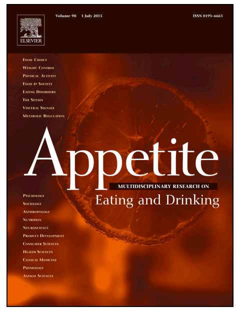

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The role of sensory sensitivity in predicting food selectivity and food preferences in children with Tourette syndrome

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Abstract

Tourette syndrome (TS) is a neurodevelopmental disorder characterised by involuntary, repetitive and non-rhythmic motor and vocal tics. Despite suggestion that diet may affect tics, and the substantial research into children's diet, eating behaviours and sensory processing in comorbid disorders (e.g. ASD), research in TS is lacking. The present study examined differences between children with and without TS in parental reports of child selective eating, food preferences and sensitivity, and aimed to examine sensory sensitivity as a predictor of food selectivity outcomes in children with and without TS. Thirty caregivers of children with TS (*M*=10 years 8 months [*SD*=2.40]) and the caregivers of 30 age- and sex-matched typically developing (TD) children (*M*=9 years 9 months [*SD*=2.50]) completed the following measures online: Short Sensory Profile, Food Preference Questionnaire for Children, Child Eating Behaviour Questionnaire. Children with TS were reported to have significantly higher levels of food selectivity and sensory sensitivity, and less preference for fruit and vegetables than TD children. Importantly, while higher levels of overall sensory sensitivity predicted eating outcomes in the TS group, only sensitivity to taste/smell was found to be a predictor of food selectivity and preference for vegetables for both groups of children. The findings suggest that efforts to address food selectivity in children with TS may be enhanced by including strategies that address atypical sensory processing.

Keywords: Tourette syndrome, food selectivity, sensory sensitivity, food preferences

1. Introduction

Tourette Syndrome (TS) is a neurodevelopmental disorder characterised by involuntary, repetitive and non-rhythmic motor and vocal tics, with a typical onset between 7 and 12 years (American Psychiatric Association, 2013). Prevalence figures of TS vary depending on the methods adopted, the diagnostic criteria employed and whether the sample was a community or clinical sample. However, the international incidence of TS is reported to be around 1% (Robertson, Eapen & Cavanna, 2009). Anecdotal and case reports have suggested that many individuals with TS are more likely to consume an unhealthy diet, and overeat energy dense foods (Liang, Sun, Ma & Liu, 2015; Ludlow & Rogers, 2017). This increases the risk of children with TS becoming overweight, along with the associated health complications and nutritional deficiencies with being overweight (Liang et al., 2015; Degrauw, Li & Gilbert, 2014). The lack of a balanced and varied diet consumed by children with TS may also contribute to the increased levels of supplements, including vitamin B and C, being given to these children (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 children with TS and TD children (Ludlow & Rogers, 2017). The current study investigates differences in food selectivity and food preferences between children with and without TS, and determines whether sensory sensitivity is a predictor of food selectivity in these groups of children.

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). Caregivers often report children's food selectivity as a common problem (Mascola, Bryson & Argas, 2010), which can have several adverse consequences for general health and well-being (Jacobi, Schmitz & Agras, 2008). While food selectivity has been found to be frequently observed in pre-schoolers, it is less common in older TD children, suggesting it is something children will often eventually grow out of (Cardona Cano et al., 2015). Food selectivity has been found to be more common and more likely to continue beyond early childhood in children with developmental disorders, such as Autism Spectrum Disorders (ASD; Legge, 2002) and Attention Deficit Hyperactivity Disorder (ADHD; Leventakou et al., 2016) both of which are highly comorbid with TS (Kadesjö & Gillberg, 2000; Freeman et al., 2000).

Maladaptive patterns of eating are reported in more than 75% of children with ASD (Cermak, Curtin & Bandini, 2010) and include adherence to specific dietary habits and preferences as well as difficult mealtime behaviours, such as a need for a routine or throwing food (Rogers, Magill-Evans & Rempel, 2012; Curtin et al., 2015). Children with ASD have also been shown to display a range of food selectivity behaviours, including lack of dietary variety (Zimmer et al., 2012), preferences for energy-dense/nutrient-poor foods, consumption of fewer fruits and vegetables (Schreck & Williams 2006), and higher consumption of sugar-sweetened beverages (Evans et al., 2012). In addition, problematic eating behaviours are common in both children with ASD (Ledford & Gast, 2006) and ADHD (Bennett & Blissett, 2017; Farrow, 2012). Given the high level of comorbidity of these disorders with TS, the underlying mechanisms for food selectivity in TS require further examination.

One explanation for food selectivity is the perceived sensory properties of food which are suggested to underlie children's reasons for rejecting food in both typical and atypical development (Nicholls, Christie, Randall & Lask, 2001; Martins & Pliner, 2005). The process of eating involves integration of various sensory aspects, which have been found to influence individuals' preferences for particular food groups. For instance, individuals with an increased sensitivity to bitter compounds tend to have a reduced intake of vegetables, especially those that are bitter-tasting (Duffy et al., 2010). However, sensory influences on eating behaviour are not limited to taste; sensory sensitivity, as defined by one's over-responsiveness to sensory information (Reynolds & Lane, 2009), has been identified as an inherent characteristic that makes one particularly vulnerable to becoming a picky eater. For example, children's reluctance to eat new foods and/or eat fruit and vegetables has been associated with higher levels of tactile and taste/smell sensitivity (Coulthard & Blissett, 2009).

Compared to TD children, there is a greater prevalence of food refusal based on texture, taste and smell of food, in children with ASD (Hubbard, Anderson, Curtin, Must & Bandini, 2014). This food refusal has been shown to be associated with increased sensory impairment and behavioural rigidity. Furthermore, sensory impairment has been associated with an increased number of eating problems, such as food refusal and limited variety (Nadon, Feldman, Dunn & Gisel, 2011; Shmaya, Eilat-Adar, Leitner, Reif & Gabis, 2017), and has been found to surpass repetitive and ritualistic behaviour in predicting food selectivity in children with ASD (Suarez, Atchison & Lagerwey, 2014). Despite the paucity of research addressing eating behaviours in TS, an important symptom of TS is sensory over-responsivity. For example, heightened sensory sensitivity to external stimuli has been reported in 80% of TS patients, compared to 35% of TD children (Belluscio, Jin, Watters, Lee & Hallett, 2011). More recently, Ludlow and Wilkins (2016) identified similar levels of atypical sensory behaviour in ASD and TS participants whereby both groups exhibit higher levels of sensory sensitivity. Thus, sensory sensitivity is a plausible mechanism by which children with TS might be at greater risk of problematic eating behaviour.

There were two main aims of the current investigation: 1) To determine whether children with TS are reported to show more food selectivity, show less preference for fruit and vegetables, and have greater sensory sensitivity compared to a group of age- and sex-matched TD children; 2) To address whether sensory sensitivity would be a predictor of food selectivity and preference for fruit and vegetables in both groups of children. Based on previous research in children with other developmental disorders, it was hypothesized that children with TS would show more food selectivity and show less preference for fruit and vegetables compared to TD children. It was also predicted that children with TS would show significantly higher levels of sensory sensitivity than TD children, and that sensory sensitivity would be a predictor of eating outcomes for both groups of children.

2. Method

2.1 Participants

Sixty caregivers (aged 26-66 years [*M* = 39 years, *SD* = 7.19]) reported information on their child. All of the caregivers were mothers. Fifty-eight caregivers described their nationality as British and 2 as American. Thirty children with TS (25 male and 5 female; aged between 7 years 4 months- 15 years 10 months; *M*= 10 years 8 months, *SD* =2.40) were matched to a group of 30 TD children (25 male, 5 female; aged between 7 years 0 months- 16 years 3 months; *M*= 9 years 9 months, *SD*=2.50). The groups did not differ in age (t (60) = 1.56, p= .12). Caregiver report of a TS diagnosis and the Premonitory Urge for Tics Scale (PUTS; Woods, Piacentini, Himle & Chang, 2005) were used to confirm children's status 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 9 to 31 (M=24.88, SD = 6.00). Twenty-five of the children with Tourette syndrome had a comorbid disorder: ADHD (*n* = 4), ASD (*n* = 10), Anxiety (*n* = 6), PTSD (*n* = 1), OCD (*n* = 10), Dyspraxia (*n*= 4) and Dyslexia (*n* = 1). None of the parents reported any of the TD children to have any known clinical diagnosis. Of the children with TS taking medication (*n = 15*), the most commonly reported was melatonin (*n* = 6). Other prescription drugs recorded were sertraline (*n* = 4) and clonidine (*n* = 2). Participants were recruited through Tourette's Action charity online website in addition to online forums and local organisations who agreed to advertise the study.

2.2 Measures

Demographic variables collected included: child's sex, birth date, any clinical diagnosis including comorbid disorders, age at which the child was diagnosed with TS (*M* = 7 years 9 months, *SD* =2.09). Parents were asked to provide a measurement of their child's weight and height, which was then converted to a BMI standard deviation score (SDS). The Child Growth Foundation Package (1996) was used to standardise the measurements for age and sex according to standardised norms for a UK sample. Caregivers were also asked to describe their age, ethnicity and their relation to the child. Finally, parents were asked to complete the following questionnaires:

2.2.1 The Short Sensory Profile (SSP; Dunn, 1999)

The SSP is a 38-item caregiver questionnaire designed to assess children's responses to sensory stimuli. Three subscales from the questionnaire 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). The total scores from all seven subscales of the questionnaire, which included Auditory Filtering, Low Energy/Weak, Movement Sensitivity, were also computed to provide a total sensory sensitivity score. Caregivers responded to items on a 5-point Likert scale ranging from 1 (always) to 5 (never) with lower scores indicating higher sensory impairment. The subscales range from weak to strong internal consistency (Cronbach α=.47 to α=.91; Dunn, 1999). In the current study good to excellent internal reliability was found for the subscales used; tactile sensitivity (Cronbach α=.88), taste/smell sensitivity (Cronbach α=.95), visual/auditory sensitivity (Cronbach α=.90) and overall sensory sensitivity (Cronbach α=.96).

2.2.2 The Food Preference Questionnaire for children (FPQ; Fildes et al., 2015)

The FPQ requires caregivers to rate their child's liking for 75 commonly consumed individual foods from 6 food groups: fruit, vegetables, meat/fish, dairy, snacks and starches. The items are rated on a 5-point Likert scale, ranging from 1 (dislikes a lot) to 5 (like a lot), with an option of 'never tried' which is scored as a missing response. The mean score of items pertaining to each subscale was calculated, with the higher the score indicating an increased like towards the given food category. In terms of psychometric properties, the current study found a good to excellent internal reliability for the food groups; fruit (Cronbach α=.95), vegetables (Cronbach α=.93), meat/fish (Cronbach α=.92), snacks (Cronbach α=.82), dairy (Cronbach α=.74), however the reliability for the starch subscale was lower (Cronbach α=.66).

2.2.3 The Child Eating Behaviour Questionnaire (CEBQ: Wardle, Guthrie, Sanderson & Rapoport, 2001)

The 'food fussiness' subscale from the CEBQ was used to assess parental perceptions of their child's food selectivity behaviour. This subscale consists of six items and includes how difficult the child is to please with meals; how often the child refuses to taste new foods and the variety of foods the child will eat. Caregivers rated the frequency of which the child exhibits the behaviour on a 5-point Likert scale ranging from 1 (never) to 5 (always). Development of the questionnaire revealed good internal reliability coefficients (Cronbach's alpha) for all the subscales, ranging from 0.74 to 0.91 (Wardle et al., 2001). In the present study Cronbach's alpha for food selectivity was 0.68.

2.3 Procedure

Ethical approval for this research was obtained from the University of Hertfordshire University Ethical Advisory Committee Protocol Number: LMS/PGT/UH/02784 and the research was performed in accordance with the Declaration of Helsinki. Informed consent was given by all participants prior to their participation in the research. The study was advertised on Tourette's Action charity website, which aided the recruitment of caregivers of children with TS. Additionally, local organisations and online parenting forums were contacted and with their permission the advertisement was distributed. Participants volunteered to participate in the study by clicking on the given link, which directed them to the online survey. Following this, every participant was presented with the questionnaires in the same order. Information on how to seek further advice if the parents had any concerns regarding their child's eating behaviours was also provided. The survey took approximately 25 minutes to complete and was active for two months. Families were provided no incentive to participate. Approximately 177 parents were sent the link to the survey (123 parents of TS, and 54 parents of TD) and 79 completed (32 TS and 47 TD) the survey, rendering a response rate of approximately 46%. Two children with TS were removed due to being much older than the TD children, and then 30 TD children were selected from the 47 to be nearest in both age- and sex- of the 30 children with TS. Where single items were missing from the data and equated to less than 10% of a participant's questionnaire data, the means substitution method was adopted (N=6 participants).

2. 4. Analysis

Independent t-tests were first computed to compare differences in BMI SDS between groups and to examine whether there were sex differences in outcome measures. The data was then analysed using Two-tailed Pearson's correlations establish whether child age or BMI SDS were related to food selectivity.

To investigate differences between the children with and without TS, a series of independent t-tests were conducted for each of the questionnaires (SSP, FPQ, CEBQ). To examine whether sensory sensitivity was a predictor of eating outcomes in the two groups (TS and TD), a series of simple Multiple Linear Regressions were carried out. This included the overall sensory sensitivity score as well as Taste/smell, Tactile and Visual/Auditory subscales as a predictors of food selectivity and preference for fruit and vegetables.

3. Results

3.1. Descriptive Statistics

Independent t-tests revealed no significant differences between BMI SDS for children with TS (*M*= -1.59: *SD*= 4.17) compared to TD children (*M*= -.36: *SD*= 1.95), *t* (45) = 1.28, *p* =.21. Furthermore, BMI SDS did not significantly differ between children with TS taking medication (*M*= -.36: *SD*= 2.90) and children with TS not taking medication (*M*= -2.82: *SD*= 4.96), *t* (22) =1.48, *p* = .15. The data were then analysed to establish whether child age, BMI SDS, or sex were related to food selectivity. Two-tailed Pearson's correlations indicated that child food selectivity was not significantly associated with child age (*r* = -.02, *p* = .94) or BMI SDS (*r* =.09, *p* =.67) in TD children. For the children with TS, food selectivity was also not correlated with age (*r* = -.29, *p* =.11) or BMI SDS (*r* = -.25, *p* =.24). Therefore, these measures were not controlled for in further analyses. While an independent samples t-test revealed a significant difference in food selectivity between males and females in the TD children, *t* = (28) = 2.48, *p*=.02, with males showing higher levels of food selectivity (Males, *M* = 2.90 *SD*= .96; Females *M*= 1.80: *SD*= .36), no significant difference in food selectivity between males and females was found in the children with TS, *t* = (4.52) = -.12, *p* = .91, (Males, *M* = 3.46 *SD*= 1.07; Females *M*= 3.53: *SD*= 1.89).

3.2. Differences in food selectivity, food preference and sensory sensitivity

To examine whether there were group differences in food selectivity between the two groups, an independent t-test was conducted to examine differences in the food fussiness subscale of the CEBQ. This revealed a significant effect of group on food selectivity, *t* (77) = -2.32, *p*= .02. Parents reported children with TS had significantly higher levels of food selectivity (*M*= 3.47: *SD*= 1.20) compared to TD children (*M*= 2.71: *SD*= .98).

Further t-tests were carried out to address differences between the groups in the six individual subscales of the Food Preference Questionnaire. Results revealed children with TS had significantly lower preferences for meat, *t (*58) = 2.31, *p* = .02; fruit, *t (*58) = 4.20, *p* < .001 and vegetables, *t* (58) = 2.03, *p* =. 04 than TD children. There were no differences in preference for snacks, *t (*58) = .87 *p* = .08; starches, *t (*58) = 1.76, *p* = .39 and dairy, *t* (58) = 1.78, *p* =. 08.

Finally, to examine whether there were differences in sensory sensitivity between the two groups, differences between the groups in the overall total score on the sensory profile and the three selected scales of the sensory profile were analysed using independent samples t-tests. Results revealed children with TS were significantly more sensory sensitive overall, t (58) = 717, p < .001; and were significantly more sensitive to tactile, t (58) = 7.06, p < .001; taste/smell, F (58) = 2.61, p < .01, and visual/auditory information, F (58) = 5.86, p < .001 than TD children. Total scores and standard deviations are shown in Table 1.

Table 1: Mean scores (standard deviation) for each of the questionnaires for children with Tourette syndrome and typically developing children.

	Typically Developing		**Tourette Syndrome**	
	Mean	**SD**	**Mean**	**SD**
Demographics				
Age in Months	154.36	12.92	155.73	17.74
Height	144.96	16.23	149.09	17.75
Weight	37.57	18.96	38.84	17.25
BMI SDS kg/m^2	-.36	1.94	-1.59	4.17
Sensory Profile				
Tactile	31.73	3.96	22.13***	6.31
Taste/Smell	16.80	3.90	12.73**	7.57
Visual/Auditory	22.67	2.96	15.70***	5.80
Total	163.60	20.91	115.20***	30.47
CEBQ				
Fussiness	16.45	5.86	20.72**	7.12
FPQ				
Meat/Fish	48.13	1005	40.17*	15.89
Dairy	30.20	6.01	27.00	7.78
Starches	22.87	4.11	21.93	4.24
Snacks	50.10	7.98	46.43	8.810
Fruit	64.63	11.52	46.57**	19.05
Vegetables	61.13	18.68	50.27*	22.65

*Note: *** = p < .001, ** = p < .01, * = p < .05*

3.3. Multiple Regressions

Multiple linear regression analyses were first carried out exploring total levels of sensory sensitivity as predictors of food selectivity, preference for meat/fish and preference for fruit and vegetables. Results revealed a significant overall model of sensory sensitivity as a predictor of food selectivity for the TS children F (1, 29) = 9.35, p < .01, with an R^2=.25, but not for the TD children, F (1, 29) = 1.77, p= .19, with an R^2=.06. Overall levels of sensory sensitivity were also found to predict preference for fruit (F (1, 29) = 13.69, p < .001, R^2=.33) and vegetables in the TS group (F (1, 29) = 4.15, p < .05, R^2=.13). However, overall levels of sensory sensitivity was not found to be a significant predictor for fruit (F (1, 29) = 1.48, p = .23, R^2=.05) or vegetables (F (1, 29) = .51, p = .48, R^2=13) in the TD group. Sensory sensitivity was not predictor of preference for meat/fish in either group.

Multiple linear regression analyses were then carried out to explore the relationship between the three sensory subscales as predictors of food selectivity, preference for meat/fish and preference for fruit and vegetables. Tactile, taste/smell and visual/auditory sensory subscales were all entered into the model in the same step. Results revealed that no sensory subscales were significant predictors for preference for meat. Taste/smell sensitivity was the only significant predictor for food selectivity and preference for vegetables in both groups of children. While Taste/smell predicted preference for fruit in TD, it was not a significant predictor for TS. Table 2 shows the models accounted for a large variance of both food selectivity and preference for fruit and vegetables. Taste/smell sensitivity accounted for a greater variance in food selectivity, compared to preference for fruit and vegetables in both groups.

Table 2: Standard Coefficients of the three sensory profile subscales predicting eating outcomes.

	Tactile	Taste/ Smell	Visual/ Auditory	R^2	F(3,29)
TD					
Food Selectivity	.02	-.85***	.14	.65	15.21***
Preference Fruit	-.08	.67***	-.17	.41	5.93**
Preference Veg	-.21	.84**	-.02	.61	13.47***
TS					
Food Selectivity	-.002	-.74**	-.01	.55	10.75***
Preference Fruit	.24	.33	.28	.47	7.76***
Preference Veg	.04	.60**	.76	.35	4.65**

*Note: *** = p < .001, ** = p < .01, * = p < .05*

4. Discussion

The current research found significant differences in the eating behaviours of children with TS compared to an age- and sex-matched group of TD children. Children with TS reported more food selectivity and showed less preference for several food categories, namely meat, fruit and vegetables compared to TD children. Children with

TS showed higher overall levels of sensory sensitivity and were also more sensitive to tactile, taste/smell and visual/auditory information than TD children. Higher overall sensory sensitivity was found to be a significant predictor of food selectivity and lower preferences for fruit and vegetables for the TS group only. However across the individual subscales, taste/smell sensitivity was found to be an independent predictor of food selectivity and preference for vegetables in both groups of children.

Differences in food preferences of children with TS, compared to TD children, showed children with TS to display less preference for meat, fruit and vegetables overall. Research has found iron deficiencies are frequently identified in individuals with TS, the decreased level of iron has been suggested to exacerbate tic severity (Gorman, Zhu, Anderson, Davies & Peterson, 2006). This iron deficiency may be partially explained by the lack of preference for meat and vegetables in children with TS as found in the current study. However, it was not known if any of children with TS included in this study were iron deficient. In previous research, a reduced consumption of a variety of food groups has been consistently associated with poor nutrition (Sharp et al., 2013), and intakes of dairy, grains and total fruits and vegetables are inversely associated with central obesity among adolescents (Bradlee, Singer, Qureshi & Moore, 2010). However, in this sample, no difference was found between TS and TD in their preference for snacks, starches & dairy, and no significant differences were found in BMI SDS between the two groups. However, parents provided this information via self-report, and future studies need to collect a direct measure of height and weight of participants to ensure an accurate comparison across samples.

In addition, children with TS were shown to have higher levels of food selectivity than TD children. Not only does greater food selectivity increase the health risk for the child, it has also been suggested that food selectivity can contribute to elevated anxiety for the child and their family (Farrow & Coulthard, 2012). Children who are selective eaters have been shown to have an adverse impact on their family's quality of life (Rogers et al., 2012) by increasing stress (Curtin et al., 2015), frustration (Rogers et al., 2012) and difficulty eating in social environments (Twachtman-Reilly, Amaral & Zebrowski, 2008; Nadon et al., 2011). The wide impact of food selectivity highlights the importance of early intervention and the need to understand the origin of this maladaptive behaviour.

Children with TS displayed greater overall, tactile, visual/auditory and taste/smell sensitivity compared to TD children. The finding of increased sensory sensitivity in the TS group is consistent with previous research and the symptomology of TS (Belluscio et al., 2011). In the current study, higher levels of overall sensory sensitivity was able to account for significant variance in both food selectivity and a reduced preference for fruit and vegetables in the TS group. Importantly, the present findings are similar to those found in children with comorbid disorders. Within the ASD literature, food refusal has been found to have a sensory basis (Hubbard et al., 2014) and increased sensory processing impairments predict maladaptive eating behaviours (Johnson et al., 2014). The role of sensory sensitivity identified in the current study highlights the need to further investigate this across comorbid disorders, where sensory-oversensitivity is a transdiagnostic feature. Overall, the findings suggest that efforts to address food selectivity in children with TS may be enhanced by understanding the sensory basis of mealtime behaviour difficulties. This may be an important part of developing effective treatment and intervention for both the child and their family (Shmaya et al., 2017).

Findings also revealed that taste/smell sensitivity predicted preference for vegetables in both groups. This is consistent with the majority of studies addressing food consumption in children with ASD, which have indicated that children with ASD consume fewer fruits and vegetables compared to current recommendations (Emond, Emmett, Steer & Golding, 2010; Lukens & Linscheid, 2008). It is likely the lack of preference for fruit and vegetables when a greater level of taste/smell sensitivity is present, is due to the susceptibility of fruit and vegetables to have greater potential differences and changes to their sensory properties, compared to other food groups. Therefore, the unpredictable sensory properties of fruit and vegetables may decrease preference for these specific food groups (Coulthard & Blissett, 2009). However, it is important to note that despite being a predictor of vegetable preference in children with TS, taste/smell sensitivity did not predict preference for fruit in this group. It is likely that there other sensory factors aside from taste/smell sensitivity that will also influence food preferences in this group of children, as evidenced by higher overall levels of sensory sensitivity being a significant predictor. However, increased parental fruit and vegetable consumption (Patrick, Nicklas, Hughes & Morales, 2005) and reoffering various foods within the food group (Birch, Gunder, Grimm-Thomas &

Laing, 1998) can increase the acceptance of fruit and vegetables in typically developing children, and the potential for these kinds of intervention strategies now needs to be examined in children with TS.

The present study is not without limitations. First, the measures were based on parental self-report rather than direct observations of children's food choices. Parents may make assumptions about their children's food choices and sensory problems. Second, the forced choice aspect of the questionnaires may not have identified important aspects of the children's eating behaviours, and therefore limited the responses the parents gave. For example, in the SSP, taste and smell are combined into a single subscale precluding the ability to separate these characteristics (Hubbard et al., 2014). Third, while the food preference questionnaire showed a lower preference for fruit and vegetables in the children with TS, the exclusion of a food frequency questionnaire prevented detail about the frequency of consumption and portion size of these food groups. Therefore, this would be an important direction for future research to address. Last, the small sample size limited the ability to compare whether there were significant differences between TS with and without comorbid disorders. Given the high comorbidity between ASD and ADHD in TS, it is important for future studies to examine the eating behaviours of TS in comparison to groups with ASD without TS, and ADHD without TS. In addition, it will be important to screen for comorbid ADHD in all groups, to identify the degree to which eating problems are syndrome specific.

This is the first exploratory study addressing the relationship between sensory sensitivity and child eating behaviours in TS. It is clinically important for future research to understand the origin and nature of these differences in eating behaviours. Not only can feeding problems lead to growth delay, but they can also cause significant family stress, with parents worried about the child's nutritional intake and troublesome mealtime behaviours (Reynolds, Kreider, Meeley & Bendixen, 2015).

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6. Declarations

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