Running title: Avoidant Food Behaviours in adults with Tourette syndrome

A comparison of food avoidant behaviours and sensory sensitivity in adults with and without Tourette syndrome

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Abstract

Food selectivity has been shown to be more persistent and severe in children with Tourette syndrome (TS) compared to their typically developing peers. The current study aimed to examine differences in food selectivity, food neophobia and avoidant restrictive intake disorder associated behaviours, between adults with and without TS. Fifty-three adults diagnosed with TS were compared to 53 neurotypical adults and completed the following measures online: Adult Eating Behaviour Questionnaire (AEBQ), Nine-Item Avoidant/Restrictive Food Intake disorder screen (NIAS), Food Neophobia Scale (FNS) and the Sensory Perception Quotient (SPQ). Higher levels of food avoidant behaviours, in terms of food fussiness, food neophobia and Avoidant Restrictive Food Intake Disorder (ARFID)-associated behaviours, were identified in adults with TS compared to adults without TS. While heightened sensory sensitivity failed to predict selective eating, greater sensitivity to taste was found to be predictive of food neophobia in TS. These are the first findings to suggest that food avoidant behaviours are more prevalent for adults with TS and signal a need to address health implications.

Keywords: Tourette syndrome; adulthood; food neophobia; food selectivity; sensory sensitivity

1. Introduction

Tourette syndrome (TS) is a neurodevelopmental disorder characterised by non-rhythmic, repetitive, and involuntary movements and vocalisations, termed motor and phonic tics respectively. TS incorporates a spectrum of severity with tics ranging in form, frequency, complexity and intensity (Cavanna et al., 2017). Tics must be present for at least one year for an individual to receive a diagnosis of TS (American Psychiatric Association, 2013).

Amongst the effects TS may have on an individual's everyday life, there is a growing body of research suggesting that individuals with TS may have a range of feeding-related difficulties (Ludlow & Rogers, 2017). Anecdotal evidence from online forums contains first-hand accounts of challenges people with tics experience when eating. For example, tics were noted to inhibit a person's ability to eat through the upper limb and throwing tics. As tics can worsen throughout the day, parents have been reported to have earlier mealtimes to accommodate these tics (Ludlow, Brown & Schulz, 2018).

Individuals with TS have been suggested to be prone to unhealthier diets, favouring more energy dense food as adults (Liang, Sun, Ma, & Liu, 2015), and less preference for fruit and vegetables in children with TS compared to those without TS (Smith, Rogers, Blissett & Ludlow, 2019). The lack of a balanced and varied diet consumed by individuals with TS may also contribute to the increased levels of supplements being given to these children, including vitamin B and C (Mantel, Meyers, Tran, Rogers, & Jacobson, 2004). Despite anecdotal reports suggesting that eating behaviours are a substantial concern in individuals with TS, there is no empirical evidence comparing eating behaviours between adults with and without TS (Ludlow & Rogers, 2017). The current study investigates differences in food selectivity, food neophobia and avoidant restrictive food intake disorders associated behaviours between adults with and without TS and determines whether sensory sensitivity is a predictor of avoidant food behaviours. The term food avoidance will refer to all of the behaviours and strategies that an adult might use to not eat the food presented to them.

1.1 Food fussiness, food neophobia and restrictive eating

Food selectivity, also termed food fussiness and selective eating, can be defined as consuming “an inadequate variety of foods” (Galloway, Fiorito, Lee & Birch, 2005; p.542). In addition to the types of food, food selectivity can also encompass inadequate amount of food consumed (Rydell, Dahl, & Sundelin, 1995), as well as the rejection of certain food textures (Smith et al., 2005). Food neophobia has generally been defined as the reluctance and/or avoidance to try new foods (Dovey, 2008), and in contrast to food selectivity, only occurs before the tasting phase (Brown, 2010). Furthermore, food neophobia has sometimes been considered a subset of selective eating, largely due to the rejection of foods being focused on those that are novel and unfamiliar, whereas selective eating can include a larger proportion of foods, both those familiar and unfamiliar (Potts &Wardle, 1998, Raudenbush & Frank,1995).

Food selectivity and food neophobia are considered in the literature as similar but distinct restricted eating phenotypes (Hunot et al., 2016). For example, research has suggested that both phenotypes have a strong genetic basis in the early years (72-78%; Cooke et al., 2007; Faith et al., 2013) and a shared aetiology (Smith et al., 2017). Furthermore, both food selectivity and food neophobia are aspects of a wider eating behaviour, namely food avoidance, which encompasses all movements an individual makes away from food.

Importantly, food selectivity has also been considered to be the subclinical level of Avoidant/Restrictive Food Intake Disorder (ARFID), with a recent study finding 35.5% of participants with AFRID to show characteristics of selective eating (Kauer. Pelchat, Rozin, Zickgraf (2015). AFRID, previously referred to as a selective eating disorder, is defined simply as "the avoidance or restriction of food intake manifested by clinically significant failure to meet requirements for nutrition or insufficient energy intake through oral intake of food" (DSM-5, 2013 p.334). It is also characterised by a lack of interest in food, its avoidance based on sensory properties and concern about the negative consequences of eating (American Psychiatric Association, 2013). The stability of food avoidance overtime has been argued as being crucial to differentiating food neophobia and food selectivity from ARFID (Dovey, 2018). Moreover, it has even suggested that these three concepts exist on a continuum, with developmental food neophobia on one end of the spectrum and ARFID at the other more severe end (Dovey, 2018).

1.2. Implications

There are several adverse consequences associated with food avoidant behaviours in terms of diet, weight and wellbeing. Adults self-identified as selective eaters were more likely to report consuming an unhealthy diet, have greater food neophobia and reject food based on sensory characteristics, compared to adults self-identified as non-selective eaters (Kauer et al., 2015). This is an important finding as patterns and negative consequences associated with anomalous eating behaviours in adults are likely to be largely consistent with those found in children, including unhealthy weight status and nutritional deficiencies. For example, some behaviours such as food selectivity can limit the variety of an individual's diet and reduce their preference for fruit and vegetables, which ultimately leads to adverse consequences in terms of nutritional deficiencies (Fildes et al., 2015; Galloway et al., 2005). In adults, higher food neophobia has been associated with reduced preference for the act of eating fruit and vegetables (Costa et al., 2020). Research has shown that severe levels of food selectivity in adulthood to be associated with less enjoyment of eating (Kauer et al., 2015), and greater impairment in quality of life related to eating (Wildes et al., 2012).

Eating behaviours where the individual makes actions to avoid or restrict food are generally associated with weight loss or slower growth development (Sleddens et al., 2008; Webber et al., 2009; Fernandez et al., 2020), with AFRID associated with more chronic than acute weight loss compared to those diagnosed with anorexia nervosa (Keery et al., 2019). Furthermore, the nutritional risks associated with rigorous adherence to eliminations diets have also been well documented (refs)

Food selectivity is not currently recognised as a clinical concern (Kerzner et al., 2015) although this has been disputed amongst health professionals (McCormick & Markowitz, 2013). Despite the suggestion that food selectivity and similar eating behaviours are transient and are outgrown during childhood (Cano et al., 2015), emerging research does suggest that food selectivity may be a stable appetitive trait with adverse consequences for a subgroup of individuals (Pesch et al., 2020). For example, if food selectivity is left untreated for a period of time it being more likely to contribute to subclinical levels of eating behaviours and/or even ARFID (Zickgraf et al., 2020). Equally, ARFID is now recognised as not solely being a childhood condition but is also commonly observed in adults (Gupta, 2021).

1.3 Why would adults with TS be at heightened risk for food-avoidant behaviours?

Neurodivergent individuals may be a group at particular risk from showing behaviours associated with food avoidance and food rejection. For example, research has shown high levels of food neophobia in Autism Spectrum Disorder (ASD; Yolanda Martins et al., 2008) and Attention Deficit Hyperactivity Disorder (ADHD) during childhood (Mayes & Zickgraf, 2019). There is also a high prevalence of neurodivergent children with AFRID. Specifically, co-occurring rates of ADHD have ranged from 4% (Nicely et al., 2014) to 26% (Duncombe Lowe et al., 2019) and co-occurring rates of ASD from 3% (Lieberman et al., 2019) to 13% (Nicely et al., 2014). Food avoidant behaviours are also frequently reported across the lifespan in adults with neurodivergent conditions. For example, food selectivity has been reported in adults with ADHD and ASD (Matson & Fodstad, 2009), with adults with ASD less likely to try novel food (Kuschner et al., 2015).

Despite clear differences in core symptomology, population-based twin studies have suggested shared genetic aetiology between ASD, tic disorders and ADHD (Lichtenstein et al., 2010). These disorders have also been recognised as sharing many overlapping features, in addition to being highly comorbid with each other, for example, ADHD is diagnosed in 60% of individuals with TS (Freeman et al., 2000). Recent studies have also documented that TS is comorbid with ASD (Cath & Ludolph, 2013), with research showing the presence of autistic symptoms in two-thirds of individuals with TS (Kadesjö & Gillberg, 2000).

In comparison to ASD and ADHD, there has been minimum research exploring food avoidant behaviours in individuals with TS. Recent research has identified children with TS to show higher levels of selective eating compared to typically developing (TD) children, which has been found not to be explained by their comorbidity with ASD and ADHD (Smith et al., 2019, 2020). In addition, children with TS have been shown to be more likely to take nutritional supplements including probiotics, omega-3, multivitamins and magnesium, with the majority taking two or more. More recently, caregivers reported their children with TS to be currently and/or had previously adopted a special diet (Smith & Ludlow, 2021). This is important as food avoidant eating behaviours such as those associated with AFRID can be associated with significant nutritional deficiencies, dependence on nutritional supplements and/or significant weight loss (Dovey, 2018).

Only one study to date has looked at eating in adults with TS. A dietary recall study in adults with TS revealed higher consumption of carbohydrates and fats than the recommended guidelines. Over half of the adults surveyed reported consuming low levels of zinc, vitamin C, protein, calcium and thiamine (Liang et al., 2015). These findings suggest that unhealthier diets may be consumed by adults with TS compared to adults without TS, meaning future research needs to understand eating behaviours as a viable method to encourage healthier dietary consumption.

1.4 Can food avoidant behaviours be explained by sensory sensitivity?

Sensory sensitivity can be seen as a spectrum from hyposensitivity to hypersensitivity. Hyposensitivity is categorised as an under-response to sensory stimuli and individuals with hypersensitivity show an over-response in terms of speed, intensity and duration of response to sensory stimuli (Miller et al., 2007). While over-responsiveness to stimuli may result in more selective eating, whereas under-responsiveness to stimuli which may result in a desire for more sweet, salty or fatty foods (Martins & Pliner, 2005). Both sensory processing issues have been shown to limit the range of food consumed and the social enjoyment of eating (Johnson et al., 2014). Furthermore, sensory sensitivities have been strongly associated with food neophobia (Coulthard & Blissett, 2009) and selective eating (Nederkoorn et al., 2015). Furthermore, the food choices of children who are sensory sensitivity have been shown to similar to those ARFID, including low variability in diet, intolerance of textures and avoidant behaviours (Smith et al., 2005). Thus, there is a strong link between the three similar constructs around food avoidance and sensory sensitivity

Furthermore, severity in the sensory sensitivity profile has been shown to contribute to both current and lifetime likelihood of a neurodivergent condition and highlight some of the overlapping shared features with AFRID (Kambanis et al., 2020). For example, sensory sensitivity has been found to underlie high levels of food selectivity and food preferences identified in children with TS (Smith et al., 2020) and children with ASD and ADHD (Ghanizadeh, 2011; Lane et al., 2010; Simpson et al., 2019) as well as also predicting food selectivity and food neophobia in other neurodivergent adults (Kinnaird et al., 2019). Importantly sensory symptoms can remain prominent throughout the life course (Isaacs & Riordan, 2020).

At least 80% of individuals with TS reported heightened perception of sensory stimuli (Belluscio et al., 2011; Isaacs & Riordan, 2020). However, while higher levels of sensory sensitivity have been reported in adults with TS (Cheng et al., 2017). Greater sensitivity to sensory stimuli has also been suggested to be partly accountable for why children with TS may be more likely to be selective eaters (Smith et al., 2019; 2020). However, the research in this area does not consider this potential relationship in adults with TS.

The aims of the current study were: 1) To determine whether adults with TS show differences in 3 food avoidant associated behaviours that have been suggested as being part of a continuum (Dovey, 2018), food selectivity, food neophobia, and avoidant restrictive intake behaviours, compared to a group of neurotypical adults. 2) To address whether differences in food avoidant behaviours could be explained by sensory sensitivity. Given the research highlighting food avoidant behaviours to commonly occur in adults with other comorbid neurodevelopmental disorders (e.g., Matson & Fodstad, 2009; Kuschner et al., 2015), it was expected that adults with TS would also show a higher level of food avoidant behaviours. Furthermore, research has shown a relationship to be established between sensory sensitivity, food neophobia and food selectivity in neurotypical and neurodivergent children and adults (Martins & Pliner, 2005; Kinnaird et al., 2019), and that greater sensitivity to taste/smell may account for why neurodivergent children are more likely to be selective eaters (Smith et al., 2020). Therefore, it was hypothesised that adults with TS would not only show heightened sensory sensitivity, but it would be a predictor of some of the food avoidance behaviours in the TS group.

2. Method

2.1 Participants and procedure

Ethical approval for this research was obtained from the University of Hertfordshire University Ethical Advisory Committee Protocol Number: LMS/PGR/UH/03968 and the research was performed in accordance with the Declaration of Helsinki. Two online links were created, and the participant clicked on the relevant link based on whether they had a diagnosis of TS. Upon opening the link, the participant learnt about the study via an online participant information sheet, and once participants signed a consent form, they were given access to the online survey. A community sample of participants with TS was recruited through Tourette's Action charity online website in addition to online forums and local organisations who agreed to advertise the study.

Fifty-three adults diagnosed with TS, 17 males, 33 females, 2 prefer to self-describe (they, agender), with ages between 18 and 65 years (*M* = 35.58; *SD* = 14.02) were included in the study. Self-report of diagnosis and the Premonitory Urge for Tic Scale (PUTS; Woods et al., 2005) were used to assess diagnosis in the TS group only. This measure reflects the presence and frequency of premonitory urges, along with the relief that may be experienced after tics have been performed. A score above 31 indicates extremely high intensity with probable severe impairments. In the current sample, scores ranged from 11 to 34, and the age of TS diagnosis ranged from 4 to 50 years. On average, adults with TS scored 26 (*SD* = 5.88) on tic severity, as measured by the PUTS. One participant was categorised as low intensity, twenty adults categorised as medium intensity and 11 as extremely high intensity with probable severe impairments. Eight adults reported having an additional comorbid diagnosis, four with an Obsessive-Compulsive Disorder diagnosis, three with ADHD and one with ASD. Of the adults with TS taking medication (*N* = 30), the most reported were sertraline (*N* = 4) and clonidine (*N* = 4), Quetiapine (*N* = 2), Fluoxetine (*N* =2), Venlafaxine (*N* =2).

Data were compared to 53 adults without a developmental or an eating disorder, determined through self-report, (9 males, 44 females) and between the ages of 18 and 68 years (*M* =31.12; *SD* = 13.89). None of the neurotypical adults reported having any known clinical diagnosis. Participants were recruited from local universities and social media forums. The questionnaires were presented in the same order to each participant and took approximately 25 minutes to complete. The questionnaire remained active for three months and participants volunteered to take part. At the end of the study, participants were provided with details of where to seek information and support for any concerns around eating and were also reminded how they could withdraw their data from the study.

2.2 Measures

Demographic variables were collected first and included: adult's gender, birth date, ethnicity, any clinical diagnosis including comorbid disorders, frequency of exercise and alcohol consumption. BMI was calculated from self-reported height and weight (kg/m2). Finally, all adults were asked to complete the following questionnaires:

2.2.1 Adult Eating Behaviour Questionnaire (AEBQ; Hunot et al., 2016)

The 'food fussiness' subscale from the AEBQ was used to assess adult's food selectivity behaviour. Participants rated the frequency of which they exhibit the behaviour on a 5-point Likert scale ranging from 1 (never) to 5 (always). The higher the score demonstrates the greater the expression of the given behaviour. Development of the questionnaire revealed good internal reliability coefficients (Cronbach's alpha) for all the subscales, ranging from .75 to .90 (Hunot et al., 2016). In the present study, the Cronbach's alpha ranged from .69 to .91.

2.2.2 Nine-Item Avoidant/Restrictive Food Intake disorder screen (NIAS; Zickgraf & Ellis, 2018)

The NIAS is a 9-item scale developed as a screening tool for potentially problematic eating, specifically ARFID-associated eating behaviours. This screen measures patterns of ARFID through three subscales, namely picky eating due to sensory properties, fear of negative consequences of eating and poor appetite. Participants rated their agreement with the statements on a 6-point Likert scale, ranging from 0 (strongly disagree) to 5 (strongly agree). Total scores are calculated with a maximum possible score of 15 for each subscale and an overall score of 45, with higher scores indicating higher expression of ARFID. Development of the screening tool revealed good internal reliability for all subscales (Cronbach alpha = .87 to .93; Zickgraf & Ellis, 2018).

2.2.3 Food Neophobia Scale (FNS; Pliner & Hobden, 1992)

The FNS is a 10-item scale designed to measure food neophobia, defined as avoidance or rejection of novel foods. Statements are rated on a 7-point Likert scale ranging from 1 (strongly agree) to 7 (strongly disagree) with a lower score indicating greater expression of food neophobia. In the current study, strong internal reliability was identified (Cronbach alpha = .93).

2.2.4 Sensory Perception Quotient (SPQ; Tavassoli et al., 2014)

The SPQ is a 38-item an adult-adapted version of the original Sensory Profile (Dunn, 1999) designed to assess adult's responses to sensory stimuli. The three sensory domains, which have previously been found to be common correlates of food fussiness, were used to assess children's tactile sensitivity (e.g., avoids going barefoot, especially in grass and sand), taste/smell sensitivity (e.g., avoids tastes or food smells that are typically part of a child's diet), and visual/auditory sensitivity (e.g., covers eyes, or squints to protect eyes from light). Participants responded to items on a 5-point Likert scale ranging from 1 (always) to 5 (never) with lower scores indicating higher sensory sensitivity. SPQ total scores can range from a minimum of 38 (greatest frequency of sensory symptoms) to 190 (no sensory symptoms). McIntosh et al., (1999) have shown good psychometric properties internal consistency of the total and subscale scores (Cronbach's alpha ranged from 0.68 to 0.92) with a discriminant validity of 95% in distinguishing individuals with and without sensory modulation difficulties. In the current study good internal reliability was found for the subscales used; tactile sensitivity (Cronbach alpha =.88), taste/smell sensitivity (Cronbach alpha =.95), visual/auditory sensitivity (Cronbach alpha =.90).

2. 4. Analysis

All analysis was conducted using SPSS IBM version 25 (SPSS Inc., Chicago, IL, USA). Independent *t*-tests were carried out to investigate differences in age and BMI between adults with and without TS. Subsequently, a series of independent *t*-tests were conducted to explore eating behaviours and sensory sensitivity between the groups. To examine relationships between eating behaviours and sensory sensitivity, a series of two-tailed Pearson's correlations were conducted.

To investigate differences between the adults with and without TS, a series of one-way ANOVAs and post-hoc tests were conducted for each of the questionnaires (AEBQ, NIAS; SPQ). To examine whether sensory sensitivity was a predictor of eating outcomes in adults with and without TS, a series of multiple linear regressions were carried with four of the sensory subscales (taste, smell, touch, vision) as predictors of food fussiness, food neophobia, and ARFID-associated eating patterns.

3. Results

3.1. Descriptive statistics

Demographic characteristics of adults with and without TS are presented in Table 1. Independent *t*-tests revealed no significant differences in age, *t*(102) = 1.63, *p* =.105, gender, *t*(94) = -1.26, *p* =.211, and BMI, *t*(100) = -.04, *p* =.969, between adults with and without TS these measures were not controlled for in further analyses. Furthermore, BMI did not significantly differ between adults with TS taking medication (*M* = 26.48: *SD* = 6.67) and those not taking medication (*M*= 26.68: *SD*= 7.67), *t* (47) = .10, *p* = .92.

3.2. Differences in eating behaviours and sensory sensitivity

Mean and standard deviations for standardised measures exploring eating behaviours are presented in Table 1. Independent *t*-tests revealed in the adults with TS compared to controls to show significantly higher levels of food selectivity. According to the NIAS, individuals with TS also showed greater total food avoidant/restrictive food intake disorder eating behaviours, reported having higher fear of consequences of eating, and picky eating due to sensory properties. There were no significant differences between the groups on the ARFID poor appetite subscale. Adults with TS also showed greater food neophobia compared to adults without TS.

As shown in Table 1, a series of independent *t*-tests also revealed that adults with TS reported overall significantly greater sensory sensitivity. In addition, adults with TS showed greater sensitivity to taste, touch and vision compared to adults without TS.

Table 1. Descriptive statistics for eating behaviour and sensory sensitivity standardised measures in adults with and without TS.

	TS (n=53)	**Controls (n=53)**	***t(df)***
	Mean(SD)	**Mean(SD)**	
Age (y)	35.58(14.02)	31.12(13.82)	*t*(102)=1.63
BMI (kg/m^2)	26.57(7.04)	26.62(6.59)	*t*(100)=-.04
NIAS			
Picky eating	7.62(5.37)	4.38(3.55)	*t*(103)=3.65***
Appetite	5.12(4.38)	4.04(3.36)	*t*(103)= 1.42
Fear	3.83(4.01)	2.30(3.58)	*t*(103) = 2.06*
Total	16.56(9.66)	10.71(8.48)	*t*(103)=3.29**
AEBQ			
Food fussiness	2.92(1.21)	2.34(.72)	*t*(104)=3.02**
FNS	4.00(1.87)	4.95(1.17)	t(102)=3.09**
SPQ			
Taste	13.84(5.88)	16.72(4.95)	*t*(102) =2.76**
Smell	15.16(7.14)	16.79(5.79)	*t*(102)=1.31
Touch	16.18(5.80)	22.70(5.44)	*t*(102)=5.63***
Vision	22.94(7.61)	27.00(5.00)	*t*(102)=3.30**

Total	95.16(27.20)	112.38(20.00)	*t*(102)=3.68***

*Note: *p < .05, **p < .01, ***p < .001*
Body Mass Index (BMI), Nine Item Avoidant/Restrictive Food Intake Screen (NIAS), Adult Eating Behaviour Questionnaire (AEBQ), Food Neophobia Scale (FNS), Sensory Processing Quotient (SPQ)

3.3. Sensory sensitivity as predictors of eating behaviours

A series of multiple regressions were conducted to assess the relationship between sensory and eating behaviours. High sensitivity to smell predicted less enjoyment of food in both groups. Higher sensitivity to touch predicted greater picky eating, as measured by NIAS, in adults with TS only. Furthermore, greater sensitivity to taste was found to predict greater food neophobia in TS.

Table 2. Standard regression coefficients (Beta) of the four sensory perception subscales predicting eating behaviour outcomes.

	Taste	**Touch**	**Vision**	**Smell**	R^2	***F***
TS						
Food Fussiness (AEBQ)	-.287	-.241	.089	.107	.053	1.705
Picky Eating (NIAS)	-.297	-.460*	.176	.306	.122	2.743*
Fear of eating	-.262	-.013	.010	.036	-.024	.710
Total NIAS	-.323	-.402	.120	.376	.099	2.368
Food neophobia	.426*	.384	-.096	-.343	.172	3.605*
TD						
Food Fussiness (AEBQ)	-.206	.341	.052	-.100	-.005	.934
Picky Eating (NIAS)	.128	.226	-.059	-.087	-.020	.565
Fear of eating	-.003	.001	-.141	.266	-.026	.675
Total NIAS	.032	.133	-.124	.166	-.010	.867
Food neophobia	.060	-.487	.136	.112	.066	1.918

*Note: *p < .05. The R^2 and F value refer to the four sensory perception subscales simultaneously predicting each eating behaviour.*

4. Discussion

The current study aimed to explore differences in food avoidant behaviours and their relationship to sensory sensitivity in adults with and without TS. Results revealed that adults with TS compared to neurotypical controls showed greater levels of food selectivity, neophobia and ARFID-associated behaviours. In addition to showing greater sensitivity to touch, vision and taste; heightened sensitivity to some sensory modalities also predicted eating behaviours in adults with TS. More specifically, greater taste sensitivity predicted higher levels of food neophobia, while greater sensitivity to touch predicted more picky eating due to sensory properties.

This is the first study to show evidence of greater food avoidance behaviours, specifically food neophobia, food selectivity and total ARFID-associated behaviours in adults with TS. These findings are similar to the ones carried out in adults with ASD

(Kuschner et al., 2015; Kinnaird et al., 2019), and highlight the presence of limited variety of food and a lack of accepting novel foods in neurodivergent adults (Kuschner et al., 2015). While more research needs to address eating behaviours of individuals with TS further, the current research does indicate some maladaptive eating behaviours to be present in adulthood. However, while associations are found between food avoidance and TS, it is important to note that no causal relationship has been established, such that eating problems would arise as a consequence of TS. Instead evidence mainly comes from overlapping symptomology with TS. For example, children with heightened motor impulsivity and reduced inhibitory control are more prone to emotional eating (Bennett & Blissett, 2017), and therefore may underlie certain eating behaviours in TS.

As predicted, adults with TS also showed greater overall sensory sensitivity and, more specifically, greater sensitivity to taste, touch and vision than adults without TS. These self-reports of hypersensitivity to sensory stimuli supports previous literature suggesting it to be a key feature of TS (Sutherland Owens et al., 2011; Isaacs & Riordan 2020). In contrast to findings reported in children with TS and those reported in adults with ASD (Smith et al., 2019; 2020), in the current study food selectivity was not associated with sensory sensitivity in adults. However, there was a relationship between sensory sensitivity and other food avoidance behaviours. For example, food neophobia was associated with sensitivity to taste, whereas picky eating due to sensory properties was associated with higher sensitivity to touch. It is possible that different definitions of similar constructs may have led to different findings in this current study. For example, picky eating, as measured by the NIAS, focuses explicitly on fussiness due to sensory properties. In contrast, food fussiness, as measured by the AEBQ, focuses on a broader definition of food refusal (Hunot et al., 2016).

It has been suggested that the heightened food selectivity and its effect in adulthood may be guided by other factors than sensory sensitivity, such as cognitive flexibility. For example, a recent study by Zickgraf et al., (2020), addressed selective eaters including children, adolescents, and adults with and without anxiety/obsessive spectrum disorders, as well as a group of children with ASD. The results from this study suggested that in addition to sensory sensitivity, cognitive rigidity was important in the maintenance and duration of food selectivity. Here, cognitive rigidity was defined by an inability to switch between mental tasks or states, restricting individuals from modifying and expanding their food schemas, or via behavioural inflexibility (e.g., rigid expectancies about their own sensory or emotional experiences). These authors suggest that while cognitive rigidity was associated with limited exposure to different foods, acceptance of novel food appeared to be based on an individual's sensory experiences. It is possible that whilst sensory factors contribute to the avoidance of food during childhood, an individual's food intake has been established and remains largely consistent during adulthood. Therefore, sensory factors may more predictive of adults' willingness to try novel foods, i.e., food neophobia.

The current findings highlighting maladaptive eating behaviours in adults with TS have clinical implications. The adverse health consequences of the maladaptive eating behaviours identified has been widely established throughout the literature with neurotypical children and adults (Kuschner et al., 2015; Wildes et al., 2012). Therefore, eating concerns must be addressed, and early interventions are paramount to prevent persistent food avoidant behaviours (Gibson & Cooke, 2017). Additionally, identifying adults with TS who are vulnerable to showing avoidance of food due to sensory properties may also help to understand those at risk of having clinically significant distress and impairment, i.e. ARFID. Furthermore, there is a need for further research to fully understand mechanisms that influence adulthood eating behaviours, which will help to structure interventions. Hypersensitivity to some sensory domains was found to be predictive of some eating behaviours in the current study, therefore it could be an important consideration for developing interventions for adults with TS (Smith et al., 2019). One suggestion is to develop meal tasting sessions to gain insight into meal preferences based on sensory properties (Svendsen et al., 2021). It is important that foods in the diet have different sensory properties. For example, in older adults is has been shown that encouraging different sensory properties such as flavours, textures, shapes and colours in the diet, increases the energy consumed due to wider variety of food presented within a meal (McCroy et al., 2012).

One strength of the study is that it addresses adults understanding of their own current eating behaviours as this provides a voice to individuals with a TS a voice as opposed to descriptions provided by caregivers or a third-party. Behavioural measures and dietary recalls can be used in future research to confirm findings and provide insights into food consumption and whether there are nutritional concerns for this population. For example, Liang et al., (2015) suggest that adults with TS show unhealthier diets and prolonged food selectivity which have been widely associated with micronutrient deficiencies within the general population (Galloway et al., 2005; Taylor et al., 2016).

The current study is not without limitations. The SPQ was developed and validated for use in adults diagnosed with ASD. The authors deemed the scale suitable for use given the similarities between the two disorders in terms of sensory sensitivity; however, future research should assess the validity of this measure in other neurodivergent conditions. The study chose to focus on three specific elements of food avoidant behaviours, food selectivity, food neophobia and ARFID associated behaviours, however it is important to note that there are other food avoidant behaviours that were not addressed. For example, food fussiness is a subcategory of food avoidant eating behaviour, along with slowness in eating, emotional undereating and regulating eating through internal cues, namely satiety responsiveness (as characterised by the AEBQ)

Overall, the current study has demonstrated some higher food avoidance behaviours in adults with TS, with food neophobia and AFRID behaviours to be associated with heightened sensory sensitivity in adulthood. It is imperative to address eating behaviours in this group further and understand possible consequences of these eating behaviours including nutritional deficiencies, dependence on nutritional supplements and/or significant weight loss. Understanding differences in eating profiles can help to identify early warning signs in adults with TS and aid in the development of interventions to prevent long-term consequences of anomalous eating behaviours.

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