumed over a 3-day period. Finally, high-frequency single food intake (excluding beverages) was delineated as single foods eaten more than 4–5 times daily (Bandini et al., 2010).

Several hypotheses have been drawn to explain food selectivity in ASD. Some studies have observed that gastrointestinal (GI) problems are common in ASD and, even though the results are contrasting, food selectivity may contribute to GI problems in a portion of these individuals (Chaidez, Hansen, & Hertz-Picciotto, 2014; Gorrindo et al., 2012; Horvath & Perman, 2002; Ibrahim, Voigt, Katusic, Weaver, & Barbaresi, 2009; Maenner et al., 2012; Mazefsky, Schreiber, Olino, & Minshew, 2014; Mazurek et al., 2013; Mouridsen, Isager, & Rich, 2013; Nikolov et al., 2009; Valicenti-McDermott, McVicar, Cohen, Wershil, & Shinnar, 2008; Whitehouse, Maybery, Wray, & Hickey, 2001). Furthermore, it has been suggested that sensory processing problems, such as sensory sensitivity, which are common among individuals with ASD, could be possible mechanisms underlying food selectivity (Cermack, Curtin, & Bandini, 2010; Mazurek et al., 2013; Suarez et al., 2013). In fact, determining factors of food selectivity are often associated with texture, taste, temperature, smell preferences and consistency (Williams et al., 2000). Highlighting the clinical importance of this issue, one of the criteria for the diagnosis of ASD in the new DSM-5 concerns hyper- or hypo-reactivity to sensory input or unusual interests in sensory aspects of the environment (American Psychiatric Association, 2013).

Although it has been demonstrated that food selectivity is a chronic problem unlikely to change without treatment, much remains unknown about why food selectivity is so prevalent among individuals with ASD. Finally, to our knowledge, no previous study has investigated if food selectivity is associated with distinctive clinical features in children with ASD. Thus, the objective of this study was to investigate clinical and behavioral features in individuals with ASD with the aim of identifying distinctive clinical profiles in children with and without food selectivity. Specifically, we hypothesize that individuals with food selectivity exhibit higher levels of clinical symptoms and behavioral and emotional problems compared to children without food selectivity. Moreover, given that the atypical eating behaviors may become a significant stressor for families, we hypothesize that the level of parental stress would be higher in parents of children with food selectivity compared to parents of children without food selectivity. Finally, considering that restricted intakes of food may lead to growth problems and cause GI symptoms, we expect that children with food selectivity would report higher levels of these problems relative to children without food selectivity.

Materials and methods

Participants

Study participants included 158 children with ASD, all Caucasians of Italian descent (aged 3 to 12 years; mean age ± SD: 7.16 ± 2.046). At entry into the study, ASD had to be diagnosed by an expert clinician using DSM-IV-TR criteria (American Psychiatric Association, 2000). All of these children were referred to the Child Neuropsychiatry Unit of the Children Hospital Bambino Gesu' of Rome (Italy) between December 2012 and December 2013. Exclusion criteria for all children included the presence of specific genetic disorders, other medical disorders and epilepsy. The parents of all participants provided written informed consent. Data were collected in our outpatient service throughout a multidisciplinary team (i.e., pediatric neuropsychiatrists and psychologists, pediatricians and speech therapists). Given the extensive assessment battery in order to reduce testing burden and control for fatigue in children and caregivers to complete we divided the evaluation into three separate two hour sessions completed in separate visits by the same administrator.

Of the 158 participants, 79 participants with food selectivity (FS) (67 males and 12 females, aged 4 to 12 years; mean age ± SD: 7.22 ± 2.042) were age and sex matched with 79 participants without food selectivity (No FS) (69 males and 10 females, aged 3 to 12 years; mean age ± SD: 7.10 ± 2.061). Participants were included in the FS group if, on the revised Food Frequency Questionnaire (FFQ), parents indicated that their child had issues with one of the following food selectivity criteria: food refusal and/or high frequency single food intake (Bandini et al., 2010).

Assessment of atypical eating behaviors

All parents of children with ASD included in the study completed a specific questionnaire about their child's dietary habits and use of special diets. We defined food selectivity as comprising two separate domains: food refusal and high frequency single food intake. We used a modified version for parents of the Youth/Adolescent Food Frequency Questionnaire (YAQ) in order to assess food refusal and high frequency single food intake (Field et al., 1999). The revised Food Frequency Questionnaire (FFQ) contains 131 food items, and asks parents to write in foods that were not included on the FFQ if the child ate them at least once per week on average over the past year (Bandini et al., 2010). We assessed food refusal based on the absolute number of foods the parent indicated that the child would not eat, as well as the percentage of foods the child would not eat relative to the number of foods offered (Bandini et al., 2010). We defined high frequency consumption as single foods the child ate more than 4–5 times daily. Beverages were not included in this measure, because it is not uncommon to consume a beverage 4 or more times a day (Bandini et al., 2010).

Furthermore, all parents of the FS group, were interviewed about the types and sensory factors linked to food selectivity (i.e. "texture", "form", "color", "smell", "taste", "temperature", "quantity", "brand or packaging", "rituals surrounding eating", "unspecified").

GI symptoms and growth adequacy evaluation

In order to investigate the presence of GI symptoms we used the "*Consensus report*" and the "*Recommendations for evaluation and treatment of common gastrointestinal problems in children with ASD*" (Buie, Fuchs, Furuta, Kooros, Levy, & Lewis, 2010; Buie, Fuchs, Furuta, Kooros, Levy, & VandeWater et al., 2010). According to these guidelines, the parents of all participants were interviewed on the presence of GI symptoms: 1. constipation; 2. chronic diarrhea; 3. gastroesophageal reflux; 4. vomiting (Buie, Fuchs, Furuta, Kooros, Levy, & Lewis, 2010; Buie, Fuchs, Furuta, Kooros, Levy, & VandeWater et al., 2010).

Specifically, the presence of GI symptoms was investigated throughout a complete medical history. Parents were interviewed for what they mean with the term "constipation, diarrhea, gastro-esophageal reflux and vomiting," the frequency of bowel movements and vomiting, the consistency and size of stools, whether the child experiences abdominal pain, definition of the age at symptom onset, whether symptoms develop abruptly or gradually, family history of allergy or atopic disease, the presence of celiac disease, the presence of chest pain or heartburn, extraesophageal manifestation of airway (Buie, Fuchs, Furuta, Kooros, Levy, & Lewis, 2010; Buie, Fuchs, Furuta, Kooros, Levy, & VandeWater et al., 2010). Moreover, each child underwent a complete psychical examination with a pediatrician (Buie, Fuchs, Furuta, Kooros, Levy, & Lewis, 2010; Buie, Fuchs, Furuta, Kooros, Levy, & VandeWater et al., 2010). Given that the body mass index (BMI) (kg/m^2) is one of the objective growth parameters useful for diagnosis and monitoring of failure to thrive or obesity, weight and height were measured, and the BMI was calculated for all participants (Cole, Bellizzi, Flegal, & Dietz, 2000; Cummings, John, Davis, & McTimoney, 2005).

Evaluation of ASD symptoms

All the children were assessed for the presence of ASD symptoms through the Autism Diagnostic Observation Schedule-Generic (ADOS-G) performed by a licensed clinician (Lord, Risi, Lambrecht, Cook, & Leventhal, 2000). The ADOS-G is a semi-structured, standardized, play-based assessment measuring current autistic behaviors. The ADOS-G is divided into four separate modules, and each module is aimed at a specific level of expressive language ability. Specifically: Module 1 is intended for children who do not use spontaneous phrase speech consistently; Module 2 is for children with some flexible phrase speech who are not verbally fluent; Module 3 is for verbally fluent children for whom playing with toys is age appropriate; Module 4 for verbally fluent adults and for adolescents who are not interested in playing with toys such as action figures (Lord et al., 2000). In the present study, 79 children (37 of the FS group and 42 of the No FS group) performed Module 1, 54 children (30 of the FS group and 24 of the No FS group) performed Module 2, and 23 children (12 of the FS group and 11 of the No FS group) performed Module 3. However, the ADOS-G algorithm does not include Restricted/Repetitive Behavior or Interests (RRB) and literature studies have suggested that if this domain is included in the algorithm it might help to increase ADOS-G diagnostic stability (Lord et al., 2006). Therefore, in order to evaluate ASD severity a revised algorithm has been used in the present study (Gotham, Risi, Pickles, & Lord, 2007). In more detail, the total cut-off of the revised algorithm comprise the Social Affect (SA) and the RRB domains and is divided into a 10-point severity score (de Bildt et al., 2011; Gotham, Pickles, & Lord, 2009).

Furthermore, in order to evaluate the presence of ASD symptoms through parent reports, the parents of all participants completed the Autism Diagnostic Interview-Revised (ADI-R), the Social Responsiveness Scale (SRS) and the Social Communication Questionnaire (SCQ) with a licensed clinician (Constantino & Gruber, 2005; Lord, Rutter, & Le Couteur, 1994; Rutter, Bailey, & Lord, 2003). The ADI-R is a 93-items standardized, semi-structured interview schedule based on the DSM-IV (American Psychiatric Association, 1994) and ICD-10 (World Health Organization, 2010) diagnostic classification of ASD. A subset of 37 items from ADI-R is used to create a diagnostic algorithm, which includes three domains: A. qualitative abnormalities in reciprocal social interaction; B. qualitative abnormalities in communication; C. restricted, repetitive and stereotyped patterns of behavior.

The SRS is a 65-item questionnaire evaluating social and autistic behaviors for 4- to 18-year-olds (Constantino & Gruber, 2005). The Italian adaption was used in this study and this version has demonstrated good to excellent psychometric properties (Zuddas, Di Martino, Delitala, Anchisi, & Melis, 2010).

The SCQ is a 40-item parent-report screening questionnaire for ASD, based on ADI-R (Rutter et al., 2003). It is available in two forms: lifetime and current. We used the lifetime form, which focuses on the child's entire developmental history, providing a total score that is interpreted in relation to specific cut-off points. Specifically, a cut-off score of 15 or greater is used as possible indicator of ASD. This tool has shown good psychometric properties (Cianchetti & Fancello, 2007).

Assessment of cognitive and adaptive skills

A total of 135 children with ASD were able to perform a cognitive evaluation. Specifically, 63 children (36 of the FS group and 27 of the No FS group) were assessed through Griffiths Mental Developmental Scale-Extend Revised (GMDS-ER) and 72 children (34 of the FS group and 38 of the No FS group) were evaluated through Leiter International Performance Test-Revised (Leiter-R) (Griffiths, 2006; Leiter, 1979; Roid & Miller, 1997). Furthermore, the parents of all participants were interviewed by a trained and experienced clinician in order to measure the children's adaptive skills through the Adaptive Behavior Scale-Survey Form (VABS-SF) (Balboni & Pedrabissi, 2003; Sparrow, Balla, & Cicchetti, 1984).

The GMDS-ER I and II assess the child's strengths and weaknesses in all developmental areas, and can be used to measure the rate of development for children from birth to 8 years of age. The GMDS-ER comprises six scales evaluating six areas of development. In the present study, all children were not able to perform GMDRS-ER Practical Reasoning area. Griffith's six subscales are expressed as quotients to constitute the General Developmental Quotient (GDQ). Developmental quotients rather than mental age are used in order to make possible comparisons of children of different chronological ages and of a child's performance at different time periods.

The Leiter-R is a nonverbal intelligence test of cognitive abilities for children from 2 to 18 years (Roid & Miller, 1997). In the present study, four subtests (Figure Ground, Form Completion, Sequential Order and Repetitive Pattern) of the Visualization and Reasoning domains were administered. Based on these four subtests, the Leiter–R yields a standardized nonverbal Brief Intelligence Quotient (IQ) score. Each of the subtests used and brief IQ scores have shown excellent validity and reliability.

The VABS-SF is a 297-item parent interview of everyday adaptive behaviors divided into four general domains of functioning: Communication Skills, Daily Living Skills, Social Skills and Motor Skills. An adaptive behavior composite score for each of the four domains was attained for all participants and transformed into equivalent ages based on published Italian norms (Balboni & Pedrabissi, 2003).

Evaluation of children behavioral problems and parental stress

The parents of all children included in the study completed the Child Behavior Checklist (CBCL) and the Parent Stress Index-Short Form (PSI-SF) to rate children's emotional and behavioral problems and the perceived stress in parenting role (Abidin, 1990, 1995; Achenbach & Eofbrock, 1983; Achenbach & Rescorla, 2000, 2001; Guarino, Di Blasio, D'Alessio, Camisasca, & Serantoni, 2008).

The CBCL is an extensively used questionnaire available in two versions: the preschool checklist (CBCL 1½-5) intended for use with children aged 18 months to 5 years and the school-age version (CBCL 6–18) for children aged 6 to 18 years. In the present study we evaluated the scores for three broad-brand scales: internalizing symptoms, externalizing symptoms and total behavioral problems. Raw scores for each clinical factor were transformed into T-scores based on published norms. The psychometric properties of the CBCL show good validity and reliability (Achenbach & Eofbrock, 1983; Achenbach & Rescorla, 2000, 2001).

The PSI-SF is a 36-item questionnaire that measures different aspects of perceived stress in the parenting role using three subscales: parental distress (PD), parent–child dysfunctional interaction (P-CDI), and difficult child (DC). The total PSI-SF score is used as an indicator of the parent's overall experience of parenting stress (Abidin, 1990, 1995; Guarino et al., 2008). The PSI-SF has been shown to be a valid and reliable measure (Abidin, 1995; Guarino et al., 2008).

Data analysis

Data analyses were performed using the Statistical Package for Social Sciences (SPSS 20.0 for Windows). Chi-square analyses were used for dichotomous variables and one-way ANOVA was applied to continuous variables. Prevalence rates of domains and type or sensory factors associated with food selectivity were calculated on the total number of participants of the FS group. Listwise deletions were used to deal with missing data. An alpha level of 0.05 was set for statistical significance.

Results

Characterization of the ASD sample with atypical eating behaviors

Of the 158 children with ASD, 79 parents reported the presence of at least one domain of food selectivity; therefore these participants were included in the FS group. Specifically, 73 (92.4%) parents observed food refusal in their child. Contrarily, parents of only 9 children reported a consumption of a single food more than 4–5 times daily (5 children snacks foods/desserts, 3 children breads and cereals and one child main dishes). Moreover, parents of only one child described that their child consumed one food more than 6 times daily (breads and cereals).

According to parent interviews, all of the FS children showed at least one sensory factor linked to food selectivity. Moreover, 33 (41.7%) of these children reported a second sensory factor linked to food selectivity and 18 (22.7%) children showed a third sensory factor associated with food selectivity. In more detail, 68.4% ($n = 54$) for "texture", 53.2% ($n = 42$) for "taste", 20.3% ($n = 16$) for "color", 16.5% ($n = 13$) for "form", 12.7% ($n = 10$) for "brand or packaging", 10.1% ($n = 8$) for "smell", 7.6% ($n = 6$) "unspecified", 3.8% ($n = 3$) for "rituals surrounding eating", 2.5% ($n = 2$) for "quantity", 1.3% ($n = 1$) for "temperature."

GI symptoms and growth adequacy in the study population

Of the total sample, 13.9% ($n = 22$) showed GI symptoms: 8.2% ($n = 13$) of the FS group and 5.6% ($n = 9$) of the No FS group. Particularly, 6.3% ($n = 10$) reported vomiting (6 participants of the FS group and 4 participants of the No FS group), 4.4% ($n = 7$) presented chronic diarrhea (3 participants of the FS group and 4 participants of the No FS group), 2.5% ($n = 4$) reported constipation (4 participants of the FS group) and 0.6% ($n = 1$) presented gastroesophageal reflux (1 child of the No FS group). There were no statistically significant differences between the FS group and the No FS group in relation to GI symptoms.

Furthermore, evaluating growth adequacy through BMI, there was no statistically significant difference between the FS group (mean ± SD: 17.59 ± 2.97) and the No FS group (mean ± SD: 18.22 ± 3.93).

Participants' clinical symptoms, behavioral problems and parental stress differences

Evaluating ASD symptoms by ADOS severity score, ADI-R, SRS and SCQ, variance analysis showed that the FS group scored significantly higher in SRS total score ($p < .001$) and SCQ total score ($p = .003$) as compared to the No FS group. Differences on cognitive abilities, revealed a significant difference between the FS and the No FS group evaluated by Leiter-R ($p = 0.023$), with the No FS group scoring significantly higher than the FS group. Contrarily, adaptive skills assessment showed no statistically significant differences between the FS and the No FS groups on any skill domain. Rating behavioral and emotional problems, significant differences were detected between the FS and the No FS groups on CBCL total subscale ($p = .005$), as well as internalizing ($p = .002$) and externalizing ($p = .011$) CBCL subscales. In more detail, the parents of the FS group reported a larger degree of impairment on CBCL total (mean ± SD: 60.86 ± 9.21) and along the CBCL internalizing (mean ± SD: 62.06 ± 9.25) and CBCL externalizing (mean ± SD: 56.08 ± 9.56) subscales compared to parents of the No FS group (CBCL total: mean ± SD: 55.79 ± 10.7; CBCL internalizing: mean ± SD: 56.78 ± 10.08; CBCL externalizing: mean ± SD: 51.78 ± 9.16) (Fig. 1). Furthermore, parents of the FS group reported significantly higher level of parental stress than parents of the No FS group on PSI total score ($p < .001$) as well as PD ($p = .006$), P-CDI ($p < .001$) and DC ($p = .035$) subscales (Fig. 1).

Comparisons of the clinical symptoms, behavioral problems and parental stress between the FS and the No FS groups are provided in Table 1.

Discussion

Several studies have shown that food selectivity is one of the most frequent behavioral problems for many children with ASD (Ahearn et al., 2001; Bandini et al., 2010; Dominick et al., 2007; Heiss et al., 2005; Kerwin et al., 2005; Nadon et al., 2011; Schmitt et al., 2008; Schreck et al., 2004; Williams et al., 2005). The everyday management of mealtime behaviors among children with ASD can have a negative impact on family routines, become a significant stressor for families, and be a challenge for clinicians (Cornish, 1998; Williams et al., 2000). Previous studies on the prevalence of food selectivity in individuals with ASD have reported highly variable rates, ranging from 13% to 87%, probably accounted by the use of different methodologies and distinct definitions of food selectivity (Ahearn et al., 2001; Bandini et al., 2010; Collins et al., 2003; Cornish, 1998; Dominick et al., 2007; Field et al., 2003; Kalyva, 2009; Klein & Nowak, 1999; Nadon et al., 2011; Schmitt et al., 2008; Schreck & Williams, 2006; Schreck et al., 2004; Suarez et al., 2013; Whiteley et al., 2000; Williams et al., 2000, 2005). In our study we found similar levels of food refusal to the incidence rates of this domain reported by other authors (Bandini et al., 2010; Schreck et al., 2004). In line with the study of Bandini et al. (2010), we did not observe the high frequency consumption of a single food in our sample: only 9 parents of the FS group reported that their child consumed a single food
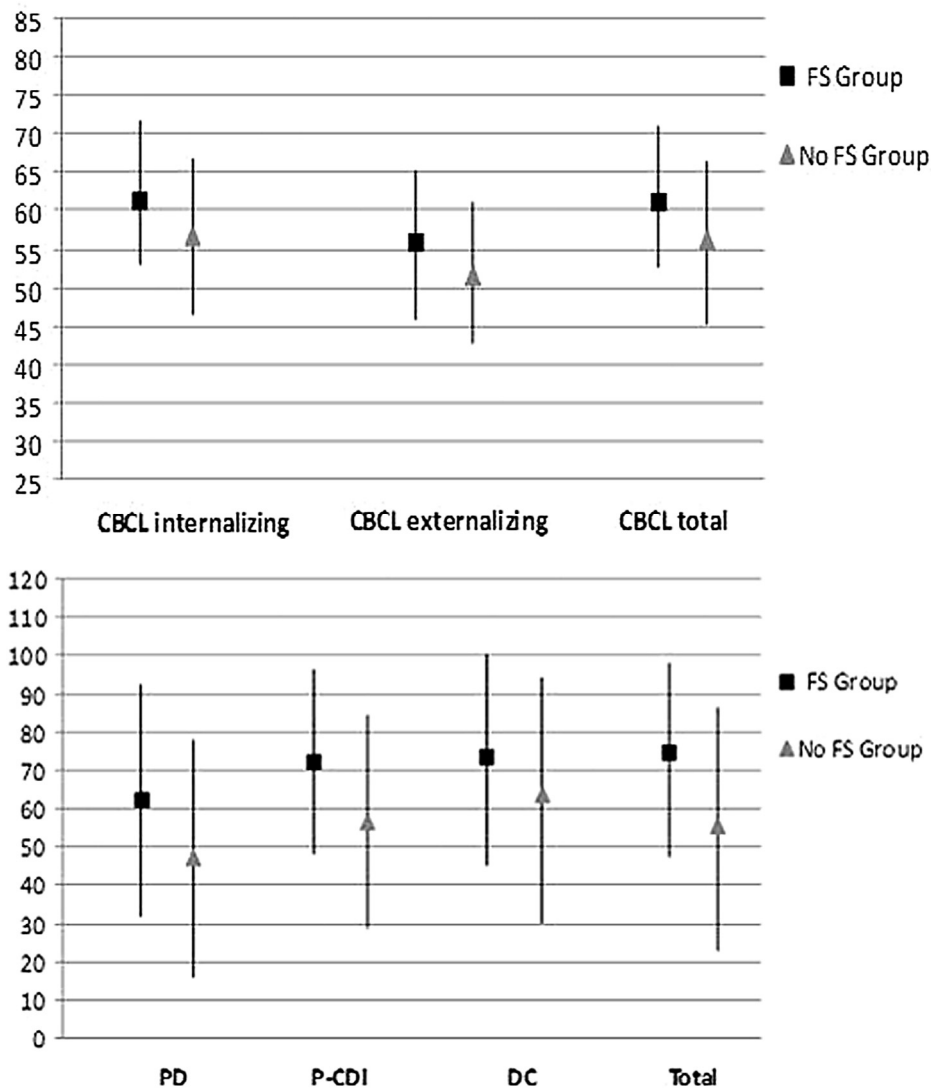
Fig. 1. CBCL and PSI profile in children with ASD with and without food selectivity.

more than 4–5 times daily. Studies have hypothesized sensory sensitivity as a possible mechanism underlying food selectivity (Cermack et al., 2010; Mazurek et al., 2013; Suarez et al., 2013). A recent longitudinal follow-up study examining the relationship between food selectivity and sensory over-responsivity in 52 children with ASD, at baseline and after 20 months, reported that higher level of over-responsivity were associated with fewer foods accepted and this association appeared to be stable over time (Suarez et al., 2013). Our results show that all participants of the FS group reported at least one sensory factor linked to food selectivity. Specifically, as reported in the study of Williams et al. (2000), the most common factors that parents felt influenced food selectivity were "texture" (69.4%) and "taste" (53.2%). Another hypothesis that has been drawn in order to explain the mechanisms underlying food selectivity in ASD is the relationship between this atypical eating behavior and GI symptoms: food selectivity may be a reason of GI symptoms at least in a part of these individuals (Ibrahim et al., 2009; Nikolov et al., 2009; Whitehouse et al., 2001). In our sample of children with ASD the prevalence of GI symptoms was of 13.9%. Even though there were no statistically significant differences between the FS and the No FS group on the prevalence of GI symptoms, the FS group reported a higher rate of these problems (8.2%). Thus, these data could suggest that food selectivity may cause GI symptoms in a part of these individuals. However, further longitudinal studies are needed in order to determine the relationship between GI symptoms and food selectivity in individuals with ASD. Previous studies investigating the association between food selectivity and growth adequacy have shown highly inconsistent results: either being under or being overweight have been reported in children with ASD (Al-Farsi et al., 2011; Bicer & Alsaffar, 2013; Bolte, Ozkara, & Poutska, 2002; Curtin, Bandini, Perrin, Tybor, & Must, 2005; Mouridsen, Rich, & Isager, 2002; Xia, Zhou, Sun, Wang, & Wu, 2010). For instance, Bicer and Alsaffar (2013), evaluating growth adequacy by BMI-for-age percentile charts in 164 children with ASD, found that only 11% of them were severely thin or thin, whereas the majority of the children were overweight and obese (58.5%). However, we did not detect any differences between the FS and the No FS group in growth adequacy, and either the FS or the No FS group resulted within the normal weight range.

Moreover, in order to shed light on the distinctive features eventually associated with food selectivity in individuals with ASD we seek to understand if clinical and behavioral differences were detected in children with ASD with and without food selectivity. Overall, the FS group showed significantly higher rates of ASD symptoms as compared to the No FS group in the questionnaires completed by parents (i.e., SRS and SCQ). However, we did not observe any

Table 1

Comparisons of clinical symptoms, behavioral problems and parental stress between the FS and the No FS groups (Mean ± SD).

	FS[a] Group	No FS[b] Group	ANOVA	
	(N = 79)	(N = 79)	F	P[c]
ADOS severity score[d]	5.80 ± 2.331	6.22 ± 1.830	9.971	NS
ADI-R A domain[e]	16.78 ± 7.774	15.90 ± 6.401	0.372	NS
ADI-R B domain[f]	9.33 ± 4.100	9.14 ± 4.306	0.047	NS
ADI-R C domain[g]	8.12 ± 4.156	6.67 ± 3.071	3.852	NS
SRS[h]*	81.17 ± 13.485	67.88 ± 18.366	14.793	<.001
SCQ[i]**	16.12 ± 7.660	12.06 ± 7.868	9.086	.003
GMDS-ER-GDQ[j]***	72.58 ± 22.165	66.19 ± 23.060	1.242	NS
Leiter-R-BIQ[k]****	86.53 ± 23.403	98.58 ± 20.737	5.366	.023
VABS-SF[l]				
Communication Skills	3.79 ± 2.396	4.19 ± 2.333	1.098	NS
Daily Living Skills	3.66 ± 2.005	3.72 ± 1.640	0.036	NS
Social Skills	2.98 ± 1.577	3.29 ± 1.697	1.404	NS
Motor Skills*****	3.34 ± 0.935	3.49 ± 0.909	0.678	NS
CBCL Int[m]	62.06 ± 9.253	56.78 ± 10.084	9.550	.002
CBCL Ext[n]	56.08 ± 9.566	51.78 ± 9.168	6.732	.011
CBCL Tot[o]	60.86 ± 9.216	55.79 ± 10.701	8.259	.005
PSI-SF[p]				
PD[q] Percentile	61.09 ± 30.429	46.85 ± 31.065	7.837	.006
P-CDI[r] Percentile	72.09 ± 24.043	56.47 ± 27.856	13.182	<.001
DC[s] Percentile	72.68 ± 27.498	62.17 ± 31.904	4.553	.035
Total Percentile	73.85 ± 25.341	54.43 ± 31.696	16.768	<.001

[a] Group with ASD and food selectivity.
[b] Group with ASD without food selectivity.
[c] Indicates P < 0.05.
[d] Autism Diagnostic Observation Scale severity score.
[e] Autism Diagnostic Interview-Revised domain of qualitative abnormalities in reciprocal social interaction.
[f] Autism Diagnostic Interview-Revised domain of qualitative abnormalities in communication.
[g] Autism Diagnostic Interview-Revised domain of restricted, repetitive and stereotyped patterns of behavior.
[h] Social Responsiveness Scale total score.
[i] Social Communication Questionnaire total score.
[j] Griffiths Mental Developmental Scale-Extend Revised-General Developmental Quotient.
[k] Leiter-R-Brief Intelligence Quotient.
[l] Adaptive Behavior Scale-Survey Form.
[m] Child Behavior Checklist Internalizing score (T-Score).
[n] Child Behavior Checklist Externalizing score (T-Score).
[o] Child Behavior Checklist Total score (T-Score).
[p] Parent Stress Index-Short Form.
[q] Parental Distress.
[r] Parent–Child Dysfunctional Interaction.
[s] Difficult Child.
* SRS was completed by n = 157 parents.
** SCQ was completed by n = 157 parents.
*** GMDS-ER was performed by n = 36 of the FS group and n = 27 of the No FS group.
**** Leiter-R was performed by n = 34 of the FS group and n = 38 of the No FS group.
***** VABS-SF-Motor Skills domain was evaluated for n = 33 children.

difference between the two groups in ASD symptoms in the measures scored by clinicians. Furthermore, parents of the FS group reported significantly higher levels of parental stress and a larger degree of their children's behavioral problems as compared to the No FS group. Finally, there were no differences between the FS and the No FS group on any adaptive skill domain. An explanation of these findings could be addressed as a result of parents' perception. Specifically, parents of children with ASD and food selectivity probably perceive their child to have significantly more behavioral and emotional problems than parents of children with ASD without food selectivity, therefore experiencing higher levels of parental stress.

Although this study supplements the available literature concerning food selectivity in children with ASD, the interpretation of our results should take into account some limitations. First, this is a cross-sectional study, and although extremely useful for generating hypotheses, these hypotheses need to be further confirmed by longitudinal investigations. Second, the participants included in the study were clinically referred and not intended to be representative of children with ASD in the general population. Finally, food selectivity evaluation was not derived from a day record food diary; therefore our evaluation may not adequately capture the variety of the typical diet.

Conclusions

In conclusion, food selectivity has been extensively studied in samples with ASD, and, despite the fact that recent studies have highlighted that this problem remains stable over time, further research should better understand the clinical phenomenology of food selectivity in children with ASD. Moreover, given that food selectivity may be a significant stressor for families with a negative impact on quality of life, this is an important research area that warrants more attention.

The identification of distinctive clinical and behavioral patterns in children with ASD and food selectivity is a crucial issue for parents and therapists in the daily management. Recognizing these patterns would be useful to develop adequate interventions and treatment strategies.

References

Abidin, R. R. (1990). *The parenting stress index-short form. Test manual*. Charlottesville, VA: Pediatric Psychology Press.

Abidin, R. R. (1995). *Parenting stress index. Professional manual* (3rd ed.). Odessa, FL: Psychological Assessment Resources, Inc.

Achenbach, T. M., & Eofbrock, C. (1983). *Manual for the child behaviour checklist*. Burlington, VA: University of Vermont.

Achenbach, T. M., & Rescorla, L. A. (2000). *Manual for the ASEBA preschool forms & profiles*. Burlington, VT: University of Vermont, Research Center for Children, Youth, & Families.

Achenbach, T. M., & Rescorla, L. A. (2001). *Manual for the ASEBA school-age forms & profiles*. Burlington, VT: University of Vermont, Research Center for Children, Youth, & Families.

Ahearn, W. H., Castine, T., Nault, K., & Green, G. (2001). An assessment of food acceptance in children with autism or pervasive developmental disorder-not otherwise specified. *Journal of Autism and Developmental Disorders*, 31, 505–511.

Al-Farsi, Y. M., Al-Sharbati, M. M., Waly, M. I., Al-Farsi, O. A., Al-Shafaee, M. A., & Deth, R. C. (2011). Malnutrition among preschool-aged autistic children in Oman. *Research in Autism Spectrum Disorders*, 5, 1549–1552.

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: American Psychiatric Association.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders-fourth edition-text revision*. Washington DC: American Psychiatric Association.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders-5*. Washington, DC: American Psychiatric Association.

Balboni, G., & Pedrabissi, L. (2003). *Vineland adaptive behavior scales. Intervista. Forma completa*. Firenze: Giunti Organizzazioni Speciali.

Bandini, L. G., Anderson, S. E., Curtin, C., Cermak, S., Evans, E. W., Scampini, R., et al. (2010). Food selectivity in children with autism spectrum disorders and typically developing children. *The Journal of Pediatrics*, 157, 259–264.

Bicer, A. H., & Alsaffar, A. A. (2013). Body mass index, dietary intake and feeding problems of Turkish children with autism spectrum disorder (ASD). *Research in Developmental Disabilities*, 34, 3978–3987.

Bolte, S., Ozkara, N., & Poutska, F. (2002). Autism spectrum disorders and low body weight. Is there a really systematic association? *The International Journal of Eating Disorders*, 31, 349–351.

Buie, T., Fuchs, G. J., III, Furuta, G. T., Kooros, K., Levy, J., & Lewis, J. (2010). Recommendations for evaluation and treatment of common gastrointestinal problems in children with ASDs. *Pediatrics*, 125, S19–S29.

Buie, T., Fuchs, G. J., III, Furuta, G. T., Kooros, K., Levy, J., VandeWater, J., et al. (2010). Evaluation, diagnosis, and treatment of gastrointestinal disorders in individuals with ASDs. A consensus report. *Pediatrics*, 125, S1–S18.

Cermack, S. A., Curtin, C., & Bandini, L. G. (2010). Food selectivity and sensory sensitivity in children with autism spectrum disorders. *Journal of the American Dietetic Association*, 110(2), 238–246.

Chaidez, V., Hansen, R. L., & Hertz-Picciotto, I. (2014). Gastrointestinal problems in children with autism, developmental delays or typical development. *Journal of Autism and Developmental Disorders*, 44, 1117–1127.

Cianchetti, C., & Fancello, G. S. (2007). M. Rutter, A. Bailey, & C. Lord (Eds.), *Social Communication Questionnaire (SCQ)*. Firenze: Giunti Organizzazioni Speciali. (adattamento Italiano a cura di).

Cole, T. J., Bellizzi, M. C., Flegal, K. M., & Dietz, W. H. (2000). Establishing a standard definition for child overweight and obesity worldwide. International survey. *British Medical Journal*, 320, 1–6.

Collins, M. S. R., Kyle, R., Smith, S., Laverty, A., Roberts, S., & Eaton-Evans, J. (2003). Coping with the usual family diet. Eating behavior and food choices of children with Down's syndrome, Autistic Spectrum Disorders, or Cri du Chat Syndrome and comparison groups of siblings. *Journal of Learning Disabilities, 7*, 137–155.

Constantino, J. N., & Gruber, C. P. (2005). *Social responsiveness scale*. Los Angeles: Western Psychological Services.

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

Cummings, E. A., John, H., Davis, H. S., & McTimoney, C. A. M. (2005). Documentation of growth parameters and body mass index in a paediatric hospital. *Paediatrics & Child Health, 10*, 391–394.

Curtin, C., Bandini, L. G., Perrin, E. C., Tybor, D. J., & Must, A. (2005). Prevalence of overweight in children and adolescents with attention deficit hyperactivity disorder and autism disorders. A chart review. *BMC Pediatrics, 5*, 1–7.

de Bildt, A., Oosterling, I. J., van Lang, N. D., Sytema, S., Minderaa, R. B., van Engeland, H., et al. (2011). Standardized ADOS Scores. Measuring severity of autism spectrum disorders in a Dutch sample. *Journal of Autism and Developmental Disorders, 41*, 311–319.

Dominick, K. C., Davis, N. O., Lainhart, J., Tager-Flusberg, H., & Folstein, S. (2007). Atypical behaviors in children with autism and children with a history of language impairment. *Research in Developmental Disabilities, 28*, 145–162.

Field, A. E., Camargo, C. A., Taylor, C. B., Berkey, C. S., Frazier, A. L., Gillman, M. W., et al. (1999). Overweight, weight concerns, and bulimic behaviors among girls and boys. *Journal of the American Academy of Child and Adolescent Psychiatry, 38*, 754–760.

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

Gorrindo, P., Kent, C., Williams, K. C., Lee, E. B., Walker, L. S., McGrew, S. G., et al. (2012). Gastrointestinal dysfunction in autism. Parental report, clinical evaluation, & associated factors. *Autism Research: Official Journal of the International Society for Autism Research, 5*, 101–108.

Gotham, K., Pickles, A., & Lord, C. (2009). Standardizing ADOS scores for a measure of severity in autism spectrum disorders. *Journal of Autism and Developmental Disorders, 39*, 693–705.

Gotham, K., Risi, S., Pickles, A., & Lord, C. (2007). The autism diagnostic observation schedule. Revised algorithms for improved diagnostic validity. *Journal of Autism and Developmental Disorders, 37*, 613–627.

Griffiths, R. (2006). *Griffiths mental development scales extended revised manual*. Firenze: Giunti Organizzazioni Speciali.

Guarino, A., Di Blasio, P., D'Alessio, M., Camisasca, E., & Serantoni, G. (2008). *Parenting stress index. Forma breve*. Firenze: Giunti Organizzazioni Speciali.

Heiss, C. J., Moody, L. N., Crosley, J., & Campbell, E. (2005). Nutrient intake and eating behaviors of boys with and without autism. *Journal of the American Dietetic Association, 105*, A28.

Horvath, K., & Perman, J. A. (2002). Autism and gastrointestinal symptoms. *Current Gastroenterology Reports, 4*, 251–258.

Ibrahim, S. H., Voigt, R. G., Katusic, S. K., Weaver, A. L., & Barbaresi, W. J. (2009). Incidence of gastrointestinal symptoms in children. A population-based study. *Pediatrics, 124*, 680–686.

Kalyva, E. (2009). Comparison of eating attitudes between adolescent girls with and without Asperger Syndrome. Daughters' and mothers' reports. *Journal of Autism and Developmental Disorders, 39*, 480–486.

Kerwin, M. L., Eicher, P. S., & Gelsinger, J. (2005). Parental report of eating problems and gastrointestinal symptoms in children with pervasive developmental disorders. *Children's Health Care, 34*, 217–234.

Klein, U., & Nowak, A. J. (1999). Characteristics of patients with autistic disorder (AD) presenting for dental treatment. A survey and chart review. *Special Care in Dentistry: Official Publication of the American Association of Hospital Dentists, the Academy of Dentistry for the Handicapped, and the American Society for Geriatric Dentistry, 19*, 200–207.

Leiter, R. G. (1979). *Instruction manual for the Leiter International performance scale*. Wood Dale, IL: Stoelting Co.

Lord, C., Risi, S., DiLavore, P. S., Shulman, C., Thurm, A., & Pickles, A. (2006). Autism from 2 to 9 years of age. *Archives of General Psychiatry, 63*, 694–701.

Lord, C., Risi, S., Lambrecht, L., Cook, E. H., & Leventhal, B. L. (2000). The autism diagnostic observation schedule-generic. A standard measure of social and communication deficits associated with the spectrum of autism. *Journal of Autism and Developmental Disorders, 30*, 205–223.

Lord, C., Rutter, M., & Le Couteur, A. (1994). Autism diagnostic interview-revised. A revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorders, 24*, 659–685.

Maenner, M. J., Arneson, C. L., Levy, S. E., Kirby, R. S., Nicholas, J. S., & Durkin, M. S. (2012). Brief report. Association between behavioral features and gastrointestinal problems among children with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 42*, 1520–1525.

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: The International Journal of Research and Practice, 18*(5), 493–501.

Mazurek, M. O., Vasa, R. A., Kalb, L. G., Kanne, S. M., Rosenberg, D., Keefer, A., et al. (2013). Anxiety, sensory over-responsivity, and gastrointestinal problems in children with autism spectrum disorders. *Journal of Abnormal Child Psychology, 41*, 165–176.

Mouridsen, S. E., Isager, T., & Rich, B. (2013). Diseases of the gastrointestinal tract in individuals diagnosed as children with atypical autism. A Danish register study based on hospital diagnoses. *Autism: The International Journal of Research and Practice, 17*, 55–63.

Mouridsen, S. E., Rich, B., & Isager, T. (2002). Body mass index in male and female children with infantile autism. *Autism: The International Journal of Research and Practice, 6*, 197–205.

Nadon, G., Feldman, D. E., Dunn, W., & Gisel, E. (2011). Mealtime problems in children with Autism Spectrum Disorder and their typically developing siblings. A comparison study. *Autism: The International Journal of Research and Practice, 15*, 98–113.

Nikolov, R. N., Bearss, K. E., Lettinga, J., Erickson, C., Rodowski, M., Aman, M. G., et al. (2009). Gastrointestinal symptoms in a sample of children with pervasive developmental disorders. *Journal of Autism and Developmental Disorders, 39*, 405–413.

Roid, G. M., & Miller, L. J. (1997). *Leiter International performance scale-revised. Examiners manual*. Wood Dale, IL: Stoelting Co.

Rutter, M., Bailey, A., & Lord, C. (2003). *Social communication questionnaire (SCQ)*. Los Angeles, CA: Western Psychological Services.

Schmitt, L., Heiss, C., & Campbell, E. (2008). A comparison of nutrient intake and eating behaviors of boys with and without autism. *Topics in Clinical Nutrition, 23*, 23–31.

Schreck, K. A., & Williams, K. (2006). Food preferences and factors influencing food selectivity for children with autism spectrum disorders. *Research in Developmental Disabilities, 27*, 353–363.

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*, 433–438.

Sparrow, S. S., Balla, D. A., & Cicchetti, D. V. (1984). *Vineland adaptive behavior scales*. Circle Pines, MN: American Guidelines Services.

Suarez, M. A., Nelson, N. W., & Curtis, A. B. (2013). Longitudinal follow-up of factors associated with food selectivity in children with autism spectrum. *Autism: The International Journal of Research and Practice*.

Valicenti-McDermott, M. D., McVicar, K., Cohen, H. J., Wershil, B. K., & Shinnar, S. (2008). Gastrointestinal symptoms in children with an autism spectrum disorder and language regression. *Pediatric Neurology, 39*, 392–398.

Whitehouse, A. J., Maybery, M., Wray, J. A., & Hickey, M. (2001). No association between early gastrointestinal problems and autistic-like traits in the general population. *Developmental Medicine and Child Neurology, 53*, 457–462.

Whiteley, P., Rodgers, J., & Shattock, P. (2000). Feeding patterns in autism. *Autism: The International Journal of Research and Practice, 4*, 207–211.

Williams, K., Gibbons, B. G., & Schreck, K. A. (2005). Comparing selective eaters with and without developmental disabilities. *Journal of Developmental and Physical Disabilities, 17*, 299–309.

Williams, P. G., Dalrymple, N., & Neal, J. (2000). Eating habits of children with autism. *Pediatric Nursing, 26*, 259–264.

World Health Organization. (2010). International Classification of Diseases (ICD).

Xia, W., Zhou, Y., Sun, C., Wang, J., & Wu, L. (2010). A preliminary study on nutritional status and intake in Chinese children with autism. *European Journal of Pediatrics, 169*, 1201–1206.

Zuddas, A., Di Martino, A., Delitala, L., Anchisi, L., & Melis, E. G. (2010). J. N. Constantino & C. P. Gruber (Eds.), *Social responsiveness scale SRS*. Firenze: Giunti-Organizzazioni Speciali. (adattamento Italiano a cura di).