Running title: Sensory sensitivity, anxiety and selective eating

Relationships between sensory sensitivity, anxiety and selective eating in children

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Abstract

The present study examines whether parental reports of child selective eating are associated with child anxiety and sensitivity to sensory stimuli in their environment. Parents of 95 children aged 5-10 completed questionnaires about child eating behavior, child anxiety and sensory sensitivity. Results indicated that both anxiety and sensory sensitivity were associated with selective eating. In addition, child sensory sensitivity fully mediated the relationship between anxiety and selective eating in children suggesting that it is greater sensitivity to sensory information which explains why more anxious children are more likely to be selective eaters. Further research is necessary to better understand these relationships and indicate whether gradual exposure interventions with children who are sensory sensitive may help to prevent or reduce selective eating.

Keywords: selective eating, food fussiness, picky eating, sensory sensitivity, child, anxiety

INTRODUCTION

Selective eating (also known as picky or fussy eating) in children can be defined as the consumption of "an inadequate variety of foods" (Galloway, Fiorito, Lee & Birch, 2005, p542). Selective eating is a common complaint reported by many caregivers (Mascola, Bryson & Agras, 2010; Carruth, Ziegler, Gordon & Barr, 2004) which can have significant adverse effects for child dietary variety (Galloway et al., 2005) weight gain (Wright, Parkinson, Shipton & Drewett, 2007; Dubois, Farmer, Girard, Peterson & Tatone-Tokuda, 2007), health and general well being (Jacobi, Schmitz & Agras, 2008). Selective eating, like other feeding problems, can also create a significant amount of stress and anxiety for parents and caregivers (Hagekull & Dahl, 1987).

Research exploring the development of selective eating has focussed on the role of both the parent and the child in influencing children's eating behaviours. Selective eating has been associated with experiential characteristics such experiencing pressure to eat (Galloway et al., 2005), a shorter period of breast-feeding, and lower levels of maternal dietary variety (Galloway, Lee & Birch, 2003). In addition, more intrinsic and temperamental based child characteristics have also been shown to predict selective eating in children. For example, boys are more likely to report not eating fruits and vegetables compared to girls (Cooke & Wardle, 2005) and selective eaters have also been shown to display more temperamental difficulties (Farrow & Blissett, 2006; Hagekull, Bohlin & Rydell, 1997; Jacobi et al., 2008). Therefore, there is some indication that selective eating is associated with inherent characteristics in the child. There is starting to be some evidence, mainly from clinical reports that selective eating may be associated with child

anxiety and sensitivity to sensory information in the environment (Bryant-Waugh, Markham, Kreipe & Walsh, 2010).

Child anxiety has been shown to be a significant predictor of children's eating behaviour, being related to irregular eating patterns and food aversions in children (McDermott et al., 2008; Smith, Powell & Ross, 1955), to food neophobia (Pliner & Hobden, 1992; Galloway et al., 2003), and levels of eating psychopathology in adolescents (Raney et al., 2008). In clinical case reports of children presenting with selective eating, anxiety and obsessive-compulsive behaviours have also been found to be commonly co-morbid (Timimi, Douglas & Tsiftsopoulou, 1997; Nicholls, Christie, Randall & Lask, 2001; Williams, Gibbons & Schreck, 2005) in both feeding and non-feeding situations. Relaxation techniques are widely used to increase the range of foods eaten by clinical groups of children with severely restricted diets (e.g. Nicholls et al., 2001). The experience of anxiety in the feeding situation may cause physiological changes, such as sickness, retching and appetite suppression, as well as cognitive changes such as hypervigilance, which can cause individuals to focus on, and then avoid, the aversive or feared stimulus (Pflugshaupt et al., 2005). Obviously clinical groups are skewed on the basis that they represent the extreme end of any spectrum of behaviour, and parents may be more likely to seek help if their children have concomitant problems. However, the same pattern is observed in non-clinical samples where neophobia, or reluctance to eat new foods, has been found to be associated with child anxiety (Galloway et al., 2003).

The anticipated sensory properties of food are often cited as one of the main reasons for rejection of novel foods (Martins & Pliner, 2005), however there is increasing evidence that there are individual differences in how we perceive and evaluate sensory information.

Sensory sensitivity (also known as sensory over reactivity) can be defined according to individual differences in the detection of, and reaction to, sensory information, including information from the taste, touch, vision and smell senses (Dunn, 1999). Sensory sensitivity is believed to be an inherent characteristic (Dunn, 1999), which has been associated with physiological markers. For example, neuroimaging methods to measure the processing of sensory stimuli in the brain indicate that children with sensory processing difficulties demonstrate different brain processing mechanisms to control children (Davies & Gavin, 2007), and children with sensory processing problems are often unable to filter out responses to repeated sensory information (Davies, Chang & Gavin, 2009). In addition sensory sensitivity has been associated with other characteristics, with adults who are more sensory sensitive being described as more anxious (Liss, Timmel, Baxley & Killingsworth, 2005). The process of eating involves integration across a variety of sensory modalities and differences can be seen in individual's sensitivity to the different qualities of food, such as how bitter a food is (Bell & Tepper, 2006) and it's texture (Smith et al., 2005).

Children with higher levels of tactile and taste/ smell sensitivity have been shown to eat less fruits and vegetables and to be more reluctant to eat new foods (Coulthard & Blissett, 2009). Children who are more sensory sensitive have lower thresholds for detecting sensory information and are more able to detect subtle changes in the sensory properties of foods. Coulthard & Blissett (2009) propose that these children are more likely to reject new foods or fruits and vegetables because fruits and vegetables are vulnerable to differences in their sensory properties (e.g. variations in look or taste). It is also quite likely that children who are more sensory sensitive will be pickier eaters in response to these sensitivities and will refuse to eat more new foods, or foods that they have tasted before.

Previous research suggests that child anxiety and sensory sensitivity appear to both related to eating behaviour in children and further that anxiety and sensory sensitivity may be related in young adults (Liss et al., 2005). It is imperative that we begin to understand exactly why more anxious children are more selective about the foods that they will eat, and how it is that more anxious children process and respond to information about foods in ways that lead to food rejection. It may be that heightened sensitivity to sensory information in more anxious children may mediate the relationships between anxiety and selective eating. This understanding would provide evidence to inform future interventions with children who are selective eaters.

This study has two aims, first to explore whether parental reports of selective eating in children are related to their descriptions of child anxiety and child sensory sensitivity. It was hypothesised that children with higher levels of tactile, taste and visual/ auditory sensory sensitivity would also have higher scores on selective eating scales. It was also hypothesised that more anxious children would have higher scores on selective eating scales. The second aim was to explore whether child sensory sensitivity mediates the relationship between anxiety and selective eating in children. It was hypothesised that child sensory processing would fully mediate the relationship between anxiety and selective eating in children.

METHOD

Participants

Parents of ninety five children (ages 5-10 years) participated. Parents responded concerning 43 male and 50 female children (gender not disclosed for 2 children) with a

mean age of 7.34 years (SD=2.00). Mean child BMI z score was .13 (SD= 1.56). Ninety one of the parents were mothers and 4 were fathers[1]. Their mean age was 38 years (SD=5.10). Eighty six parents described their ethnicity as White; 5 as Black or Black British; 2 as Asian or Asian British and 2 as 'Other.' Parents reported a mean of 4.83 years of education after the age of 16 years (SD=2.82). Parental occupation (or most recent occupation prior to parenthood) was coded using the Office of National Statistics Coding Scheme (Standard Occupation Classification, 2000); parents were from a wide range of occupations ranging from category 1 (13%: Managers and senior professionals) to category 9 (2%: Elementary Occupations), with the modal occupation being category 2 (33%: Professional occupations). No parents reported that their children had medical or organic feeding concerns, or had ever been hospitalised for a feeding related problem.

Procedure

A series of schools in the Leicestershire area of the United Kingdom were invited to distribute letters and questionnaire packs to parents inviting them to take part in this research study. Approximately 250 questionnaires were distributed to parents, 98 were returned rendering a response rate of approximately 39%. Three questionnaires were removed because there were significant amounts of missing data (e.g. full subscales or complete pages unanswered). Where single items were missing the data was coded as missing in SPSS. Families were given no incentive to take part. Each pack contained a pre-paid envelope with which parents could return the questionnaire confidentially to the researcher in. Ethical approval for this research was obtained from Loughborough University Ethical Advisory Committee and the research was performed in accordance with

the Declaration of Helsinki, all participants gave informed consent to participate in this research

Measures

Each questionnaire contained a demographics questionnaire where parents reported their child's gender, birth date, weight, and height. Parents were asked to report height and weight data only if they had accurate scores and not to estimate measurements (64% of the sample provided such data). Child weight and height was converted to a BMI z score to standardise for child age and gender using the Child Growth Foundation Package (1996) which standardises to UK norms. Parents also described their age, education, occupation and ethnicity. They were then asked to complete the following questionnaires:

Short Sensory Profile (SSP; Dunn, 1999). The SSP is a 38 item, 7 sub-scale, questionnaire used to assess children's responses to sensory stimuli. Three subscales of the questionnaire were used to assess parent's perceptions of child tactile sensitivity (e.g., 'Avoids going barefoot, especially in sand or grass'), taste/ smell sensitivity (e.g., 'Avoids tastes or food smells that are typically part of a children's diet') and visual/ auditory sensitivity (e.g., 'Covers eyes, or squints to protect eyes from light'). In addition a total sensory sensitivity score was computed from the complete questionnaire. Parents respond to the items using a 5 point Likert scale, with higher scores indicating lower sensory impairment. The questionnaire has good internal and external validity (Dunn, 1999), as well as good reliability and discriminant validity in identifying children with sensory modulation dysfunction (McIntosh, Miller, Shyu & Hagerman, 1999). The SSP has been

used and validated in non-clinical as well as clinical samples of children (Tomchek & Dunn, 2007). In the present study Cronbachs alpha for the SSP as a whole was 0.97, with 0.92 for taste/smell sensitivity subscale, 0.89 for tactile sensitivity subscale and 0.90 for visual/auditory subscale.

The Spence Children's Anxiety Scale for Parents (SCAS-P: Spence, 1998). The total anxiety score on the SCAS-P was used to assess parental report of symptoms of anxiety in children. The questionnaire consists of 44 items assessed on a 3 point Likert scale with higher scores indicating greater anxiety. The questionnaire has good internal reliability, concurrent, convergent and discriminant validity (Whiteside & Brown, 2008; Essau, Muris & Ederer, 2002). In the present sample Cronbachs alpha was 0.85.

The Child Eating Behaviour Questionnaire (CEBQ: Wardle, Guthrie, Sanderson & Rapoport, 2001). The 'food fussiness' subscale from the CEBQ was used to assess parent's perceptions of their child's selective eating behaviour. This measurement consists of 6 items which assess 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. Questions are rated according to the frequency with which the child exhibits a range of behaviours on a scale from never (0) to always (5). For example: 'My child is difficult to please with meals'. The CEBQ is internally valid (α = .72 - .91) and has good test-retest reliability (Carnell & Wardle, 2007; Wardle et al., 2001). In the present study Cronbach's alpha for selective eating was .86.

Data Analyses.

The data package IBM Statistical Package for the Social Sciences (SPSS) version 19 was used to analyse the data. Descriptive statistics were first computed, the data was then analysed to establish whether child age, child BMI z scores, or child gender were related to selective eating. Pearson's 2-tailed correlations indicated that child selective eating was not significantly correlated with child age ($r=-.10$, $p>.05$), or child BMI z scores ($r=-.13$,$p>.05$), and an independent sample t-test suggested no significant gender differences in selective eating for boys and girls [$t(91)=.39$, $p>.05$]. Parental years in education and occupational code were not significantly associated with selective eating, child anxiety or sensory sensitivity (Peasron's 2-tailed correlations: all $r>.05$). Parental demographics, child gender, age and BMI were therefore not controlled for within further analyses. Next 2-tailed Pearson's correlations were used to investigate the relationships between selective eating, child sensory sensitivity and child anxiety.

Meditational analyses were used to evaluate the nature by which anxiety might influence selective eating, and specifically whether sensory sensitivity mediates this relationship. The Baron & Kenny (1986) method is the conventional psychological methodology used to test for mediation in SPSS and is well justified in the literature (e.g. Baron & Kenny, 1986). This method was chosen over bootstrapping as it is less liberal (Fritz, Taylor, and MacKinnon, 2012).

RESULTS

Descriptive Statistics and relationships with demographic variables

Descriptive statistics for the questionnaires are presented in Table I, means and standard deviations are similar to other published data (Houchhauser & Engel-Yeger, 2010; Nauta et al., 2004; Webber, Hill, Saxton, Van Jaarsveld & Wardle, 2009). [Table I about here]

Correlation analyses.

Pearson's 2-tailed correlations were used to explore the relationships between parental reports of children's sensory sensitivity, anxiety and selective eating. As indicated in Table 2, children's reports of selective eating were significantly correlated with greater anxiety, and great reports of tactile, taste and total sensory sensitivity. Children's levels of anxiety were also significantly correlated with higher levels of tactile, auditory/ visual and total sensory sensitivity. Total sensory sensitivity was correlated with tactile, taste and auditory/ visual sensitivity, and tactile and auditory/ visual sensitivity were also inter-correlated. [Table II about here]

Mediation analyses

Using the procedure outlined by Baron & Kenney (1986) meditational analyses indicated that child sensitivity to sensory information fully mediated the relationship between anxiety and selective eating in children. As shown in Figure 1: In step 1, anxiety significantly predicted selective eating (R^2=.048, $F(1,90)=4.52$, $p<.05$). In step 2 child anxiety significantly predicted child sensory sensitivity (R^2=.16, $F(1,90)=17.53$, $p<.01$). In step 3 child sensory sensitivity significantly predicted selective eating (R^2=.05, $F(1,93)=4.97$, $p<.05$). In step 4, child anxiety failed to continue to be a significant predictor

of selective eating when child sensory sensitivity was added to the regression (ß=.01, t(89)=1.18, p>.05). [Figure I about here]

DISCUSSION

The aims of this study were firstly to examine whether parental reports of selective eating behavior were related to child anxiety and child sensory sensitivity, and secondly to examine whether sensitivity to sensory information mediates the relationship between anxiety and selective eating in children. In support of the hypotheses, child anxiety and aspects of sensory sensitivity were correlated with selective eating behaviour, and further sensory sensitivity mediated the predictive value of anxiety upon selective eating in children.

Supporting the hypothesis, and previous research in this area (Timimi et al., 1997; Nicholls et al., 2001; Williams, Gibbons & Schreck, 2005), parental reports of child anxiety were associated with selective eating behavior. It is difficult to ascertain, from parental report studies, the nature of the relationship between anxiety and selective eating in children. The fact that reports of child anxiety were not focused on the feeding interaction, but on all aspects of behavior, suggests that children who are generally anxious may not approach new situations as readily, including eating a varied diet of foods. It is not yet clear whether children who are more anxious never eat a varied diet, or begin to reduce variety after 18 months, when the behavior of food neophobia becomes more common. It could also be that more anxious children show more overt behaviours of rejection and problematic mealtime behaviours. Further investigation would be required to unpack

whether the association between anxiety and selective eating is due to fear of new experiences/sensations, or behavioural difficulty at mealtimes.

It was originally hypothesised that selective eating would be associated with sensory processing, in particular sensitivity in the domains of taste/smell, tactile and visual/auditory processing. It was found that parental reports of selective eating were associated with sensitivity in taste/smell and tactile domains, but not in the domain of visual/auditory processing. This is a very similar finding to previous research, which found that food neophobia was associated with sensory sensitivity in the taste/smell and tactile domains but not in the visual domain (Coulthard & Blissett, 2009). This does not concur with the theory that children may notice small visual changes in foods and reject foods according to these changes. It may be that the questions in the visual/auditory domain of the Short Sensory Profile (Dunn, 1999) do not accurately measure differences in the ability to focus on small local changes in objects, rather sensitivity to light perception. The literature in this field indicates that children will reject foods according to visual changes, for example black marks or colour differences, and will also accept food based on colour similarities (Addessi, Galloway, Visalberghi, & Birch, 2005; Dovey, Staples, Gibson, & Halford, 2008; Harris, 2000). However, it may not be the ability to detect these changes which influences acceptance of new/ altered foods, but the cognitive expectation of what these changes mean.

There has been little research to examine the association between anxiety and sensitivity to sensory information; however, there is some indication that they may be strongly associated to one another in research with adults (Liss et al., 2005). The findings of the present research suggest that anxiety and sensory sensitivity in children are

intercorrelated, and furthermore that sensitivity to sensory information mediates the impact of child anxiety upon selective eating behavior. These findings are novel and begin to help to explain why it is that more anxious children are more likely to be selective eaters. It is well established that children with feeding problems often experience elevated anxiety, as do their parents (Coulthard & Harris, 2005; Galloway et al., 2003), but it is not yet clear how children with heightened anxiety process information about food or why they often respond negatively to foods. These findings suggest that co-morbid sensory sensitivity may help to explain these relationships. The characteristics of sensory sensitivity (e.g., noticing small perceptual changes, a tendency to respond negatively to change) may be markers of higher child anxiety which then predict greater negativity in the context of food.

Whilst the findings of this research add to the important body of knowledge concerning the aetiology and development of selective eating in children, this research is not without its limitations. The sample size is relatively small and the data collected was cross sectional and based on parental report, further research in needed using longitudinal and experimental designs to replicate these findings and develop our understanding of these relationships. In addition, the sample was self-selected and thus may be biased by a greater interest in child eating than the general population.

Despite these limitations, this research does strengthen the finding that there are child contributors to problematic feeding behaviour, and these may be based in inherent characteristics of the child. Little is known about the developmental pathway to child anxiety or sensory sensitivity, or how they relate to how the child is provided with sensory stimulation by those around it. It may be that the physiological and cognitive experiences that result from anxiety (e.g., hypervigilance, sickness, reduced appetite; Pflugshaupt et al.,

2005) may heighten sensory sensitivity and predict disgust or avoidance responses to food in children. Further research is necessary to explore how and why greater anxiety and sensory sensitivity may develop and how their development may be informed by specific experiences with food or exposure to overly controlling or aversive caregiver feeding practices (e.g., child chocking, parent force-feeding). Both parental anxiety and parental feeding practices which have been shown to impact upon child feeding and eating (Farrow & Blissett, 2008; 2009) and these factors may moderate or exacerbate the effects of child anxiety or sensory sensitivity upon selective eating. It is likely that exposure to subtle changes in sensory information will gradually desensitise sensitive, anxious children, and increase their acceptance of different sensory experiences. Recent research has begun to explore how exposure may strengthen child intake and whether this relationship may depend upon variety in the child's diet, as well as the properties of particular foods (Williams, Paul, Pizzo, & Riegel, 2008). Further clinical work in this area is needed to explore pathways to develop appropriate interventions for children who are selective eaters.

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Footnote:

[1] The results remain consistent if the analysis is repeated excluding fathers and using mothers only.

Table I: Mean and standard deviation scores for selective eating, sensory sensitivity and anxiety

Measure	Mean	Standard Deviation
Selective eating	1.76	.75
Sensory sensitivity		
Tactile sensitivity	32.71	2.57
Taste/smell sensitivity	17.93	2.57
Visual/ auditory sensitivity	22.38	2.93
Sensory sensitivity total	166.61	14.55
Anxiety	16.42	8.59

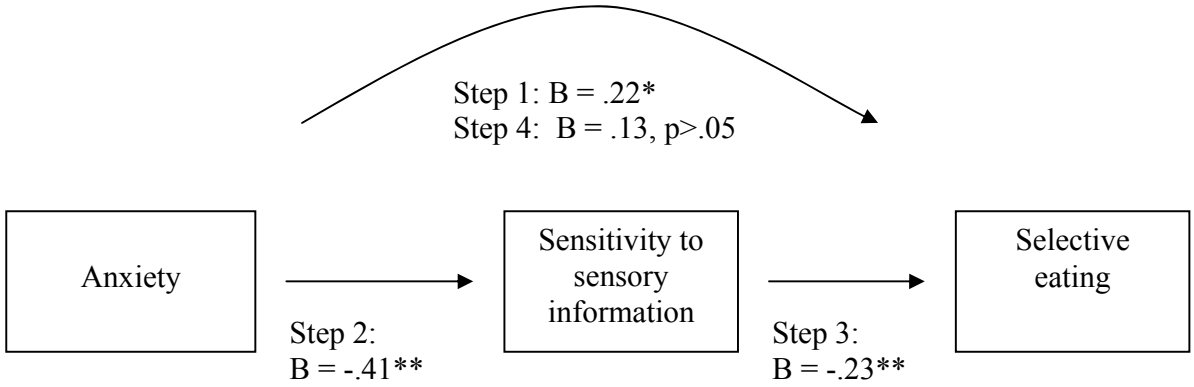
Note Selective eating is defined as 'food fussiness' in the measure used.

Table II: Correlations between selective eating, anxiety and sensory sensitivity

	Selective eating	Anxiety	Tactile sensitivity	Taste sensitivity	Auditory/ visual sensitivity
Selective eating	----	----	----	----	----
Anxiety	.219*	----	----	----	----
Tactile sensitivity	-.281**	-.281**	----	----	----
Taste sensitivity	-.565**	-.183	.103	----	----
Auditory/ visual sensitivity	-.011	-.454**	.240*	.131	----
Total sensory sensitivity	-.225*	-.404**	.507**	.333**	.708**

Note: Items on the sensory profile are negatively coded, thus lower scores indicate greater sensory sensitivity.

Selective eating is defined as ‘food fussiness’ in the measure used.



* $p < .05$, ** $p < .01$.

Figure 1

A graphical depiction of the relationship between child anxiety and selective eating, with sensory sensitivity as a mediator