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A Preliminary Study of Self-Reported Food Selectivity in Adolescents and Young Adults with Autism Spectrum Disorder

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Abstract

Although it is well-established that picky eating is a common feature of early development in autism spectrum disorder (ASD), far less is known about food selectivity during adolescence and adulthood. Using portions of the Adult/Adolescent Sensory Profile, food selectivity self-ratings were obtained from 65 high-functioning adolescents/young adults with ASD and compared to those of 59 typically developing controls matched on age, IQ, and sex ratio. Individuals with ASD reported preferring familiar foods (food neophobia) and disliking foods with particular textures and strong flavors. Providing linkage to everyday behavior, parent ratings of daily living skills were lower among individuals with ASD and food neophobia than among those without food neophobia. Food selectivity continues to be an important issue for adolescents/young adults with ASD.

Keywords

autism; food; taste; sensory; adolescent; adult

Picky eating is a common problem in children with autism spectrum disorder (ASD) apparent across age groups and intellectual ability levels (Williams, Gibbons, & Schreck, 2005; Schreck, Williams & Smith, 2004; Ahearn, Castine, Nault, & Green, 2001; Fodstad & Matson, 2008; Zimmer, Hart, Manning-Courtney, Murray, et al., 2011; Bandini, Anderson, Curtin, Cermak, et al., 2010; Kozlowski, Matson, Belva, & Rieske, 2012; for a review see Ledford & Gast, 2006; Cermak, Curtin, & Bandini, 2010; Sharp, Berry, McCracken, Nuhu,

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et al., 2013). Historically, atypical eating was so common in children with ASD that it was considered a criterion for diagnosis (Ritvo & Freeman, 1978). Eating is a complex behavior that relies on skills and functions that are often challenging for children with ASD (reviewed in Twachtman-Reilly, Amaral, & Zebrowski, 2008). Development of food preferences and diet variety requires repeated exposure to novel foods, along with processing the similarities and differences of items within a food group or category (e.g., cheese varies widely in color, flavor, and form). Mealtime is also inherently variable, with most people regularly changing menus, utensils and dishes, and eating environments. Difficulties with managing novelty (Spratt, Nicholas, Brady, Carpenter, et al., 2012; Maes, Eling, Wezenberg, Vissers, et al., 2011), prototype formation and generalization (Klinger & Dawson, 2001; Gastgeb, Dundas, Minshew, & Strauss; 2012), and behavioral inflexibility and a need for sameness (Yerys, Wallace, Harrison, Celano, et al., 2009; D'Cruz, Ragozzino, Mosconi, Shrestha, et al., 2013; South, Ozonoff, & McMahon, 2007; Reed, Watts, & Truzoli, 2011) prime children with ASD to have feeding challenges. Sensory processing differences (Ben-Sasson, Hen, Fluss, Cermak, et al., 2009; Lane, Young, Baker, & Angley, 2010), oral motor impairments, (Dowell, Mahone, & Mostofsky, 2009; Dziuk, Gidley Larson, Apostu, Mahone et al., 2007), fine motor impairments (Green, Charman, Pickles, Chandler et al., 2009; Barron-Linnankoski, Reinval, Lahervuori, Voutilainen, et al., 2014), and gastrointestinal problems (Kang, Wagner, & Ming, 2014; Coury, Ashwood, Fasano, Fuchs, et al., 2012; McElhanon, McCracken, Karpen, & Sharp, 2014) common in individuals ASD may also contribute to feeding challenges.

Neurologically, taste processing involves a complex network involving portions of the brainstem, thalamus, and multiple cortical regions, most crucially, the mid-insula and surrounding operculum. The insula and overlying operculum are classified as primary gustatory cortex, based on many non-human primate single/multi-neuron recording and tract-tracing investigations, as well as human functional neuroimaging studies (Rolls, 2006; Yaxley, Rolls, & Sienkiewicz, 1990; Baylis, Rolls, & Baylis, 1995; O'Doherty, Rolls, Francis, & Bowtell, 2001). fMRI studies indicate that brain activity within the insula is correlated with the subjective intensity of taste and is likely the critical region involved in taste identification (Grabenhorst, Rolls, & Bilderbeck, 2008).. Likewise the same regions of the insula that are involved in taste are also implicated in oral texture processing (deAruajo & Rolls, 2004; Verhagen, Kadohisa, & Rolls, 2004.). To date, only one food-related fMRI study has been completed in a sample of individuals with ASD (Cascio, Foss-Feig, Heacock, Newsom, et al., 2012). Compared to matched controls, the ASD group exhibited greater activity to food pictures in bilateral mid-insula (Cascio et al., 2012), the same region shown in earlier studies to be both primary gustatory cortex and a center for oral texture processing (Verhagen, Kadohisa, Rolls, 2004).

While picky eating is common in neurotypical development between 2 and 6 years (Birch, 1999), food selectivity in ASD does not necessarily resolve in these early years. Severity of food selectivity appears to decrease across childhood in ASD (Beighley, Matson, Rieske, & Adams, 2013), however several studies suggest that symptoms may persist into adulthood (Fodstad & Matson, 2008). The majority of research on food selectivity in ASD has focused on early childhood and primary school age children. Some studies documenting increased food selectivity in ASD have included adolescent participants (e.g., Beighley, Matson,

Rieske, & Adams, 2013; Collins, Kyle, Smith, Lavery, et al., 2003; Matson et al., 2009), but mean ages across groups are primary school age or younger.

Prior research broadly related to food selectivity and associated symptoms in adults with ASD has generally focused on broad sensory functioning or olfactory or taste processing via laboratory tasks. For example, Crane and colleagues (2009) utilized the Adult/Adolescent Sensory Profile to obtain self-ratings of overall sensory functioning among 18 adults with ASD and 18 matched controls. These investigators found that the overwhelming majority of participants with ASD reported at least some examples of extreme levels of sensory sensitivity. However, it should be noted that data were collapsed across sensory modalities (e.g., taste/smell vs. vision vs. audition), rather than examining modality-specific abnormalities; thus, food-related atypicalities specifically were not reported. Using laboratory-based tasks, Tavassoli and Baron-Cohen (2012a) found comparable olfactory detection thresholds among 38 adults with ASD compared to 42 matched controls in one study but documented lower taste identification scores for 23 adults with ASD compared to 26 matched controls in a separate investigation (Tavassoli & Baron-Cohen, 2012b). Finally, Damiano and colleagues (2014) recently showed equivalent sweet taste sensitivity and preferences for sweet tastes between 20 adults with ASD and 38 matched controls. The adults' ASD symptom severity was associated with sweet taste sensitivity (i.e., greater symptoms related to lower sensitivity), but not with sweet taste hedonic responses.

Although evidence of differences in laboratory tests of sensory sensitivity is important, it remains unclear how these findings relate to real-world eating behaviors. One previous study by Fodstad and Matson (2008) examined general feeding and mealtime behavior in a sample of 30 adults with ASD and intellectual disability (ID) and 30 adults with ID alone (age range 18–69) using the Screening Tool of Feeding Problems (STEP). Adults with both ASD and ID demonstrated more feeding difficulties than the adults with ID alone, particularly with respect to behaviorally based food selectivity and refusal. At present, to the author's knowledge, there are no extant published findings addressing aberrant eating in young adults with ASD without ID or the relationship of eating problems to adaptive behavior or daily living skills in this age group (see Lane et al., 2010 for associations between taste sensitivity and adaptive functioning in children with ASD). The present study focuses on self-ratings of these issues in a relatively large sample of adolescents and young adults with ASD compared to neurotypical adolescents and young adults. Secondary analyses from a broader study examining brain and behavioral functioning in ASD contributes to first steps toward examining food selectivity in older adolescents and young adults with ASD. Using items from the *Adult/Adolescent Sensory Profile* (AASP; Brown & Dunn, 2002) as a measure of convenience, we hypothesized that self-rated food selectivity would still be evident in this older age range of the ASD population and that these food-related issues would be negatively correlated with parent ratings of adaptive behavior skills, suggesting ongoing real-world impact.

Methods

Participants

Participants included 65 adolescents/young adults with ASD (12–28 years) and 59 adolescents/young adults with neurotypical development (12–23 years) recruited from the Washington, DC metropolitan area. All 65 participants with ASD met Diagnostic and Statistical Manual of Mental Disorders-5 diagnostic criteria as assessed by an experienced clinician. ASD diagnoses were confirmed with the Autism Diagnostic Observation Schedule (Lord et al., 2000) and the Autism Diagnostic Inventory (Le Couteur et al., 1989) or Autism Diagnostic Inventory-Revised (Lord et al., 1994), administered by clinicians trained to research reliability. All ASD participants' scores met cut-off for the category designated as 'Broad ASD' according to criteria established by the NICHD/NIDCD Collaborative Programs for Excellence in Autism (CPEA; see Lainhart et al., 2006). Because the Autism Diagnostic Interview and Autism Diagnostic Observation Schedule do not provide an algorithm for Asperger's syndrome, Lainhart et al. (2006) developed criteria that include an individual on the broad autism spectrum if s/he meets the Autism Diagnostic Interview cut-off for 'autism' in the social domain and at least one other domain or meets the Autism Diagnostic Observation Schedule cut-off for the combined social and communication score. Exclusion criteria for the ASD group included any known comorbid medical, genetic, or neurological disorder that may affect cognitive functioning (e.g., Fragile X syndrome or Tourette syndrome). Parents of typically developing adolescents and neurotypical adults themselves underwent telephone screenings to insure that inclusionary and exclusionary criteria were met. Neurotypical individuals were excluded from participation if they had ever received mental health treatment for anxiety, depression, or any other psychiatric condition, taken psychiatric medications, required special services in school, been diagnosed with a genetic, neurodevelopmental, or neurological disorder, or had brain trauma/injury that could potentially affect cognitive functioning. IQ scores were obtained from all participants. All Full Scale IQ scores were 75 or above, as measured by the Wechsler Abbreviated Scale of Intelligence. Groups did not differ in terms of age, Wechsler Abbreviated Scale of Intelligence Full Scale IQ, sex ratio, or socioeconomic status (see Table 1 for demographics).

Procedures

Participants completed the self-report *Adult/Adolescent Sensory Profile* (AASP; Brown & Dunn, 2002). Items from the Taste/Smell modality section and the Touch modality section were analyzed for contributing components to food selectivity (i.e., food neophobia and reactivity to food textures and strong tastes). Analyses evaluated Food Neophobia status based on participants' response (scoring 1–5: 1=much less than most people, 2=less than most people, 3=similar to most people, 4=more than most people, 5=much more than most people) to the item, "I only eat familiar foods." Because self-ratings of a 4 or 5 on this item indicated an unwillingness to eat unfamiliar foods at rates greater than most people, these responses were labeled as "neophobic" while those rated as a 1 or 2 on this item were considered "non-neophobic." Participants with ratings of 3 were deemed neutral on the measure of neophobia and excluded from this analysis. Additional items were analyzed to characterize response to Food Textures ("I don't like particular food textures [i.e., peaches

with skin, applesauce, cottage cheese, chunky peanut butter”]) and general Taste Seeking/Avoiding behavior (composite of “I add spice to my food” and “I don’t like strong tasting mints or candies”). The AASP provides four quadrant scores (Sensation Seeking=high thresholds and active responding; Low Registration=high thresholds and passive responding; Sensation Avoidance=low thresholds and active responding; Sensation Sensitivity=low thresholds and passive responding), which represent the various combinations of sensory threshold (high vs. low) and responding strategy (active vs. passive). To evaluate the specificity of the food selectivity responses above and beyond more global sensory function, the accompanying quadrant score to which these items contributed was used as a covariate (with the above food-related items removed) in follow-up analyses. Sensory Sensitivity was used as a covariate for the Food Textures analysis, and both Sensory Sensitivity and Sensory Seeking were used as covariates for Taste Seeking/Avoiding. Finally, parents of individuals with ASD independently completed the Adaptive Behavior Assessment System-II (ABAS-II), providing a well-validated and highly reliable measure of adaptive functioning (Harrison & Oakland, 2000) often used in studies of ASD (e.g., Kenworthy, Case, Harms, Martin, et al., 2010). The ABAS-II provides composite scores for Practical/Daily Living Skills, Social Skills, and Conceptual/Communication Skills that in this study were compared between the food neophobic and non-neophobic individuals to assess the real-world impacts of food neophobia.

Data Analysis

The proportions of individuals self-rated as food neophobic were compared between the ASD and neurotypical groups using Chi-square analyses. Analysis of variance was used to assess ASD-neurotypical group differences in self-ratings of response to food textures and general taste seeking/avoiding behavior. The same domains were compared between groups using analysis of covariance, but included the superordinate sensory quadrant (i.e., Sensory Sensitivity for food textures and both Sensory Sensitivity and Sensory Seeking for general taste seeking/avoiding) as covariates. Finally, within the ASD group, analysis of variance was used to examine differences in parent ratings of adaptive behavior skills among food neophobic vs. non-neophobic individuals.

Results

Adolescents and young adults with ASD were more likely to be classified as food neophobic or afraid of eating new/unfamiliar foods when compared to their matched typically developing peers ($\chi^2=6.51$, $p<.001$; see Figure 1). The adolescents and young adults with ASD were also more likely to report disliking textured foods, such as applesauce, cottage cheese, or chunky peanut butter ($F=24.4$, $p<.001$, $\eta^2=.17$; see Figure 2). This group difference remained significant after controlling for global sensory sensitivity ($F=13.5$, $p<.001$, $\eta^2=.10$). Finally, the ASD group was less likely to enjoy strong tastes, such as spices in foods or strong mints/candies ($F=8.3$, $p<.005$, $\eta^2=.06$). This group difference remained significant when controlling for global sensory sensitivity ($F=6.3$, $p=.01$, $\eta^2=.05$), but appeared to be accounted for by more generally diminished sensory seeking behaviors that cut across sensory modalities (*ns*). Finally, individuals with ASD classified as food neophobic above received significantly lower parent ratings of daily living skills on the

ABAS-II ($M=73.67$, $SD=15.85$) than those who were considered non-neophobic ($M=84.29$, $SD=16.60$; $t=2.25$, $p=.03$), while no differences emerged in the domains of adaptive social and communication skills (*ns*).

Discussion

Adolescents and young adults with ASD reported preferences for familiar foods and dislikes for foods with particular textures and strong tastes. Globally lower sensory seeking behaviors may partially explain preference for milder foods, but do not account for the dislike of textured foods. There appears to be something uniquely unpleasant about food textures for young people with ASD. At present we can only speculate about the cause of this phenomena, but it is worth noting that the Facial (VII) and Glossopharyngeal (IX) cranial nerves carrying taste and food texture information project, via dedicated brain stem and thalamic pathways, to the insula (Craig, 2002), a region that has been implicated in the neural pathophysiology of ASD (Uddin & Menon, 2009). Finally, there appears to be a link between food neophobia and daily living skills among adolescents and young adults with ASD.

The evidence of food selectivity in this adolescent/young adult sample suggests an atypical or deviant developmental trajectory for food selectivity in ASD. Picky eating does not resolve in childhood for individuals with ASD as would be expected in neurotypical development (Birch, 1999). Although it is unclear whether food selectivity is associated with macro/micronutrient insufficiency in childhood (Hyman, Stewart, Schmidt, Cain, et al., 2012; Raiten & Massaro, 1986; Levy, Souders, Ittenbach, Giarelli et al., 2007; Herndon, DiGuseppi, Johnson, Leiferman, et al., 2009; Johnson, Handen, Mayer-Costa, & Sacco, 2008; for a review, see Mari-Bauset, Zazpe, Mari-Sanchis, Llopis-Gonzalez, et al., 2015), these data highlight that possible nutritional insufficiency may remain a concern beyond early development in ASD as limited diets persist into adolescence and young adulthood.

Downstream social consequences also arise as picky eating may limit potential outings with friends and opportunities for advancement of daily living skills. Our data support this contention as adolescents/adults with ASD who self-rated as food neophobic received lower parent ratings of daily living skills than non-neophobic individuals. It is possible that food neophobia is one manifestation of broader anxiety or difficulties with novelty, so these individuals will also struggle with new situations in daily life (e.g., paying a store clerk for a purchased item). However, there may also be another factor, such as behavioral inflexibility, which is strongly associated with ASD (Granader, Wallace, Hardy, Yerys, et al., 2014; Yerys et al., 2009; D'Cruz et al., 2013; South et al., 2007; Reed et al., 2011) that mediates the observed correlation between food neophobia and lower daily living skills. Future research should seek to elucidate this potential connection.

Results highlight the need for effective intervention strategies for treating food selectivity in this older group of individuals with higher functioning ASD. To date, food selectivity issues in ASD have been addressed by taking a behaviorist perspective; however, given that these difficulties remain in older, higher functioning individuals as found here, more cognitive or cognitive-behavioral approaches to intervention may be warranted and prove more effective

(e.g., The BUFFET Program; Kuschner, deMarchena, Maddox, Morton, et al., 2015). There is already a high risk for weight gain and unhealthy eating in typical teenagers transitioning into young adulthood (Kann et al., 2014). This risk is likely even higher for individuals with ASD during this life stage. In fact, a recent CDC study of nearly 10,000 adolescents suggests that obesity rates in ASD are higher relative to those found among not only their same age typically developing peers, but also same age peers with other forms of developmental disability (Phillips et al., 2014).

Although these data offer the first look at food selectivity in adults with ASD who are able to reliably self-report their symptoms, they also highlight the need for use of more specific food selectivity assessment tools to measure this domain in adults with ASD. Subsequent studies should utilize tools emerging as clearer, operationalized measurements of food selectivity (e.g., Bandini et al., 2010). Reliance on just a few food/taste-related items from an instrument assessing broad sensory functioning is a clear limitation of the study. Collection of parent/caregiver (or roommate, spouse, close friend, etc.) report would also allow for measurement of convergent validity of reporting on these symptoms. Other aspects of food selectivity (e.g., idiosyncratic eating routines, insistence on sameness in eating utensils, brand selectivity) and food preferences remain unexplored in this older age range in ASD, as does the overall health impact of these abnormal feeding behaviors. Moreover, exploration of these symptoms in a wider age range of adults will help to characterize the adult developmental course of atypical eating in ASD.

With the notable increase in prevalence of ASD (Wingate et al., 2014) and the transition of generations of children with ASD into adulthood, there is a prominent need for independent and healthy daily living skills. As transition programs design curricula to provide skill building around food shopping and meal preparation, food selectivity and food neophobia should be assessed and addressed. Future research should explore treatment options for food neophobia in adults with ASD. Direct intervention via food exposure is likely to be effective; however, similar (or even better) outcomes may result from also targeting associated impairments contributing to food neophobia (e.g., behavioral inflexibility, anxiety and novelty management, sensory processing impairments, gastrointestinal problems)

In summary, the present study complements the existing literature by demonstrating that just as broader sensory processing difficulties are not confined to early development, but persist into adulthood (e.g., Crane et al., 2009), so too are food selectivity issues. Moreover, these issues appear to be linked to important measures of outcome, such as daily living skills, as rated independently by parents. Much more work is needed in this area to determine mechanisms underlying these food selectivity issues and their links to poor health outcomes, such as obesity and all of its concomitant risks.

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Highlights

- We examine self-reports of food selectivity in adolescents/adults with autism spectrum disorder.
- Adolescents/adults with autism spectrum disorder report preferring familiar foods.
- They also report disliking foods with particular textures and strong flavors.
- Lower daily living skills ratings correlate with self-reports of preferring familiar foods.
- Food selectivity is an important issue in adolescence/adulthood in autism spectrum disorder.

Figure 1. Self-rating of being (un)afraid of eating new/unfamiliar foods (i.e., food neophobia status) among participants in the Autism Spectrum Disorder (ASD) and Typically Developing (TD) groups.

Figure 2. Self-ratings of dislike for textured foods (on a 0–5 scale) among participants in the Autism Spectrum Disorder (ASD) and Typically Developing (TD) groups.

Table 1

Participant Demographics.

	Autism Spectrum Disorder Group (n=65) <i>M (SD)</i>	Typically Developing Group (n=59) <i>M (SD)</i>	<i>p</i>
Chronological Age (years)	16.3 (3.1)	17.3 (2.8)	.07
VIQ	109.8 (17.0)	112.6 (12.3)	.30
PIQ	108.0 (14.3)	112.6 (11.2)	.05
FSIQ	110.4 (15.5)	114.4 (10.9)	.11
Sex Ratio (M:F)	58:7	54:5	.67
Socioeconomic Status *	38.44	43.15	.25

* available for 61 individuals in the Autism Spectrum Disorder group and 51 individuals in the Typically Developing group