Autistic Traits Associated With Food Neophobia But Not Olfactory Sensitivity

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Abstract

Food neophobia has been shown to be associated with a range of personality traits (including anxiety, lower sensation seeking) and additionally sensory aspects of food such as taste and texture. Running parallel to that work, research has demonstrated higher incidences of food neophobia in autistic populations and separately evidence of hypersensitivity in some sensory domains. The aim of the current study was to extend our understanding by exploring whether the broader aspects of autistic traits can predict food neophobia in a non-autistic population and whether this is mediated by differences in olfactory sensitivity. In the present study, student participants (N=50) completed questionnaires measuring their food neophobia (FNS) and preferences for foreign cuisine, autistic traits (Autistic Quotient, AQ), and then completed an olfactory threshold test for a food related odour. The findings demonstrated a positive association between food neophobia and the magnitude of autistic traits and interestingly, an inverse relation between preference for foreign cuisine and olfactory sensitivity; those individuals less inclined toward foreign cuisine had poorer sensitivity to a food related odour. Since AQ was not related to olfactory sensitivity, these findings suggest the relation between autistic traits and food neophobia is unlikely to be mediated by olfactory sensitivity. More broadly however, our sense of smell is associated with experiencing a wider diet.

Keywords

Autism, Olfaction, Food Neophobia, Odor

Introduction

The reluctance to try new foods is commonly referred to as food neophobia (Birch et al., 1987) and is thought to reflect the tension in all humans of, on the one the hand, avoiding novel foods that may harm us and on the other, approaching novel foods that confer advantages of a wider diet (Pliner and Hobden, 1992). Food neophobia can be measured using instruments such as the Food Neophobia Scale (FNS, Pliner and Hobden, 1992), where individuals respond to questions on their propensity to try novel foods in different situations. Research has shown that younger children tend to be more food neophobic (Birch, 1999) and generally appears to reduce with age (Otis, 1984). Work has also found that in young children, those with psychological and behavioural problems are less likely to try novel foods (Pelchat and Pliner, 1986). Of particular interest to the present study is the influence of behavioural ridgity in restricted eating habits, which can be manifested by rituals in preparation and presentation (Jacobi et al., 2008). These factors are also indicative to those on the Autistic spectrum, and research has shown that childhood food neophobia is higher in those populations (Bandini et al., 2010; Barnhill et al., 2015). However, what remains unclear is to what extent these sorts of traits (i.e. behavioural ridgity) relate to food neophobia in non-clinical adult populations. This is important since personality traits such as low sensation seeking (that also relate to autistic traits, Romero-Martínez, et al., 2015) can predict lower preference for trying new foods (Frank & van der Klaauw, 1994), hence it could be that those sorts of traits are part of a wider personality constellation of autistic related tendencies.

Food neophobia is also driven by sensory factors such as the smell, taste and texture of the food (Wildes et al., 2012). For instance, research in adults has shown that those individuals less willing to try new foods rated a selection of odours as less pleasant and less intense and in a measure of ‘ideal’ taste intensities, preferred lower levels of intensity (Frank & van der Klaauw, 1994). This suggests that there are differences in odour hedonics and sensitivity in food neophobics. Separately and apart from food research, olfactory abilities in autistic versus non-autistic populations have shown either impairments (Suzuki et al., 2003), or no differences (Tavassoli and Baron-Cohen, 2012). Those findings are surprising as one might reason that given the evidence for hypersensitivity in other modalities (e.g. Vision: Simmons et al., 2009; Audition: Jones et al., 2009) that oversensitivity to odours would be a characteristic of autistic populations and by extension offer some evidence as to their role in the wider possible relationship between autistic traits and food neophobia. However, in both of the autistic/non-autistic lines of research, there is a mismatch between the types of olfactory tests employed and whether food related odours were utilized. For this reason, the present study used a reliable and widely used test of olfactory sensitivity (Threshold detection test) together with a test of hedonics (pleasantness) and intensity; and importantly, we used a food related odour.

In the current study, individuals completed questionnaires measuring their food neophobia (FNS) and preferences for foreign cuisine, with both measures found to correlate strongly in the original study (Pliner and Hobden, 1992). We included the latter as we are interested in differences in the sense of smell and how this relates to behavioural aspects (Autistic traits) and attitudes toward food. In contrast to the FNS, attitudes toward different types of food cuisine offers a more tangible measure of food neophobia, particularly relevant to these other characteristics. Individuals then completed a measure on the degree to which they present autistic traits (Autistic Quotient, AQ); followed by a test of olfactory sensitivity for a food related odour. It was expected that Food neophobia and rejection (i.e. less preference) for foreign cuisine would be positively associated with AQ and we tentatively predicted that both of these would relate to increases in olfactory sensitivity.

Method

Participants

Fifty University students, aged between 18 and 24 (40 females) participated in the study (M = 20.4 years, SD = 4.2 years). Participants were recruited using an online system where the study was advertised as examining factors that influence our sense of smell. Participants with respiratory conditions (i.e. asthma) were advised not to take part due to possible adverse effects. All participants reported good health and free from any colds that may have affected their ability to smell. Participants gave written informed consent and the study protocol was given ethical approval from the department's ethics committee (British Psychology Society guidelines, consistent with the declaration of Helsinki).

Design

The study used a regression design exploring the following variables: Autistic Quotient (AQ), Food Neophobia Scale (FNS), Preference for Foreign Cuisine (PFC) and olfactory measures (threshold/intensity/pleasantness).

Materials

Food Neophobia Scale (FNS)

The FNS consisted of ten items (Pliner and Hobden, 1992). This measured the likelihood of avoiding new foods in different situations. Responses were made on a Likert scale of 1 (Strongly disagree) to 7 (Strongly agree) for all items. Half of the items were positive statements towards food such as “I am constantly sampling new and different foods.” The other half consisted of negative statements towards food such as “I am afraid to eat things I have never had before.” Ratings from the positive items (1, 4, 6, 9 and 10) were reversed and the sum was calculated to form FNS score. Scores can range from 10 -70, with higher scores indicating higher food neophobia.

Preference For Foreign Cuisine (PFC)

Following the FNS were three additional questions that asked how often they ate foods from different countries (Chinese, Italian and Indian food). The questions were adapted from Pliner and Hobden (1992) and were found by those authors to correlate strongly with the FNS. The three cuisines were chosen as they are the most common foreign cuisine consumed in the UK. The question was “How often do you eat ‘nnn’ food?”, where ‘nnn’ was replaced with the relevant cuisine (Chinese/Italian/Indian, fixed order). Responses were made on a scale of 1 (never) to 7 (frequently). All ratings were reversed individually before summing the score, so that a high score showed that they consumed food from those cuisines less often; This scoring facilitated the comparison with other factors and in particular with the FNS. The scores on this scale can range from 3-21.

Autistic Quotient (AQ)

The AQ used was the original version for aged 16+ devised by Baron-Cohen et al., (2001) which is used to measure the level of autistic tendencies. It consisted of 50 questions made up of 10 questions covering 5 different areas: social skill (e.g. “I find social skills easy” – reversal scored), attention switching (for example “I frequently get so strongly absorbed in one thing that I lose sight of other things”), attention to detail (e.g. “I tend to notice things that others do not”), communication (e.g. “I enjoy social chit chat” – reversal scored) and imagination (for example “I find making up stories easy” – reversal item). The responses for all questions were: definitely agree, slightly agree, slightly disagree and definitely disagree, 1 point was scored when the response was either definitely/slightly in the autistic behaviour items. Any other responses were scored 0. The sum of this score was the final AQ score. The scores can range from 0 – 50. A high score represents a high number of autistic tendencies.

Olfactory Threshold Test

The odour used for the threshold test was a sweet smelling chocolate odourant (Code 0679, Anglo brands, UK) used in previous work (Stafford and Whittle, 2015) which was diluted in propylene glycol (Fisher Scientific, UK). The odourant was prepared using sixteen 250ml squeeze bottles, in 16 dilution steps, starting at 0.125% (Step 1) with each successive step diluted by a factor of two using serial dilution to the lowest (Step 16) dilution. In addition to the odour containing bottles, for each dilution step, two ‘blank’ squeeze bottles (containing dilutant only) were used in the threshold test. Testing commenced by asking participants to smell the bottle with the highest concentration to familiarise themselves with the target odour. They were then presented with the triplet containing the weakest concentration. Following presentation of the last bottle of the triplet (counterbalanced), participants were asked which bottle contained the odour (1, 2 or 3). If the participant answered correctly (and it was the lowest concentration), they were presented with the same triplet again (in a different order) and the task repeated until they made a mistake, which resulted in the triplet containing the next concentration step being presented. Using a single up-down staircase system, this was then repeated until there were seven ‘turning points’, with the mean of the last four points determining the threshold for the individual. Each bottle was held under the participant’s nose (≈ 2cm) and gently waved between each nostril to ensure optimal inhalation. A blindfold was used by the participants to avoid odour identification. The experimenter wore cotton gloves (Boots the Chemist,) to reduce any cross contamination of odours.

Procedure

Prior to the experiment, participants were instructed not to consume anything apart from water two hours before the experiment, this also included chewing gum, sweets and cigarettes. They were also told not to wear any perfume/aftershave or use any other strong smelling soaps, to ensure they were only smelling the odourant. The study took place within the University’s Department of Psychology. The room used for the study was large and well ventilated to avoid other odours in the room affecting the results of the odour test. Participants completed an informed consent form followed by ratings of how hungry they felt using a Visual Analogue Scale (VAS) of a 100mm unmarked line labelled “not at all” and “extremely” at either end. Hunger ratings were taken as some previous research has shown that level of hunger can influence olfactory sensitivity (Stafford and Welbeck, 2010). They then completed the FNS and PFC, followed by the AQ. Next, they rated the intensity and pleasantness of the chocolate odour using Visual Analogue Scales (VAS), followed by the threshold test. On completion of this test, participants were given a full debriefing and thanked for their time.

Data Analyses

Preliminary analyses revealed that hunger ratings were not significantly related to olfactory threshold score and were therefore excluded from further analyses. We then completed hierarchical linear regression analyses separately for FNS and PFC as criterion variables. For each of these analyses, the same predictor variables were entered using blockwise entry, where in step 1, we used AQ, step 2: odour threshold, step 3: odour intensity, step 4: odour pleasantness. The rationale for this order was based on the study's main areas of interest together with previous research (e.g. Ashwin et al., 2014). The data were also checked to ensure they met the assumptions for regression analyses. Finally, since it was important to examine the relationship between AQ and olfactory threshold separately to their predictive utility, we completed Pearson correlation analysis. The same method of analysis was used to test the relationship between FNS and PFC as a way of validating that these two variables were measuring similar aspects of food attitudes.

Results

Participant characteristics are presented in Table 1. In terms of the AQ scores, it is worth noting that there was good variation in this sample, but all of the scores were below the '32' cut-off point for possible ASC diagnosis, as used in previous work (Baron-Cohen et al., 2001). The scores for FNS ranged from 11 to 61, with a mean value (M=31.1 SD=12.1) similar to the original study (M=34.5, SD=11.9, Pliner & Hobden, 1992); 44% (N=22) of the participants could be described as being food neophobic/high in food neophobia, using a similar cut-off point of '31', as a recent adult study (Jaeger et al., 2017).

For FNS, analyses revealed a significant positive association for AQ (Table 2), where as predicted, increases of AQ were associated with greater food neophobia. The association between FNS and Odour pleasantness approached significance ($p = .09$) and increased the predictive utility of the final model by the same magnitude. Against prediction, there was no significant association between FNS and odour threshold.

In contrast, the regression for PFC demonstrated that olfactory threshold was negatively associated with this measure ($p = .002$) (Table 3), suggesting that increases in olfactory sensitivity were associated with increasing preference (i.e. lower dislike) for foreign cuisine.

We completed correlational analyses to understand the relationship between AQ and Olfactory threshold and separately FNS and PFC. For the former, against our prediction, this revealed no significant relation, $r(50) = .11$, $p = .43$, whereas the expected association between FNS and PFC was significant, $r(50) = .33$, $p = .02$.

Discussion

We found that increases in AQ scores were associated with increases in food neophobia, which supports the prediction that people with higher autistic traits are more reluctant to try new foods. This finding extends previous work in children and young adults with autism (Beighley et al., 2013; Kuschner et al., 2015) by demonstrating that in the wider adult population, autistic traits are associated with higher food neophobia. To date, increased food neophobia has been associated with a range of personality measures including higher trait anxiety; lower sensation seeking (Pliner & Hobden, 1992; Frank & van der Kaauw, 1994). Separately, research has demonstrated that both trait anxiety and low sensation seeking are also related to increases in AQ (Horder et al., 2014; Romero-Martínez et al., 2015). Since we found in the present study that both food neophobia and autistic tendencies are positively related in a non-autistic population, this suggests that this is part of a wider behavioural trait, where those more inclined toward aspects including behavioural rigidity, have a narrower dietary repertoire. In terms of the wider implications of this finding, it may be of applied importance when looking at ways of changing attitudes toward food neophobia, including children; whereby in addition to existing interventions (Wardle et al., 2003) it might be more fruitful to adapt some aspects from the autistic research domain, including individualized reinforcement interventions (Koegel et al., 2012).

We also found that preference for foreign cuisine was inversely related to olfactory sensitivity; individuals exhibiting lower preference for foreign cuisine had poorer olfactory sensitivity. To our knowledge, this is a novel finding and concords with work where odour identification was poorer in those individuals categorised as food neophobic (Dematte et al., 2013). This could be be related to a reduced sniff magnitude in those individuals less willing to try novel foods, as has been found in previous work (Raudenbush et al., 1998). In these populations, this could be part of a reduced desire (or indeed heightened protection) in smelling unfamiliar foods (Raudenbush et al., 1995). In the present study, the consequence of less engagement with sniffing the test odour would likely be poorer performance in the odour detection test, as suggested in some previous work (see review Mainland & Sobel, 2006). From the opposite perspective, as theorised elsewhere (Dematte et al., 2013), it could be that individuals who were more likely to try novel food cuisines would necessarily sample more food related odours and on that basis be more accurate in food odour identification. Of course, as with the current study, one cannot rule out the possibility that rather than food neophobia directly influencing odour performance it could be that those that have a better sense of smell are less food neophobic; hence the direction of the association is unclear. Evidence is therefore needed that some period of exposure or training leads to a demonstrably better sense of smell. In this vein, one study has shown that students of wine tasting had better identification for a range of general odourants compared to controls (Marino-Sanchez et al., 2010). In earlier work, we also found that individuals' performance on an odour threshold test similar to the current study, improved on a second session (Stafford and Welbeck, 2010). These two studies suggest that greater exposure or odour training may increase odour performance. This also chimes with animal work where mice exposed to an odour during an active learning phase showed greater activity in the olfactory related regions of the brain (Abraham et al., 2014).

It also needs to be acknowledged that the finding in the present study was specifically between neophobia for 'foreign cuisine' and olfactory sensitivity, whereas the previous study's finding was between the FNS and odour identification (Dematte et al., 2013). Since we also found that the two scales (FNS/PFC) were correlated in the current study, it is unclear why a similar

FNS/olfactory sensitivity association was absent. One possibility is that, had we used a larger sample as that work (n=167) with more variation in FNS scores, the association would have reached statistical significance. Additionally, it is important to recognise that the finding itself be treated with caution, since the measure is based on foreign cuisines (Chinese/Italian/Indian) that are in fact common here in the UK and therefore limiting their usefulness as a measure of 'novel' types of food. Interestingly however, the range of responses on this measure did show reasonable variability [from high preference (3) to low preference (18)] which is essential for any measure; and additionally, the scale did correlate with FNS. It also needs to be considered that selecting more unusual cuisines (e.g. Moroccan, Vietnamese) might run the risk of floor effects with minimal variability. Nevertheless, achieving a balance between low/high novel cuisines would be useful in future research.

The finding that AQ scores did not relate to olfactory sensitivity was interesting and consistent with some previous work (Tavassoli and Baron-Cohen, 2012) that compared sensitivity to a non-food odour between individuals with ASC and controls. Interestingly however, one study did find in a ASC sample (n=17) that AQ scores were positively associated with greater olfactory performance (Ashwin et al., 2014). In that work, performance was measured using the Alcohol Sniff Test, where the distance at which the odour could be detected was the dependent variable. It is therefore possible that the contrasting findings are explained by the different olfactory tests used. Nevertheless, given that the olfactory test used in the current study is a more standardised and widely used measure of olfactory sensitivity (Hummel et al., 2007), together with the use of a food related odour, all suggest that olfactory sensitivity is unlikely to play a central role in the association between AQ and food neophobia; though clearly more work is needed to support this theory.

In terms of study limitations, since the study here used a predominantly female sample, it is unclear if the same results would be seen with a larger number of males. Given that ASC is more prevalent in males (Fombonne et al., 2011), it is possible that males' AQ scores would be higher than females and provide a greater range and ability to examine the questions in the present study. Interestingly however, in the study here, the comparison of AQ scores between males and females was not significant ($p > .35$), making that possibility unlikely. Related to this point, it needs to be acknowledged in the present study, that although there was good variability in the data, none of the individuals' AQ scores reached the level for diagnoses and hence future research is recommended to see if the present findings apply equally to a wider sample.

In summary, we found that in a student sample that increases in autistic traits (AQ) were associated with higher food neophobia (FNS) and that olfactory sensitivity was greater for those with a greater preference (less neophobic) for foreign cuisines. These findings point toward the importance of further research on autism and dietary preferences.

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Table 1. Mean Participant Characteristics

	Mean	SD	Range
Age	20.4	4.2	18
FNS	31.1	12.1	50
PFC	9.6	3.7	15
AQ	17.1	5.3	25
Hunger	38.8	27.9	96
Threshold	5.9	3.6	13.5
Pleasantness	65.5	21.9	85
Intensity	44.7	22.9	86

FNS=Food Neophobia Scale; PFC=Preference for Foreign Cuisine; AQ=Autistic Quotient

Table 2. Effects Of AQ, Odour (Threshold, Intensity, Pleasantness) On Food Neophobia Scale Scores

Variable	R Square	F Change	Standardized (beta) coefficients	*t*-value	*p*-value
Model 1	.20	11.87			.001
AQ			.45	3.45	.001
Model 2	.20	.01			.92
AQ			.45	3.40	.001
Odour Threshold			.01	.11	.92
Model 3	.22	1.06			.31
AQ			.43	3.20	.002
Odour Threshold			.002	.01	.99
Odour Intensity			.14	1.03	.31
Model 4	.27	2.99			.09
AQ			.43	3.30	.002
Odour Threshold			.013	.09	.92
Odour Intensity			.13	.99	.33
Odour Pleasantness			.22	1.73	.09

Table 3. Effects Of AQ, Odour (Threshold, Intensity, Pleasantness) On Preference For Foreign Cuisine

Variable	R Square	F Change	Standardized (beta) coefficients	*t*-value	*p*-value
Model 1	.02	.74			.40
AQ			.12	.86	.40
Model 2	.20	10.99			.002
AQ			.07	.56	.58
Odour Threshold			-.44	-3.31	.002
Model 3	.21	.33			.57
AQ			.06	.46	.65
Odour Threshold			-.44	-3.30	.002
Odour Intensity			.08	.57	.57
Model 4	.21	.06			.81
AQ			.06	.46	.65
Odour Threshold			-.44	-3.28	.002
Odour Intensity			.08	.56	.58
Odour Pleasantness			.03	.24	.81